CHEMICAL HERITAGE FOUNDATION

MARVIN MARGOSHES

Transcript of Interviews
Conducted by

Michael A. Grayson

at

The Chemical Heritage Foundation
Philadelphia, Pennsylvania

on

6 April 2011

(With Subsequent Corrections and Additions)

CHEMICAL HERITAGE FOUNDATION
Oral History Program
FINAL RELEASE FORM

This document contains my understanding and agreement with the Chemical Heritage Foundation with respect to my participation in the audio- and/or video-recorded interview conducted by Michael Grayson on 6 April 2011. I have read the transcript supplied by the Chemical Heritage Foundation.

1. The recordings, transcripts, photographs, research materials, and memorabilia (collectively called the "Work") will be maintained by the 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 the 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 recording(s) heard/viewed by scholars approved by the Chemical Heritage Foundation unless restrictions are placed on the transcript as listed below.

This constitutes my entire and complete understanding.

(Signature) Marvin Margoshes
Marvin ~~X.~~ Margoshes

(Date) 6/28/2013

OPTIONAL: I wish to place the following restrictions on the use of this interview:

____

____

Regardless of any restrictions that may be placed on the transcript of the interview, the Chemical Heritage Foundation retains the rights to all materials generated about my oral history interview, including the title page, abstract, table of contents, chronology, index, et cetera (collectively called the "Front Matter and Index"), all of which will be made available on the Chemical Heritage Foundation's website. Should the Chemical Heritage Foundation wish to post to the Internet the content of the oral history interview, that is, direct quotations, audio clips, video clips, or other material from the oral history recordings or the transcription of the recordings, the Chemical Heritage Foundation will be bound by the restrictions for use placed on the Work as detailed above. Should the Chemical Heritage Foundation wish to post to the Internet the entire oral history interview during my lifetime, I will have the opportunity to permit or deny this posting.

I understand that the Chemical Heritage Foundation will enforce my wishes until the time of my death, when any restrictions will be removed.

This oral history is designated **Free Access**.

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

> Marvin Margoshes, interview by Michael A. Grayson at The Chemical Heritage Foundation, Philadelphia, Pennsylvania, 6 April 2011 (Philadelphia: Chemical Heritage Foundation, Oral History Transcript # 0697).

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

MARVIN MARGOSHES

1925	Born in New York, New York, on 23 May

Education

1950	B. S., Polytechnic Institute of Brooklyn, Chemistry, *cum laude*
1953	Ph.D., Iowa State College, Physical Chemistry

Professional Experience

	Harvard Medical School
1954-1957	Research Fellow and Research Associate, Biophysics Research Laboratory, Peter Bent Brigham Hospital
	National Bureau of Standards
1957-1969	Spectrochemical Analysis Section, Analytical Chemistry Division
	Digilab, Inc. (Block Engineering, Inc.)
1969-1970	Project Manager
	Technicon Instrument Corporation
1971-1989	Director, Chemical Instrumentation, Corporate Research; Manager, Program of Grants for Research on Scientific and Industrial Instrumentation
	Techtransfer Service, Inc.
1990-1993	President

Honors

1953	First Annual Phi Lambda Upsilon Award for Graduate Research, Iowa State College
1964	Department of Commerce Merit Award
1969	Department of Commerce Merit Award
1971	Outstanding Member Award, Baltimore-Washington Section, Society for Applied Spectroscopy
1976	Society for Applied Spectroscopy Gold Medal
1998	Distinguished Service Award, Society for Applied Spectroscopy

ABSTRACT

Marvin Margoshes grew up in New York City, New York, one of three children. His parents had left the Austro-Hungarian Empire, his father from Galicia and his mother from Hungary, and had met as members of a Zionist organization. Margoshes's father, though he did not finish high school and only obtained a GED when he was sixty, helped organize the national dental laboratory business and founded a school for technicians. Margoshes himself was always interested in science, settling on chemistry when he was at Brooklyn Technical High School. After high school Margoshes worked in a chemistry lab at New York University Medical School until he enlisted in the U.S. Army. The Army sent him to become an instrument technician in Kalamazoo, Michigan, but he was soon sent on to the Pacific theater, where he fought in the Battle of Leyte and the Battle of Okinawa. He describes his experiences in battle, in typhoons, and with pygmies on Mindoro.

Finally back from war, Margoshes enrolled at Brooklyn Polytechnic Institute, intending to major in chemistry, though he also liked physics. For a PhD Margoshes entered Iowa State University, where his advisor, Velmer Fassel, assigned him to run an infrared spectroscopy lab with George Hammond. For fun in Ames, Iowa, Margoshes and his classmates bowled, worked crossword puzzles, and ate all they could at buffets. Margoshes then moved on to Harvard University, where he was a research fellow. He also had an unpaid job in flame spectroscopy at Massachusetts Institute of Technology, and worked with Bert Vallee on a study of cadmium as a cause of hypertension; this work required rapid transfer of kidneys to the lab, first from human cadavers and then from horses. The invention of the AutoAnalyzer, which provided a profile of blood results; previous methods performed only one test at a time.

Margoshes began work in the analytical chemistry spectrometry group of Bourdon Scribner at the National Bureau of Standards (NBS). At the NBS he worked with cyanogen and spent a year studying Russian, as most of the work published about cyanogen was in that language. Stanley Rasberry worked with Margoshes on inductively coupled plasma with argon, while Fassel used helium; he also worked with Rasberry on the first laser probe. Margoshes began computer work using the time sharing computer; he invented a coenzymometer (DetermiTubes), which he says had a good run; and he had an idea for a glucose analyzer but could not sell the idea to Technicon.

After nearly twenty years at NBS Margoshes went to work at Block Engineering, doing Fourier transform analysis with Tomas Hirschfeld. After just two years he moved to Technicon. Morris Shamos liked Margoshes and recognized his scientific knowledge and ability. He put Margoshes in charge of a program that offered grants for projects with a commercial value. Margoshes felt this was the perfect job for him: he became known as the "company skeptic" because his extensive knowledge allowed him to understand and evaluate proposals. Technicon was sold several times; when Bayer AG acquired it Margoshes quit because Bayer refused to do business in Israel.

During the course of his career, Margoshes performed an analysis of sodium for United Fruit Company, who wanted to emphasize the importance of bananas in a low-sodium diet; that article was published in *New England Journal of Medicine*, a fact of which Margoshes is proud; he also analyzed potassium in bananas and discovered its importance for astronauts. He has written the chapter on emission spectroscopy in *Treatise on Analytical Chemistry*, as well as a chapter (with Donald Burns) on automation. In addition he has been review editor of *Analytical*

Chemistry, and admits that he is not immune from editors' annoying criticisms of his own writing.

At the end of the interview, Margoshes moves on to a discussion of the evolution of electronics, the development of small instruments, and the size and power of computers. He explains demand-pull and science-push and how users, wanting to improve instruments, often change their purpose. He talks about his experiences on the school board in Tarrytown, New York. Throughout the interview Margoshes stresses the importance of broad general knowledge. His mantra is that there is no such thing as useless knowledge, and he gives several examples. His advice to young people is not to specialize too much, as everything changes, often rapidly. He talks about his patents and his experiences getting patents, which he says are like puzzles. He explains a little about his work with the echelle spectrometer and noise in Fourier infrared and emission spectroscopy. He considers his plasma jet work his most significant.

INTERVIEWER

Michael A. Grayson retired from the Mass Spectrometry Research Resource at Washington University in St Louis in 2006. He received his B.S. degree in physics from St. Louis University in 1963 and his M.S. in physics from the University of Missouri at Rolla in 1965. He is the author of over forty-five papers in the scientific literature dealing with mass spectrometry. Before joining the Research Resource, he was a staff scientist at McDonnell Douglas Research Laboratory. While completing his undergraduate and graduate education, he worked at Monsanto Company in St. Louis, where he learned the art and science of mass spectrometry under O. P. Tanner. Grayson is a member of the American Society for Mass Spectrometry [ASMS], and currently is the Archivist for that Society. He has served many different positions within ASMS. He has served on the Board of Trustees of CHF and is currently a member of CHF's Heritage Council. He continues to pursue his interest in the history of mass spectrometry by recording oral histories, assisting in the collection of papers, researching the early history of the field, and preparing posters recounting historic developments in the field.

TABLE OF CONTENTS

INTERVIEWEE: Marvin Margoshes

INTERVIEWER: Michael A. Grayson

LOCATION: The Chemical Heritage Foundation
Philadelphia, Pennsylvania

DATE: 6 April 2011

GRAYSON: […What I] normally do, is I start with saying what it is we're about here. My name is Michael A. Grayson. This is the 6th of April 2011. I'm interviewing Dr. Marvin Margoshes at the Chemical Heritage Foundation in Philadelphia, [Pennsylvania]. We're going to talk about his scientific career, and his observations of the development of instrumentation over the years. I believe he wants to start with a preliminary statement about what we're going to do, and then we'll go ahead and get into the details. So, Marvin, why don't you go ahead and tell us about your plan for the interview.

MARGOSHES: Okay. This is not so much about me, as it is about three instrument revolutions that took place starting about 1930, when [the] first electronic instruments were developed. Then the next one started about the mid-1960s, when we began to computerize instruments. The third one which is still going on, started in, I guess, the 1990s, to keep making instruments smaller and smaller. It's [about] my experience going through these three stages and how it affected me as an individual, and I observed it generally.

GRAYSON: Okay. So, with that kind of preamble, I'd like to go ahead and get a little bit of background on Marvin, and how he got involved in science. Normally, we start by talking a little bit about his parents, their names, when he was born. So, what were the names of your parents?

MARGOSHES: Well, my father was Israel Margoshes. He was born in what was then a part of the Austrian-Hungarian Empire. That region was called Galicia. It's now part of Ukraine. Borders keep changing every time there's a war. My mother was born also in the Austrian-Hungarian Empire, but in Hungary […].

GRAYSON: No problem.

MARGOSHES: It's called "tip of the tongue" syndrome, actually. They both came over here with their families, when my father was a teenager and my mother was about eight or nine years old.

GRAYSON: What was her name?

MARGOSHES: Her name was Lillian Lenorowitz. My wife found the ship's register they came over on. The ship's register, all the names were Hungarian names. They came to Ellis Island […], they kept the family name, but changed the first names. We could figure out who everybody was by the age progression.

GRAYSON: Oh, okay.

MARGOSHES: Any rate, they met in a Zionist organization, and in fact, they're now buried with members of that same organization.

GRAYSON: Were they motivated to leave their homeland by anything other than wanting to come to the United States? Or, was there some kind of a pogrom or…

MARGOSHES: No. It wasn't a pogrom. The Austrian-Hungarian Empire didn't let that happen. But the opportunities weren't there. You know, in America the streets were paved in gold, metaphorically. That's what brought over this huge migration starting in the late 19th century and going through about the period of World War I. For some of them, it was not great, but it was better than [what they had].

GRAYSON: You were about to say that they met in this organization and got married, but that would have been, what, the early 1920s?

MARGOSHES: Well, my brother [Monroe (Monty) David Margoshes] was born in 1920.

GRAYSON: Oh, okay.

MARGOSHES: So, probably shortly after World War I. I'd have to look that up.

GRAYSON: What did they do for a living in the country?

MARGOSHES: Well, my mother was…until she was married when women stopped working typically. She […] worked for a company making fancy hats. She was very good at needlework and so on. My father <**T: 05 min**> got into the dental laboratory business. He and a partner had what was then the largest dental laboratory in New York City, [New York]. He organized the dental laboratory business first in New York State, then nationwide. So, the national organization still gives an annual Israel Margoshes Award.

GRAYSON: Oh, okay.

MARGOSHES: Yeah. He also founded the first school for dental technicians. [Until] then, it was…you were hired to pick up stuff from the dentist and bring [the] finished work back to the dentist. In your spare time you hung around the lab and watched what people were doing and you start picking things up. He felt this wasn't adequate, that they really ought to learn some of the science behind the materials they're working with. So he set up a program in the Brooklyn Community College. It was a two-year program. They learned about metallurgy and plastics and all those things. They put him on the board of the community college, and he never finished high school. It wasn't usual in those days.

GRAYSON: Right.

MARGOSHES: […] So, he went and got a General Equivalency Diploma when he was about sixty years old. [He thought it would look] a little better. He at last had his high school diploma.

GRAYSON: Yeah. So, as a parent then, education was something that was valued. I mean, the idea that he would start a school to help people learn how to do this and the science behind it.

MARGOSHES: My father's family, his oldest brother [Samuel Margoshes] had a Ph.D. from Columbia University. His youngest brother had a law degree from NYU [New York University] because for what they wanted to do that was important. My mother's youngest brother [Louis (Lou) Lenore] went to Cooper Union [for the Advancement of Science and Art]. They, I think, still have a program where high school juniors are given a very strict exam. If they pass, they're through with high school. They go directly to Cooper Union. No tuition charges. He came out with a degree in engineering and never worked at it, because nobody would hire a Jew then. But he had that education. It was…they were interested in education when it was needed, not education for its own self.

GRAYSON: And Cooper Union is the school located in…

MARGOSHES: They're located on…the main headquarters in Manhattan, [New York], on Broadway, about 8th Street, I think it is. The famous Hall, where—you know, it's still there—where so many people gave important addresses there. And it's still a very good engineering school.

GRAYSON: So, you mentioned that you had a brother, an older brother…

MARGOSHES: Yeah.

GRAYSON: Was the family very large, or did you have…

MARGOSHES: No. I have a younger sister [Sally Rose Goldblum]. My brother [Monty] passed away just about a year ago. He went into the dental laboratory business with my father. He was very good at gold work, especially. My father would have loved me to go that way, but I really wasn't interested.

GRAYSON: Okay. And you had a sister that's younger.

MARGOSHES: Yeah. She went to Barnard College. When she was married…her husband was [a] Merchant Marine officer, but he [knew as] a married man he'd be away from home too much…

GRAYSON: Yeah.

MARGOSHES: So, he dropped out. Then they went into the insurance business and they moved down to Houston, [Texas], to set up their own agency there. Now she lives in Washington. Her husband died about fifteen years ago. She met a wonderful guy from Washington who turns out was friendly with [people we are] friendly with.

GRAYSON: Oh.

MARGOSHES: Okay. But we never knew him when he was down there.

GRAYSON: So, in your family, you were…the education that you received was…and it was important to be educated. Your parents valued the idea of education. It's apparent. What happened? Where did you go to high school and […] did you have any interactions in high school with teachers that you found were interesting or exciting or fun? Or…

MARGOSHES: Well, I was very lucky in high school. In elementary school, I was an underachiever. I was bored because…not that I'm a genius, but I'm a fast learner. And of course, the teacher can't stop teaching […] a subject when [only] the fastest one in the class wants to move ahead. <**T: 10 min**>. So, I knew that, and I knew the subject and the rest of it; I was just sitting there. Then I got into the junior high school program, which in New York at that time, was covering seventh, eighth, and ninth grades in two years. But I still—was a little less bored—but still pretty bored.

I still remember the day when the principal of the junior high school walked in. He said, "Who wants to try out for Brooklyn Tech [Brooklyn Technical High School]?" I'd never heard of Brooklyn Tech, but I recognized, "It's a way out of here." Okay. So, I raised my hand. I took the exam, and it's one of the city's—still is one of the city's—very selective high schools. The year I took the exam, one of out of eight were accepted, which I understand is still pretty much the proportion, and suddenly I wasn't the bright guy in the class anymore. There were some very good teachers. There were also some teachers that weren't so good. But, the students learned from each other. I think this is part of the reason for going to one of the prestigious schools that are very selective about who they took.

GRAYSON: At what age did this occur? Probably about 15, 17, somewhere…

MARGOSHES: Well, I graduated from there a few months before my eighteenth birthday.

GRAYSON: Eighteen, you graduated…

MARGOSHES: [It was] such a big school they had graduation in June, also in January. I graduated in January. It was January 1943. The war was on. Almost anybody with skills was either drafted or working in the defense industry, and because of that situation, because I'd taken every chemistry class I could (I was already turned on by chemistry) I actually got a job as chem lab technician at the NYU Medical School, and [I was being] paid twenty dollars a week.

GRAYSON: Wow.

MARGOSHES: So I was doing chemistry and getting paid for it.

GRAYSON: So, let's back up a little bit. When did you get turned onto chemistry? What was it that got you excited about chemistry?

MARGOSHES: Well, I got interested in science generally. And I guess it was during high school that I really focused in on chemistry. Our house had a finished basement that wasn't used much, so I took it over for my chemistry lab. You could go to the main chemistry supply house, which was in Manhattan near NYU, and walk in. Even as a kid, I could walk in and buy whatever I needed in small quantities. I need two beakers and six feet of glass tubing, and, you know, a small container of this chemical, and I'd get it. I ran through the chemistry set very quickly. That wasn't enough fun.

GRAYSON: You did have a chemistry set though.

MARGOSHES: Yeah. I had a chemistry set. I have a cousin who is a little older than me, and he got one first. When he got it, I was visiting there, and we set it up on his bed and ruined the brand new bedspread that his mother had bought. She was not happy about it. [But my parents were] very tolerant [with] this. I started like lots of people. Growing crystals is fun. I needed a big flat container and my mother let me use [this beautiful] cut glass [bowl] to grow crystals, which we now own. But that was a kind of tolerance. You know, those things, crystal glass and beautifully cut…

GRAYSON: Oh, yeah.

MARGOSHES: It had to be valuable. And she let me grow crystals in it.

GRAYSON: Wow. That is fairly tolerant. So, once that you, kind of, worked your way through the chemistry set, you decided to branch out on your own by just doing other chemistry experiments that came to mind? Or did you read about these some place? Or, how did you get…

MARGOSHES: Well, I think a lot of it was just things that I'd heard about or read about somewhere, without directions, which was very fortunate, because at one point I decided I'd get nitrobenzene. But I didn't know you needed sulfuric acid, so I never did it. Just as well. [laughter] So, I did things like that, and never had any major disasters, just stunk the place up.

GRAYSON: It seems [that] just about every teenager who does chemistry ends up having some kind of an event that causes [a little bit of] consternation in the family. So, you're already turned on to chemistry and you're **<T: 15 min>** graduating from high school. You're employed, gainfully employed at the NYU Medical School. What specifically were you involved in at that time?

MARGOSHES: Well, at that time, the first year medical students had to take a lab. They were supposed to learn how to do their own laboratory tests. My job was to set up those experiments, and related jobs. They'd get in for research a shipment of mice, and I had to put those mice in separate cages. Those little things, you know, you had a box full of them, and you're trying to grab a tail, and they're trying to bite you.

Then, some of the experiments they needed urine for, so I had a big carboy I had to take into the men's room and set up there for everybody to pee in. Then, when it's full, I had to take it out. That wasn't so fun. Labs then had wooden bench tops and they had to be periodically treated, which [means] you rubbed them down with linseed oil and then went over them with a hot iron. So, it wasn't all playing with chemicals, but I got to do that.

GRAYSON: How long did this last?

MARGOSHES: Well, it went on till June. My birthday's late May. I'd decided, [don't] wait for the draft. I'll go sign up. What I had in mind, though, is I knew the Army had a program called ASTP, where they were sending young people to college. I thought, I'd love to get into that.

GRAYSON: What does ASTP stand for?

MARGOSHES: Army [Specialized Training] Program, something like that.

GRAYSON: Okay. But, it was well known that they had this program.

MARGOSHES: Right. What they were doing with medical students, they were drafting all the medical students and then sending them right back to college, and now the Army was paying tuition, but they wanted them the minute they […] got out of medical school.

GRAYSON: They came out of medical school.

MARGOSHES: Yeah. But so, I went into the Army and they sent me down to Biloxi, Mississippi, for my training in the summer. The heat was the hard part. Of course, as soon as you're in the Army, they give you a test which is, sort of, a mixture of an aptitude test and IQ test. I guess because of that I was sent to my training in the Air Force. You know, Keesler Field was in Biloxi, Mississippi. You've seen *Biloxi Blues*?[1]

GRAYSON: Oh, yeah […].

MARGOSHES: It was poverty row then, very affluent now. They were going to send me to school to become an instrument technician. […] Going to college it sounded better. They sent me to Kalamazoo College, Kalamazoo, Michigan.

GRAYSON: This would have been 1940…

MARGOSHES: 1943, it was [19]43. I had a month stop in between at the University of Mississippi, which was an interesting experience. A New Yorker, I wandered into the soda fountain in town and sat down […], and I asked for a New York specialty in soda fountains, a black-and-white soda. A sudden quiet, and everybody's looking at me, including myself. You know, say, "black and white" in the same sentence with a Northern accent…

GRAYSON: Yeah.

MARGOSHES: Any rate…

GRAYSON: Figured you were a troublemaker.

---

[1] Neil Simon, *Biloxi Blues*, directed by Mike Nichols (1988; Los Angeles, CA: Universal Pictures).

MARGOSHES: Yeah. Kalamazoo College, the chemistry professor, Professor [Lemuel F.] Smith, and he was great, really a great teacher.

GRAYSON: So, what courses is he teaching in?

MARGOSHES: Well, he taught chemistry. This was general chemistry.

GRAYSON: General chemistry.

MARGOSHES: Right.

GRAYSON: And you were very impressed by his teaching style, the way he did it or…

MARGOSHES: He just…he had ways of making his point. I'll just mention one. He set up one classic experiment on this long laboratory table in front of the room. At one end, he set up a Kipp generator, and a glass tube […] running…

GRAYSON: Did you say, "Kip"?

MARGOSHES: Kipp. Did you learn about those in school, or were they archaic <**T: 20 min**>?

GRAYSON: Sounds pretty archaic, because it doesn't ring any bells for me…

MARGOSHES: Well, it's a gas generator. And he put in some zinc and hydrochloric acid, and started generating hydrogen.

GRAYSON: Sure.

MARGOSHES: Okay. He got that going, and he started talking. After a while he glanced at his watch, and he says, "Well, I think we can light hydrogen coming out at the other end, went and lit a match, and blew up that much…you know, a few inches of glass. And of course, you know, "He made a mistake!" Later on, I realized, that was no mistake. He had it timed. He got our attention.

GRAYSON: So, he basically, when he lit the match at the other end of the tube, it ended up, you say, breaking off some of…

MARGOSHES: It blew off, exploded.

GRAYSON: Blew off. Exploded.

MARGOSHES: Yeah. But, nobody was there. He was at the other end of the long table […], so it was safe.

GRAYSON: So, it was a lesson that…you […] at first thought it was a mistake, but it was a lesson in the dangers of hydrogen.

MARGOSHES: Yeah. Well, it also, if we're starting to fall asleep, this woke us up. We didn't fall asleep in the lab. It wasn't a great college, but, you know, for the first year, it really doesn't matter that much [where you're going to college and to have] really great…When he died, I read his obituary in *Chemical and Engineering News* and they noted how well [he was] respected [as a] teacher.[2] So I wasn't the only one [who recognized] that.

GRAYSON: So, [did you stay] at Kalamazoo for your whole undergraduate…

MARGOSHES: No.

GRAYSON: Okay.

MARGOSHES: In early 1944, the Army was running short. They knew they still had a lot of fighting to do. Unless they could get more people somewhere into the infantry, they'd have to shut down divisions so they decided that they really didn't need these educated guys for the

[2] A search of the *Chemical& Engineering News* archive did not turn up anything on Professor Smith. However, see John R. Sampey, "Lemuel F. Smith," *Journal of Chemical Education* 29 (1952): 331.

future. We [thought we could] end the war before they'd be needed anyway. So, in early March they put all of us, except one, on a train. One guy had come there, not from basic training at Keesler Field like we did, but he had been running a crash boat at Keesler Field, which is a nice job. You just sit around polishing the brass and nobody…they had trainees there, and every so often, one of the trainees lands his plane in the water by mistake. He'd just have to go pick them up, not a bad life. But he'd rather go to college too. Well, as soon as they [told] him he was going to get in the infantry, he got on the phone and got back to his crash boat. But the rest of us couldn't do that.

GRAYSON: So, they call it crash boat?

MARGOSHES: Crash boat, yeah. That's what the boats that went out to pick up the pilots when they downed a plane…

GRAYSON: And when they had to ditch…okay.

MARGOSHES: Okay.

GRAYSON: So, yeah, he must have had some pull to go back to his old job, I guess.

MARGOSHES: Yeah. Yeah. Because he grew up around small boats so he was really good [with them]. But the rest of us, they put us on a train to Chicago, [Illinois]. In Chicago, we switched to another train with other soldiers from universities in the area, like University of Chicago, and others in that area. We took off by train, and we wound up in Oregon, in the 96^{th} Infantry Division, which was then getting close to its final training and shipping out. They had some empty spaces, and we were put in. Now, the 96^{th} Infantry Division, their nickname was the Deadeyes, because the Assistant Divisional Commander was Claudius Easley […]. He was the Army's top marksman with pistols, and he was also very good with rifles. So, I spent several weeks in Oregon on the rifle range learning to fire a rifle Easley's way. Then we moved down to California for the rest of our training, in the Marine base south of Los Angeles, [California], amphibious training.

A few years ago, I was visiting my daughter who was [then] living in Los Angeles. (She's now moved back to New Jersey.) We turn on the late news before we go to bed, and they have a story about some Japanese soldiers taking amphibious training at that Marine base. I looked at **<T: 25 min>** [her] and said, what? The world really has changed.

GRAYSON: Well, yes. It does, kind of, rotate around.

MARGOSHES: Any rate, that summer we were given leave for a couple weeks. Then came back, and put on boats to the Pacific.

GRAYSON: The method of Easley for…I mean, he had a special approach to improve marksmanship.

MARGOSHES: Yeah. That was it.

GRAYSON: And how…what was it that was so special?

MARGOSHES: It was mainly the way you hold the rifle, the way you…rifles, you have adjustable sights on them, and you just […] train them. Also, techniques like how to compensate for the distance of the target, if the target is moving, and how to compensate for that.

GRAYSON: So, he had actually, kind of, worked out all this as a method to improve your ability to hit a target…

MARGOSHES: Yeah.

GRAYSON: At a distance and even moving.

MARGOSHES: Right. And I only had to use that once in combat, because most of the time, you're shooting quickly, close up, or else it's just what's called suppressive fire. Or, one night on Leyte, [Philippines], there was a *banzai* charge on a position and we're shooting into the dark. But you shoot, because they're out there somewhere.

GRAYSON: So, what was the date of your ship out to the Pacific?

MARGOSHES: Well, I don't the exact date, but it was I'd say, late June.

GRAYSON: Of 1944.

MARGOSHES: 1944, right. We went to Oahu, [Hawaii], and had some more training in jungle warfare. We had a practice landing on another one of the Hawaiian islands, I think it was Maui.

GRAYSON: So, by this time you are prepared to actually go into battle.

MARGOSHES: Right. They put us on ships and we headed out. They then told us we were going to Truk, [Micronesia]. Truk was famous for these big round stones that were supposed to represent currency. You probably heard about them. But, it was an island the Japanese had taken. It had been bypassed, in the Japanese cut-off, but it had a very good harbor. I guess the Navy wanted it back, so since the Japanese had already been cut off for some time, it was also another training exercise for us. But we never got there, because in the Western Pacific progress had been faster than they expected. They moved up the time to move back into the Philippines and they needed more troops for that.

GRAYSON: So the Western Pacific would be…

MARGOSHES: That was Leyte.

[…] And because we had to change course and wait for everything to get organized there, so we spent forty days on the troop ship, except a couple of days when we got off just for the day. They put us ashore. The first was Enewetak Atoll, [Marshall Islands], which later was the subject of a[n] H bomb test. But then, I looked at it, and I said, "Hey, this is a swimming pool twenty miles across." When they put us ashore there, it was glorious swimming. It was. The other one, we stopped for a few days in the Admiralty Islands, [Papua New Guinea], which are off of New Guinea, off the eastern end of New Guinea. They put us ashore again, there. That wasn't […] as beautiful a place, I'll say. It's good to get off the ship.

GRAYSON: I'm sure.

MARGOSHES: Plus, we got some beer. You couldn't drink on the ship.

GRAYSON: Ah, okay.

MARGOSHES: On shore [leave], we had some beer.

GRAYSON: Yes. Drinking on ship would be a disaster…

MARGOSHES: Right.

GRAYSON: So, you really were kind of idling all this time…

MARGOSHES: Yeah.

GRAYSON: In regard to the war.

MARGOSHES: Yeah. Now, one of the things was that General Easley, who I mentioned before, was on our ship, and because of him, we continued our rifle practice, but this against a different [type of] target: flying fish. It was perfectly safe <**T: 30 min**>. I don't think anybody ever hit one, because the flying fish, when they're scared by anything, like the ship, they bounce. They come out of the water, and they fly a little distance, but not in a straight line […]—back and forth—and then they dive back in the water. Your chance of hitting them is very small. But in terms of close combat, it was very good practice. So, at least you pass the day some of the time that way. It's not exactly a cruise ship though.

GRAYSON: No. No. You guys were, kind of, landlubbers, right? I mean, you didn't sign up to be in the Navy, but you, kind of, were…

MARGOSHES: Right. Well, some of the guys, as soon as I step foot on the ship, they got into the bunks. They were seasick. Some of them…I knew the ocean growing up in Brooklyn, [New York], the beach. But, these guys that came from the center of the country; there were quite a few of them came from the Dust Bowl. I mean, they'd never seen anything like this.

GRAYSON: So, eventually, what happened after the West got organized? Were you able…

MARGOSHES: Well, we made the landing on Leyte, which was uneventful, at least the Navy.[3] By that time, the Japanese were not trying to defend the beach, because the Navy [would] just [make] it hell for anybody. They'd do a week's worth of bombardment. Then, just before you landed, they'd move an LST [Landing Ship, Tank] up to the beach with the deck full of rocket launchers, and just fire off all the rockets at once. Now, if anybody was left alive there, he was not going to bother you.

So, there was nothing happening on the beach, but we didn't know that. It was a quiet landing. But also, it was confusing when we got there, what they told us we'd find and that was not what we found [when we got there]. Finally, we got together and proceeded on landing.

GRAYSON: Then, what was eventually the outcome of Leyte?

MARGOSHES: Well, we captured the island. We [used to talk about] a "million dollar wound," one that would get you off the island, but not permanently disabled. And I got one. We never had any contact with the Japanese for the first nine days. We were moving inland, but we were not in the front lines. We were following other units. On the ninth day, we came to a road, which only just a few years ago, I was reading a book about the Leyte campaign, to find out what this was. It was the main east/west road across the middle of the island.

The Japanese decided [they had to] defend there, so that's where the fighting started. To get to that road, we were walking across a very open field, and two Japanese soldiers came tramping down the road carrying a machine [gun and started] to set it [up]. Well, they didn't last very long. It was a stupid thing to do, but they followed orders.

Any rate, I actually saw a Japanese airman before that. As we moved inland the first few days, we could still see the air, all the sky over Leyte Gulf. The Japanese were sending off a reconnaissance plane every day, and we'd see it. The whole Navy's shooting at them with antiaircraft, because they had to fly straight so they could get the pictures. Then they'd do something, and disappear. Well, this time the pilot came down to tree-top level. I heard some noise, and I look up, and this plane flies over so low I could see the pilot clearly. If I knew him, I would have recognized him, but of course, nobody ever got a shot at him, because it happened too fast.

But, when we got to that…on the ninth day, we started down that road. Nothing else happened that day on the road, and we dug in for the night. It was rainy; we were in the rainy season. We'd dig foxholes, and the foxholes would fill up with water. You're sleeping in water. That was the night I tried the experiment: could I see my hand in front of my face? I couldn't. That was also the night the Japanese pulled a *banzai* charge. So, that was kind of

[3] Some of Dr. Margoshes recollections of his service during World War II are also in Gerald Astor, *Crisis in the Pacific: The Battles for the Philippine Islands by the Men Who Fought Them* (Random House LLC, 2009), pp. 348, 353, 412-3, 618.

stressful, but as far as I know we had no casualties from it. The next day we started down the road again and ran into some opposition. There was a fork in the road. The Japanese had a machine gun set up there <**T: 35 min**>. By the time I got there, it had been knocked out, but they told us that we should pull back because they were going to let the artillery take over and soften up the position. So we did, and got off to the side of the road. My company got off to the side of the road in some trees. Leaning against the tree, I saw one round land off in a field to the side. I figure that's ours, and they'd go back to the [target]. The next shell landed right in us, killed a guy who was as close to me as you [are], and wounded me and another guy. That got me off the island. I'm still carrying the shrapnel. It's in my hip, right next to the main nerve that runs down to the leg, and they're afraid to go in there and do anything, so…it bothers me sometimes, but not that much. But by the time—they sent me to a hospital in New Guinea—by the time I got back, the fighting was all over.

GRAYSON: Well, that was an experience.

MARGOSHES: Oh, yeah, and a short one.

GRAYSON: Yeah. Then, when you got back…I guess, by the time you were able-bodied again, the war, like you say, the war was over. You just…

MARGOSHES: No, no. […] Just that [battle].

GRAYSON: Oh, just that battle, okay.

MARGOSHES: Yeah, okay.

GRAYSON: Okay. So, you still had to do battle.

MARGOSHES: Oh, yeah.

GRAYSON: Okay. I'm sorry. I thought…

MARGOSHES: There were other divisions that were…the next big target was down in the Luzon, [Philippines]. […] That's where the capital, Manila, is. Other units took over that, and the rest of it. We were in the planning for another stage, so it was an easy time. Not much to do. We could buy a whole stalk of bananas from a farmer for fifty cents. We ate bananas till we were tired of them. On Sundays, we'd go into the village to the cockfights and bet on them. We always lost, but it was something to do. Of course, we were on good terms with the Filipinos. They were our friends, and we were their friends.

GRAYSON: Then you can basically…how much longer did you have to be in the Army, and continue with the…

MARGOSHES: Well, I was there [until] after the war. I didn't get home until January 1946, but in March…while we were waiting, we got replacements for soldiers that were killed or wounded and couldn't come back, bringing us to size.

GRAYSON: Okay […].

MARGOSHES: Then we had another practice landing for the benefit of the replacements, and we set sail for Okinawa, [Japan], this time. That was the first Japanese territory that we were going after.

GRAYSON: So, basically, except for the one incident, you still hadn't really been involved in any real combat at that time.

MARGOSHES: Just that…well, really only that *banzai* charge. […] It's the only time I actually fired my rifle, even though just into the dark.

GRAYSON: Yeah. You had no idea whether it was effective or not. It was just, you had to quick fire to make sure that they didn't overrun you. So, at Okinawa…

MARGOSHES: Okay. Again, the landing was walk ashore. In fact, if you've ever read any histories of the battle, the question from the first day was where are the Japanese? They just weren't there. Actually, by the end of the first day […], <**T: 40 min**> my company had gone halfway across the island, and started south. Other units—in fact, the Marine units—were headed for the north, which was a hilly area, but they expected less Japanese defense there, so they just sent one of the six divisions there.

GRAYSON: Thank you.

MARGOSHES: We headed south where they expected the Japanese defense was to be. It turned out, we were on the far left flank of the division. By the second or third day, there was an escarpment off to our left, two, three hundred yards away. It was no-man's land. There were caves there, and we were catching some fire from those caves, and we had some casualties. Before we went into [Okinawa], the company commander appointed me to be the company runner. That meant that I was a messenger boy for him. My job was to stay close to him and carry messages, and sometimes he'd send me back to battalion headquarters to carry reports or maybe pick something up from them, so I had to be moving around the battlefield on my own. So the few times when…I remember one particular one, I was coming from the battalion headquarters. I heard a bullet go by from these caves, and there was nobody else but me around. I said, "Okay. You missed me this time." Their rifles weren't very good, really. Thank goodness. But, at any rate, on the sixth day, we came into sight of the main defense line. Actually, the cliff bent around, and it wasn't alongside us anymore; it was in front of us, and that would be the objective for the next day, and things really got hot. That was the one time I actually used my rifle training. […] We were working with a light tank. The company commandeer was staying close to it and I was with him, [we were] right in back of [it]. There was an antitank gun in one of those caves, obviously, and [it] knocked out that tank. Light tanks have very little armor. I saw one of the crew bail out, on the side facing the cliffs, and I could see bullets from a machine gun going all around him. I figured he's dead.

Meanwhile, [there's all these] other things going on, and I didn't keep track of him. A few minutes later, I looked and he's standing behind me, unhit. [That was] sort of a miracle. The other miracle is one of our sergeants was yelling something, and a Japanese bullet went in his mouth, out his neck, and he survived. [It] just missed everything. The bullets…the Japanese couldn't carry heavy rifles. They're small, small people. [Their bullets] carried…has a .25 caliber bullet. So, it didn't make much of a hole; unless it hit something, it just passed through.

At any rate, what happened was I saw a shot come from behind this big rock out in the field, but there was more than one big rock. I couldn't get all the people to recognize which it was. But finally, a forward observer for the mortars came [up] and I said, "It's out in that direction." I guessed […] the yardage, and he called for a shot. I said, "Okay. You've got the right direction, but pull it back." Then a second one that came a lot closer, and two Japanese soldiers came out of there and started running for the caves. I was the only one who really expected anything, because the others…"What do you know? What did you see? You're imagining this." I barely had time to get off one carefully aimed shot, and it worked. He went down. So that's the only time I really used the training.

Then what happened is the antitank…the company commander the next morning, we set out. He went to one side of the tank. I [thought], "I don't like to be near tanks, because they draw fire." But I had to stay close to him. Well, the antitank <**T: 45 min**> gun opened up again, and I caught a piece of the shrapnel in my arm, right here. Not a serious wound. What happened was that, when I joined the division, there was one soldier in the company who had been in combat. He'd been with the 7th Calvary in the Aleutians, [and he was] wounded there.

They sent him back to the hospital in the States. He came out of the hospital, and the 7th Division, Calvary Division was in Hawaii, but they sent him to the 96th.

When they got to Hawaii, he got himself transferred out, but he taught me some practical advice. And one of his…always know where there's a hole you can jump in. So, when the antitank gun opened up I had a hole, but I was holding my rifle up like that, because you protect the rifle. So, I [had my arm] like that, and the bullet went right through there. Now, it had to be close to my head…

GRAYSON: Oh, yeah.

MARGOSHES: It was awfully lucky. It got me off the island, but I got back. I missed all the really heavy fighting. I got back. My company was down to eight.

GRAYSON: Oh, my, and started out with how many?

MARGOSHES: Hundred and eighty. […] Out of the one hundred and eighty who made the landing—and there were a lot of replacements that came in—but out of that original one hundred and eighty, two made it to the end without getting hit.

GRAYSON: Wow.

MARGOSHES: One [out of] six that made the original landing got killed. Replacements, one of five was killed, and sometimes very quickly. I heard a story from another company about a replacement [that] came in while they were on the line, and he was dead in five minutes. That was the bloodiest battle in the Pacific. The Okinawans put up a memorial with almost a quarter of a million names, American and Japanese soldiers, and a third of the Okinawan population in three months. Because the Japanese going in, the commanders knew, "We can't win this battle." The soldiers who saw the armada, the biggest armada ever put together, American ships as far as you could see in every direction, they could look at that and say, "We can't win." But their mission was to make it so bloody the Americans could not invade Japan, and they made it very bloody.

GRAYSON: So it was kind of like a last stronghold position that they had. That they wanted…they knew that if…once that fell, then Japan…

MARGOSHES: Talking about our casualties…Japanese soldiers, ninety percent killed or committed *hara-kiri*. A lot of them committed suicide in the end. And many civilians. And the same thing on Saipan, [Commonwealth of the Northern Mariana Islands]. Japanese encouraged the civilians to jump off cliffs because the Americans would do terrible things, but you know, I talked to a Japanese soldier at the end, had a little chat with him. He was one of those who surrendered, and he spoke some English. Somebody had to keep an eye on him until an MP came along, so there I am sitting on the battlefield on the edge of a foxhole chatting with a Japanese soldier. It was quite an experience.

GRAYSON: Yeah. I understand that they did make out the Americans to be really very nasty people. If you fell, if you allowed them to overrun you, either as civilians, or military, that you were…

MARGOSHES: I think it was something else; that surrendering was such a shameful thing. When I left the hospital in Saipan, the truck took me and some other soldiers down to the Navy base. It was driven by a Japanese prisoner of war. I got to the Navy base, which was right on the beach. There was a bluff behind the beach with caves, and the Navy had set up big movie screens, so the Japanese holdouts in the caves could watch the movies. They weren't bothering anybody, they'd just come out at night to steal food, but if you went to all the trouble of trying to capture them, you still had to feed them. So, you know, they changed. They hadn't even surrendered, but they weren't going to fight.

GRAYSON: Interesting.

MARGOSHES: Yeah.

GRAYSON: So, you got off the island of Okinawa. What happened? Did you […] have to go back into combat after…

MARGOSHES: Yeah. I came back before the fighting ended, mopping up. We had <**T: 50 min**> one mopping up operation, where [we had] our final casualty and I was almost the one after that. What happened is, we were cleaning out caves.

GRAYSON: This is still back in Okinawa.

MARGOSHES: It was on Okinawa. The idea is get close enough to the cave. There were other soldiers at the top of the escarpment. We just identified the cave, and they would lower satchel charges. We had a brand new second lieutenant with us. Of course, all of our officers were gone. We come up [to] one cave and [were] shot at, and one of [our soldiers] got it in the belly. There were lots of […] big rocks, and we all got behind the rocks. The medic was behind a rock with me, and the [wounded soldier's behind] another one about ten yards away. He asked me to give him cover, so he could get across there, so the rock that we were behind had a cleft at the top, and it made sense to me to stick my head up there, have a peek. But a Japanese soldier in the cave had the same thought, so as soon as I got my head up there, a bullet bounced off the rock next to me. So, I got down fast, but I saw just where the cave was, so I just hold my rifle up, and shoot it into there, and the medic was able to get to him. The wounded man got to the hospital, but he died of his injuries in the hospital. He was our last.

The second lieutenant jumps up. He's going to charge the cave, which was stupidity. See, he was green. I didn't have a lot of experience with caves, but I talked to these guys about what their experience was like. I knew something about it. I don't know if it was all of us, but a lot of us yelled an obscenity at him. We deliberately…we disobeyed an order, and he got down. The guys at the top lowered the satchel charge and took care of it.

GRAYSON: Sorry, the guys at the top…

MARGOSHES: Yeah. They're other soldiers from our division [who] were up there. We were working with them. Our job was just to find the caves, and tell them to lower the satchel charge [down]. So, nothing ever came of that officer. I never saw him again. I think he got himself transferred, because he destroyed himself. We were not going to follow him. But the rest of it then was very quiet, I'd say. It was another million, almost a million dollar wound, because it does bother me a little bit sometimes. It got me a 10 percent disability rating, which helped because later on, when I went to college, instead of sixty-five dollars a month [stipend I got] ninety dollars a month. That's a lot of money.

GRAYSON: Oh, yeah.

MARGOSHES: Yeah.

GRAYSON: So, basically, you served out through the end of the war then.

MARGOSHES: Yeah. Well, […] as soon as the fighting ended on Okinawa, they wanted us out of there, because they were going to turn the whole southern part of the island to a series of air bases for the attack on Japan. See, the whole […] leapfrog method they used from the time they regrouped [really back in] Australia…the strategy, [like], follow the same path the Japanese followed, but leapfrog. And one of the considerations is […] how far your fighter planes could provide air cover, so you wouldn't have to depend entirely on the Navy. So, Okinawa was the last one […] they needed for southern Japan. They wanted to build these air bases there. They got us off the island on whatever ship they [could] get, so we were on the decks of LSTs. We couldn't go down below deck in heavy weather, because in heavy weather—[of course], down with all sorts of vehicles down there, and if they got [loose in a big thunderstorm]—too dangerous. So, we managed a typhoon. We were on the deck there, looking at these big waves coming about, and heard all the stories about these LSTs breaking up, right.

GRAYSON: This is not an ocean-going vehicle.

MARGOSHES: They are. They are.

GRAYSON: They are?

MARGOSHES: But sometimes…you know, they built them in a hurry, and had these open bays, so they were flexible. They'd actually do this, okay. But, they didn't do it smoothly. […] And you couldn't even stand at the <**T: 55 min**> bow or the stern, because you'd be thrown up in the air, so you had us huddled in the middle, right? Finally, got it out of that typhoon, and I found out years later, because [they never told us] these things, was that the convoy had been attacked by a pack of Japanese submarines, and the Navy had lost a destroyer escort and half of its crew.

GRAYSON: Oh, my.

MARGOSHES: We got into another typhoon, and got away from that. So, we finally got back to the Philippines, not Leyte, but the island of Mindoro […] The Spanish name for it was Mindora. In old maps it still shows that way, but on ours it was Mindoro. We were told it was the most backward island in the Philippines, and in some ways it was. There are actually pygmies there.

GRAYSON: There's actually…

MARGOSHES: Pygmies.

GRAYSON: Oh, pygmies.

MARGOSHES: Yeah. Some of our guys heard that there were wild boar up in the hills, so they packed some food and they went up there. They came back after two days. No wild boar, but they said somebody was shooting [arrows] at them. We asked, "You guys been […] drinking? What do you mean shooting arrows?"

So, a few days later, three pygmies come walking down the road, each one wearing [just a] breech cloth. Each of them has a bow and a quiver of arrows. We found a translator, because they didn't speak English. Found out they'd been sent down by the villagers, because the Japanese…the war had ended and the Japanese stragglers were settling down, and they were stealing women. They want us to come in there and…

GRAYSON: Throw out the Japanese.

MARGOSHES: And we told them, well, our war is over. You've got to go find the Filipino Army which didn't exist yet, but…

GRAYSON: Yeah.

MARGOSHES: You know, Japanese soldiers were still appearing out of there thirty years later. They couldn't believe the war ended. Not that island, but other islands, they were still there.

GRAYSON: So, eventually…when did you get free of the Army?

MARGOSHES: Well, the problem in getting us home was shipping. They had to move a lot of people to Japan, and supplies, because Japan had been cut off from the food supplies from mainland Asia. There were estimates that if the war hadn't ended when it did, as much as a third of the Japanese population would have starved to death, so they had to bring in food, and medical supplies, all these things. So, I didn't actually reach California until about New Year's.

GRAYSON: Of…

MARGOSHES: 1946. […] On or about New Year's, but it was early 1946, when [I came home and] got discharged.

GRAYSON: When did you hear about the atomic bomb attack?

MARGOSHES: Back in Mindoro, and we had a big celebration.

GRAYSON: So, that was…by the time you heard, it was known that the Japanese had surrendered or did you just…

MARGOSHES: Well, we heard first [there] was a bomb. Of course, we didn't really understand…

GRAYSON: Yeah.

MARGOSHES: But, when we heard of the two bombs, that was impressive, but it was when the Japanese surrendered, because, I'll tell you. Anybody who was on [Okinawa]—and I've heard Marines say the same thing on TV—none of us thought we'd live another year. Thought we were going to Japan. In fact, what I've read, the Japanese had figured out where we were going to land, brought in more troops, and armed civilians with wooden sticks if necessary, but they prepared the same sort of defense as they used on Okinawa. It would have been bloody all over again, on both sides. In fact, the top brass, in their planning, they assumed that the Japanese would not be able to bring replacements <**T: 60 min**> in there, and they found out they had. They really [were trying to] decide again whether they [wanted] to go through with it, because they were already estimating a million casualties…[at least], not a million killed, but a million casualties. [As I said], if you lived through Okinawa, you thought it was going to be even worse.

GRAYSON: Yeah. Well, I know that in recent times, there's been people second-guessing the decision to do that, to drop the bomb, but given the situation at the time, it's…I mean, unless you were there, I don't think you could appreciate the drasticness of the situation, and…

MARGOSHES: You know, more Japanese died in one fire bomb raid on Tokyo, [Japan], than were killed by both nuclear bombs.

GRAYSON: Well, I think the same thing happened in Europe, in Dresden, [Germany]. Dresden was fire bombed…

MARGOSHES: Oh, it was even worse, because Tokyo was built of wooden and paper shacks. You know, it just burned a large part of the city overnight, one firestorm.

GRAYSON: Yeah. Conventional bombing was…if you particularly did a firestorm, it was very, very dangerous to civilians, high civilian casualty rates. So, it's just the fact, I guess, that one or two bombs can wreak such havoc, it [really] makes a very powerful impression.

MARGOSHES: Well in fact, General [Henry Harley "Hap"] Arnold who commanded the B-29s—and by the way, from the hospital in Saipan I used to watch those B-29s taking off and coming back, some of them with big holes in them I could see as they flew over, getting ready to land—General Arnold, about the time of the first atomic bomb told the brass back in Washington, "I've covered all of the targets you gave me. I've got nothing left to bomb."

Now, when I was in the hospital in Saipan, another fellow from my company came into the same tent. After a couple days, he told me that his brother was on a B-29 aircrew, and he [could contact] him, and "We can go on a raid." I looked at him, and I said, "I've been shot at enough." I'd seen these planes coming back, and those were the ones that came back. Why do that?

GRAYSON: Why—yeah…

MARGOSHES: Just for the thrill.

GRAYSON: Yeah. It's not exactly a joy ride.

MARGOSHES: Right, no. No way.

GRAYSON: You got back to the West Coast in 1946. Beginning of 1946, and you're still an enlisted man, right.

MARGOSHES: Well, they put a few of us on a plane, a DC-3, set up Army style, just bucket seats along the sides . Instead of taking the train, we fly to the East Coast, but the plane has to stop regularly for gas. We only had the one crew, so we had to stop overnight. So, instead of three and a half days by train, it took [us] two and half days, but we got there. I hadn't told my parents I was coming. I wanted to surprise them, which I did. At any rate, I got my discharge and immediately got a ten percent disability rating and a VA [Veterans' Administration] claim number, so I could immediately start planning for college. Of course, in January you can't get into college.

GRAYSON: Yeah.

MARGOSHES: But I could start working on it, because I knew [what I would have] to pay for it. Nowadays, […] soldiers are discharged, it takes them months before the VA even knows about them. It's a shame. You know, those politicians say, "Oh, we support the troops." But once they don't need them anymore…

GRAYSON: So, you're gearing up for college. You're back in New York, right? New York City?

MARGOSHES: Well, while I was gone…I grew up in Brooklyn, and while I was gone, my mother was hospitalized for a good part of that. When she came to New York with her family, they lived in the Lower East Side in tenements, and she probably contracted [tuberculosis] there. She was sick with it in the hospital for a good part of the time, or recuperating, but <**T: 65 min**> I was overseas, and of course, there was no medical insurance. My father had to sell the house, and they moved into an apartment in the same general area, so I knew where it was.

My father would have loved me to go out and take a job. I wasn't interested […]. He finally found one for me that I was totally unfit for. I did it; not very well. But at any rate, it was tough getting in, because [you had] all these guys, several years' worth of college students trying to get into college at the same time now. And I had the disadvantage…Brooklyn Tech, because technically we're not a college prep school—they were training technicians—we did not take a foreign language. But colleges have requirements, most of them. Normally, they would have forgotten about that if you [had gone to] a place like Brooklyn Tech, but this time they've got so many people that they just automatically rejected you, so that made it very hard.

What happened then…New York did not have a state university system then, New York State didn't. The private colleges thought that this—not being able to take everybody in—would make the state set it up. So, the private colleges set up temporary colleges, just the first year, and I spent the first year of college in Utica, New York, which is in the snow belt area. They built an Army hospital there, and they didn't need it anymore, so they turned it into a college. And the first year courses are all the same. They guaranteed to take your credit.

Well, Brooklyn Poly [Polytechnic Institute of Brooklyn] regularly took in Brooklyn Tech students regardless of language, and I got admitted there. It's a good school—it's now part of NYU, you know—and a very good chemistry department. It was more economical for me, because I could stay at home.

GRAYSON: Yeah. But you had some college experience…

MARGOSHES: But I didn't do the whole year, so…

GRAYSON: Okay, so you just…

MARGOSHES: I didn't complete the year. […] So I had to repeat the courses, which made it a lot easier. Yeah. No. It was an easy course. By this time, I was pushing to take as many courses as I could to get through as fast as I could. So, I was going to summer school too.

GRAYSON: So, [it was at] this time you decided you were going to stick with chemistry as a major?

MARGOSHES: I was thinking […] when I came out of the Army that I might switch to physics, because I was interested in that also, but I thought that my math wasn't quite good enough for physics, and it isn't. I got by with a minor in physics, but I couldn't have made the major with my limited math ability; pretty good for chemist, but not for a physicist.

GRAYSON: So, [the] minor in physics though, I think, probably would come in handy later on when you get into instrumentation.

MARGOSHES: Yeah, right. What happened in graduate school…again it was the same thing, because it's the same group of people now trying to get into graduate school. It was very hard. I heard about Iowa State [College]. Well, by that time, I was interested in analytical chemistry. Iowa State…first of all, the most prestigious universities like the Ivy League, had decided that they weren't going to do anything applied anymore. This is when a lot of physicists went into…created modern biology, because that was something that would not get…the public would always think it was wonderful. Well, now the public doesn't think it's so wonderful, so you can't win sometimes.

But the land grant colleges, analytical chemistry was still important to them. So, they kept it going. Iowa State had been involved in […] the atomic bomb project in terms of purifying <**T: 70 min**> uranium and graphite. They stayed on as the Ames Laboratory of the Atomic Energy Commission. They had money, and they had jobs, so they needed more than people who would work with the classrooms and mark tests and that sort of thing. They needed people to work in labs, so they were taking people in, so that turned out to be a good place for me to go.

GRAYSON: Now before we get into your graduate work though, was there anything particular at undergraduate…

MARGOSHES: Well…

GRAYSON: You kind of decided that you wanted to go into analytical chemistry during your undergraduate…

MARGOSHES: Well, Joe [Joseph] Steigman, his name was. […] He turned me on to analytical chemistry. He [got] some notoriety later on. He was one of the people who was accused of being a communist.

GRAYSON: Oh, no.

MARGOSHES: Whether he was or wasn't, I don't know, but there was no politics in [the classroom]…

GRAYSON: Yeah.

MARGOSHES: And he was a very good teacher. I liked the applied aspect of it, because think of it: analytical chemistry is like taking things apart to see how they work and later on it [began to be called] other names [like "chemical characterization"], that sounds obvious. But most of the time, you're taking things apart to find out what they're made of. That's what first got me interested. It was also, I learned when I started doing service I didn't know it so much then—but when doing service analyses, all sorts of problems come to you. That part of it I liked, too.

GRAYSON: Did you have any help in…I mean, did you look at a variety of schools for graduate work or…

MARGOSHES: Well, I applied to a lot of them, but it was just very hard to get into any.

GRAYSON: So, I mean, I'm sure you had [decent] grades, so you didn't have issues…

MARGOSHES: My grades were good.

GRAYSON: I mean, you graduated *cum laude* from Brooklyn College…

MARGOSHES: Yeah, right. I graduated *cum laude*. I got good marks, and same way from high school. You know, New York state has Regents Exams. I was a little above average for Brooklyn Tech High School, but on my Regents Exams, I only had one where my score was under ninety. You know what that was?

GRAYSON: Chemistry.

MARGOSHES: Chemistry. But, […] they didn't go by that. For example, City College, then if you were in the top 10 percent of your class, in any New York City high school, you were automatically [in at] City College. Okay. It's not a bad college. In fact, they have a good chemistry department. Now, I was in the top third or so of my class, but I [would be] easily within the top 10 percent if I'd stayed in my local high school. But they didn't look at that. So, I didn't get in that way. So, it was a struggle. Matter of fact, it turned out to be a good thing for me. It was a good place for me. I hated Ames, [Iowa. Small towns] were not for me.

GRAYSON: Yeah. Well, I mean, a New York City boy, and then, been around the world with the Army. So, the Midwest was probably not too much fun. So, I see here that you only spent two years between Brooklyn Poly, when you graduated from…

MARGOSHES: No, not quite so.

GRAYSON: Oh, okay.

MARGOSHES: I couldn't complete all the requirements of Poly for the June graduation in 1950. I had to do a thesis. So, I stayed on for that, and I completed the requirements. As soon as that got accepted, I took off for Iowa State. Meanwhile, you know, I had set it up.

When I got there, they said, "We don't see you have a diploma." So, I wrote back and said, "I need a letter explaining that I met all the requirements <**T: 75 min**>." They looked at my records and they wrote back, "You haven't. You didn't take this one required course." Well, my advisor told me I didn't have to take that, okay, because he didn't think it was such a great course. Unfortunately, he never entered it in the records, but he remembered he'd told me that, so I got the letter back, so I didn't graduate until June 1951.

Then, at Iowa State, I really had my nose to the grindstone. I was there for three years and three months. Partly it was a lot of luck, because when I got there, they took me and another incoming graduate student, told us we were going to run [an infrared] analysis lab. […] My professor I was assigned to, Velmer [A.] Fassel, I'd never heard of him. Good choice…

GRAYSON: His name…

MARGOSHES: Fassel. He was young, not much known. But he later became the leading man in emission spectroscopy.

GRAYSON: Emission?

MARGOSHES: Yeah, known as the father of the ICP [inductively coupled plasma]. The other student, his prof was…here I've got the tip of the tongue syndrome again. The guy who got the gold medal here a few years ago…

GRAYSON: Oh, okay.

MARGOSHES: Here—George [S.] Hammond. […] And between the two of us, we were shown the lab. The guy who had been running it so far was on his way out the door, because he had a better job somewhere else, better paying at least. He just showed us how to run the infrared […] spectrometer. You know, like, a one day training course, and okay, now you run the lab. We're supposed to do infrared analyses, including not just run them, but interpret them for anybody in chemistry or physics. What do we do?

GRAYSON: Yeah. That's, kind of…you don't just look at an IR spectrum and say, well…

MARGOSHES: That's it. So, we headed to the library. We found the book of the collection of some papers written by [William Weber] Coblentz starting in 1905, which really set the basis for all infrared spectroscopy. […] There [is] a Coblentz Society of infrared people; it was named after him. I never got to meet him. [He was still alive] when I came to Washington, and I asked [Bourdon F.] Scribner about it. He said, "He doesn't like to meet new people." I surmised he had gone down mentally.

GRAYSON: So, who was this fellow that you asked about meeting…

MARGOSHES: Bourdon Scribner. Okay. I'm jumping ahead now. […]

So at any rate, we found Coblentz's papers; you know, his spectra. It took him a whole day to get one spectrum, but the quality was about what you get on the Baird instrument that we had.

GRAYSON: You had a Baird machine?

MARGOSHES: Yeah. Baird IR

GRAYSON: Did it have a number or model or…

MARGOSHES: I don't recall, just the Baird IR.

GRAYSON: I guess they didn't have enough of them to have models then.

MARGOSHES: And there was a little other literature, but that was about it. Then a paper came out in the *Journal of the Optical Society of America*, with a correlation chart, which is the same chart […] layout that [you] find in the textbooks now, only just a single page. We [called] it the magic chart, because it made us experts.

GRAYSON: Yeah.

MARGOSHES: Right. There was a saying, "In the valley of the blind, the one-eyed man is king." Well, we were the one-eyed [men]. We knew a little more than anybody else [there]. So, the <**T: 80 min**> big man in organic chemistry [in] the chemistry department, also one of the two top people in the country, was Henry Gilman.

There were two important organic chemistry textbooks, Feiser & Feiser […].[4]

[4] Louis F. Fieser and Mary Fieser, *Organic Chemistry*, 1st ed. (Boston: D.C. Heath and Co., 1944).

GRAYSON: I'm familiar with that one.

MARGOSHES: And Gilman.[5] Okay. When we got there, we had to take some tests, and [I] found out that I'm not very good at organic chemistry, because it's all memorizing. I [had] trouble [even] then memorizing. So, I flunked that, and had to take a refresher course taught by him. Okay. He would get us up and say—[put the] structure of a chemical on the blackboard—"From coal tar and water, how would you make this?" We'd try to figure out. [Then] when we got done, he'd write down other [methods]. He knew them all.

But he had this fabulous memory. He was almost blind, but he had everything memorized to the point where years later when I had to make something for my research, the only prep I found was a half-page paper in *JACS* [*Journal of the American Chemical Society*], when he was just starting out his career. And something about it wasn't clear, so I dropped by his office: "Professor Gilman, about this compound…" He remembered every detail of it. Amazing.

At any rate, his students brought everything they made down to us, including all the byproducts, because it was free. They'd make [a] report back to him. This was brand new, and he was suspicious, so he didn't call me up to his office. He would come down to the lab, and grill me, not the other student, about it. I realized […] what he did, he'd ask me a series of questions and go back and ask the same ones again, and I better get the same answers, so I improved my short-term memory.

When it came time to do my thesis, I had [to get] spectra of a whole lot of compounds of similar structures. He gave me the key to these glass-fronted cabinets that lined the [halls] of the chemistry building, where everything students made over there was in there, in neatly labeled vials. "Help yourself." Because of that, I was able to do all the research over a summer. That saved a lot of time. I really owe a debt of gratitude to him for that.

GRAYSON: Yeah.

MARGOSHES: Also, George Hammond. It was wonderful to [see him and] sit down and talk to him for a while, because he remembered me. Again, I'm getting ahead. So, there I was, and Fassel, very wisely, got me not to major in analytical chemistry, because their teaching was not up to date. They had no real instrumental analysis…

[5] Henry Gilman, ed. *Organic Chemistry: An Advanced Treatise*, 2 volumes (New York: James Wiley & Sons, 1938).

Most colleges…when I was an undergraduate, I only saw one thing you could call an instrument, except the balances. You learned everything you wanted or needed to know, everything about balances, really experts on balances. […] We had to buy our own weights. I gave my weights to…they're somewhere in the collection here now. [Any time they want to] display weights they have [some]. The one experiment we had with an instrument was a polarograph.

Now, a polarograph recorded [that] on a sheet of photo paper, by a light beam, off [of a mirror] galvanometer. So, you go into this room, and set up the equipment and the chemicals, [get it] ready to go, and then you turned out the lights, except you had a darkroom safe light. You put a sheet of photographic paper in place. You press the "go" button and you wait until it's gone through the operation. Then you cover over the photographic paper, got it started in developing it, and then you turn the lights back on. That wasn't terribly exciting, but that was the only instrument we ever saw.

GRAYSON: This was undergraduate…

MARGOSHES: The schools said there were no textbooks. The equipment was expensive. Schools didn't really get into it, until the 1960s. I remember <**T: 85 min**> when I was with Bureau of Standards [talking with people from] the University of Maryland, they were trying to teach instrumental analysis without a laboratory. I didn't see how you could do this. But, they just couldn't afford to do it any other way. So, there's no…we learned the classical methods, and we learned precision, and that was very important. We […] got a little bit of knowledge about statistics, [started to learn] about that.

GRAYSON: So, when you say classical methods, this would be chemical…

MARGOSHES: Yeah, analyzing limestone, doing some titrations. Of course, in the thesis I had to do, I had to do a lot of Kjeldahl analyses, it turned out.

GRAYSON: […] Interesting.

MARGOSHES: Yeah. But I got to use a Beckman DU [spectrophotometer]. But to show [how ignorant] it was…have you used the Beckman DU? You know, you put in the reference solution. Then you balance by turning, and what you're balancing is a little galvanometer needle to get it on zero. This thing was just flopping back and forth. Well, I didn't know it wasn't supposed to do that. So, [there I am] struggling with this. First of all, when you're an undergraduate in a graduate school lab, you're the lowest thing on earth, right? So, I was lucky to get any bench space. So, a graduate student said, "Oh. You've got to change the DRIERITE in the phototube [compartment].” Okay. This was [all] you had to do. Well, I didn’t know anything about all this…

GRAYSON: Yeah.

MARGOSHES: I learned why you had to have the DRIERITE I got curious about why that was. So, I had some experience with that.

Years later, when I came to Technicon [Instrument Corporation], they had a device you’ve probably never seen. Beckman made a few of these. It was to automate the DU. It was this framework of iron rods. At the top were […two] stepping motors…two directional stepping motors that could control the knobs. Then there [was] some apparatus that caused this to go through there, and do all the step-by-step measurements. […] Really it was a robot. Okay.

GRAYSON: To push the buttons…

MARGOSHES: So, to make the DU a recording spectrophotometer. You know, it was a close connection to…you know, the [early] automobiles, they made them look like buggies. They even had buggy…they had whips. Okay. What are you supposed to whip [with] this, I don’t know. But, that’s what you put on the buggy then, right.

GRAYSON: Yeah.

MARGOSHES: So, often there’s a difference between mechanization and automation. In mechanization, you just take the manual methods, and you mechanize them. Automation, you start from the ground. This is what we’re trying to accomplish. How can I do this? Okay. Where were we?

GRAYSON: We were back in graduate school, and you were convinced that you didn’t really want to major or get a degree in analytical chemistry at that particular time.

MARGOSHES: Right. But I also [would take] a minor in analytical chemistry, and physics.

GRAYSON: And physics, and then majored in physical […] chemistry.

MARGOSHES: Yeah. Which, you know, I now say, because I think so, if you don't know physical chemistry, you don't really know chemistry. This has come up [in] a number of [cases]. Now in the medical field, you start measuring blood parameters by electrode. You're measuring activity, not concentration, and there's a difference. Sometimes that difference is medically important. But, you can't get a doctor to understand that. [Because] they ran away from physical chemistry. They avoid that course.

GRAYSON: Definitely. They ran away from [organic] chemistry [if] they could.

MARGOSHES: Well, they, sort of, have to take that. Yeah. Not so much anymore, but they still tend to do that. Well, I don't know if you can really get through biochemistry very well, if you don't know organic chemistry.

GRAYSON: Probably not.

MARGOSHES: Probably not, no. They should know biochemistry, but it's a lot of medicine. When I was working at the Harvard Medical School, the teaching method there…I don't know if this is typical of medical schools. They had these big lectures for the whole class, and then small groups <**T: 90 min**> [of them would talk] with individual physicians. Bert [L.] Vallee was one of those who talked to small groups. […] He was trying to explain to them, to these students, the biochemical basis of diseases. But, they're not interested. They want to learn, how do I diagnose it? And how do I treat it? Okay.

GRAYSON: Yeah. And they want to get a grade, so they can get onto the […] medical school part.

MARGOSHES: Yeah, right. Well, this is going on in medical school, already. They're still [not interested] in learning the basic science. Now, the researchers is a different story. Some do some very good basic science. But, they just don't…you know, if I start talking physical chemistry to them, they don't know what I'm talking about. Yet, it comes out in this. What Technicon did, they were the first ones to introduce in a standard laboratory instrument electrodes for sodium and potassium. They realized what the electrode measures is not concentration, because [depending on] the composition of a patient's blood, the activity coefficient varies.

So, what they do is for that chemistry, they added what was activity coefficient buffer, so they could report concentration. But we had a big debate later on for a later instrument, which they never made, because they screwed up. The engineers screwed up on it. They were going to measure calcium by electrode.

Now, by this time, physicians understood there was total calcium and what they call "free" calcium, calcium that's not attached to some molecule, but that again, what you measure with the electrode is the activity of the free calcium. Okay. So, I explained this to the marketing people that it's going to be a different measurement. We can't dilute it, because the nature of the instrument is you just put whole blood into it, and no reagent. So, what'll we call it? I said, "Just call it calcium." Nah, we can't do that. Well, so they let that die, but other companies later on [brought out similar instruments]. You know what they call the calcium [measurement]? "Calcium."

GRAYSON: Calcium.

MARGOSHES: The doctors don't know. They just have to know what the number means in terms of the health of the patient. You can call it "gizmo." Call it anything you want. In fact, Technicon funded an experiment by some people in Australia. They just took six of the standard laboratory measurements that [are] made for liver function. They put them together as a single parameter and gave it a new name, and started reporting it. By that time, the instruments had computers handling the output, so it was easy to do. Didn't tell the doctors what it was. Only one of them came to ask them. But they said, "You know, it's telling us something about the patient." They started using it; had no idea what's being measured. Didn't care. Now, I have respect for physicians, but they don't operate the way [I, as a scientist], operate. I want to know what's inside the box, even when the box is me.

I was explaining to my doctor now, when I have diabetes, and he's looking at my hemoglobin A1C levels, […why a] short term excursion, unless it happens often, if I accidentally get my blood sugar too high, it's not going to affect an A1C measurement. I don't think he really understood why it doesn't. But you have two very slow reactions that make this a good indicator of the long term, average glucose measurement. If I start making more of this for a short period, over the time scale of the measurement, it doesn't much matter.

GRAYSON: Yeah. It's not going to change the <**T: 95 min**> [average] much.

MARGOSHES: I said, "My understanding of what the problem [with] diabetics is, it's this excessive glycosylation of proteins that cause the damage. As long as that's coming out okay, I'm okay." But he didn't tell me this. I had to tell him that.

GRAYSON: Yes. Well, and maybe he's learning something. Who knows?

MARGOSHES: I think he knows me well enough, and he's open-minded. But the typical physician dealing with the chemist says, "What do you know?" This actually happened at the Harvard Medical School lab. The lab did a lot of research on zinc enzymes. They measure the activity by taking measurements of the amount of product. They're a substrate over time, so you're measuring the reaction rates. And they plot them to a Michaelis-Menten equation. […] Okay. If I ever took a class in biochemistry, I'd know it, but [I didn't and] I didn't want to let out that I didn't know. So, I waited until somebody wrote it down. I said, "You know, it's just first-order reaction kinetics. By the way, how do you know the reaction is first order?" "What do you know? You're just a chemist." He literally said that.

GRAYSON: No, really.

MARGOSHES: Yeah. Some years later, when I happened to be in [the] hospital on other business, I stopped by to say hello. They were telling me about this research that they're doing on zero order reactions. Well, good; they finally learned something. I had the same dispute with them about reaction mechanisms. […] I'd learned some reaction mechanisms at Iowa State. George Hammond threw some of that into a course. After [that] I got a 100. I got an A on my last organic chemistry test. I could understand it.

I've forgotten where I was.

GRAYSON: Well, we were talking about the fact you ended up going into physical chemistry and taking a degree in physical chemistry.

MARGOSHES: All right, so when they were talking reaction mechanisms, I said, "You know, you're a quarter of a century behind organic chemists on this." "Oh, no. It's too complicated." Well now, the things I've seen with computers modeling reactions are amazing. Yeah.

GRAYSON: So, you finally did get your Ph.D. degree at Iowa State.

MARGOSHES: Right.

GRAYSON: You didn't like Ames.

MARGOSHES: Well, it's a small town, and…

GRAYSON: Didn't find much to do there, just…

MARGOSHES: Well…

GRAYSON: You were able to study a lot, and move ahead…

MARGOSHES: I wasn't really…I just wanted…the only recreation I had, which we formed the chemistry department team, bowling league. Then, I was getting the [Sunday] *New York Times* by mail every week. My friends and I, we'd get together one evening, and work on the crossword puzzle, but other than that, [I had] my nose to the grindstone. The next town over was the town [that] Mamie Eisenhower was born in. They had a hotel there about fifteen miles away, […] a hotel that had an "eat all you can" Sunday buffet. So, I had a car, and I and as many of us fit in the car would go over every Sunday and eat [there]. I remember one time, when my friend went back for maybe his fourth helping of roast beef, the [guy who's] cutting it says, "I'll get you a big slice if you promise not to come back again." We put them out of business.

You know, that was it. There wasn't much to do. We'd go down to the local bar, get beer by the pitcher, but it was what's called "near beer." The alcohol content is 3.2 percent. You had to drink a lot of it.

GRAYSON: Yeah. So, when you […] did get your degree, now you have an opportunity to get a job, and get out into the world. What did you do?

MARGOSHES: Well, through Fassel, I got <**T: 100 min**> […] some job interviews. They weren't so appealing. [A] research [job at] Harvard Medical School. I got to call myself a Harvard Fellow for whatever that's worth. They have their own organization; never got involved with it. But you know, it does carry some prestige with it.

GRAYSON: Oh, yeah.

MARGOSHES: And living in a big city, Boston, [Massachusetts], and I met my wife there. That was nice. She grew up in Cambridge, [Massachusetts]. She grew up halfway between Harvard and MIT [Massachusetts Institute of Technology]. She had plenty of dates with college students. She got me into the stacks at Widener Library, because while she was a student, she was working in the library there, at the school. […] That's Harvard's main library. The stacks…even a Harvard Fellow couldn't get into the stacks.

GRAYSON: Oh.

MARGOSHES: So, you know, it was a good move. I learned a lot there, but in the long run, there was no future.

GRAYSON: So, what exactly were you doing?

MARGOSHES: Well, when I got there, they had […] almost completed work on a five-channel flame spectrometer. They took a three-quarter meter Jarrell-Ash Wadsworth spectrograph, not this [great] big one, [like] they have here. That's twenty-one foot. This is three-quarter meter, so it was a lot smaller.

GRAYSON: Lot smaller.

MARGOSHES: And set it up as a photoelectric instrument at wavelengths…they decided on five, so they had sodium, potassium, calcium and magnesium, and strontium, just for the fifth. I don't know why they decided five. It was pretty much a prototype and the guy [who] was working on it left for another job.

It's also when they were just moving into the lab at Harvard. Vallee had spent several years in the spectroscopy lab at MIT. He had some space […] there, where this work was going on. In order for me to work there, I got an appointment, a nonpaying appointment at MIT. So, I'd never put it on my resume, but I actually had appointments at Harvard and MIT at the same time, pretty nice, until they moved the instrument. Basically, the instrument [was] working, I [had] to check it out, see how well [it was] working, what the problems were.

Flame spectrometry for medical analysis started in Germany shortly before World War II. It didn't come to the States until afterwards. The first commercial instruments…the first one, I think, was PerkinElmer [Inc.]'s. [They took] a German design and brought it over here. It got into the hands of physicians who knew nothing about spectroscopy. There were big arguments going on. Is sodium enhancing potassium signal, or depressing it? Well, they couldn't both be right, so which is it?

I found out that neither. It's not affecting the sodium system. It's affecting the background. If you're using a filter [photometer], particularly, you're measuring a lot of background. So, the question is, how do we correct for that? We had a group discussion about this, and out of this came the first automatic background correction.

We realized that we can just take one of these measurement channels that we aren't using, like the strontium channel, and put it right next to the sodium channel, just off the sodium line. They have two…to amplify the signal for two of them, you had to use matched photomultipliers, and take the signals out, and put them across the connections for the ammeter. So, the ammeter would show the difference, subtract it.

GRAYSON: Right.

MARGOSHES: Get a subtraction figure…

GRAYSON: Right.

MARGOSHES: It worked very, very well. Now, people have come up with other methods since then. For certain situations they are better. But this was the first <**T: 105 min**> […] automatic background correction. It showed us, if you correct for the background, you're fine.

The other thing is the effect of phosphate on calcium. So, I did some more experiments, and realized that it's what's going on in the flame. You're spraying a solution in there that contains calcium phosphate in solution, [because] serum has a lot of phosphorus in it. You dry it down in the flame, and it immediately [loses] all the water, and you've got solid calcium phosphate. That passes right through the flame. So, the signal was suppressed that way. Now, what can you do about it? Well, we can get the phosphate out. So, developed a procedure [adds] a stannous chloride solution to this, which precipitates the phosphate, and releases the calcium…

GRAYSON: This is like…

MARGOSHES: Spin that down. Now you have to treat the samples the same way. But it worked very nicely.

GRAYSON: This is a sample prep step before you actually…

MARGOSHES: Yeah. [You have to do that] sample prep step to measure calcium. Now, electrodes do [a better] job. Yeah, the same way with [sodium] potassium. Just before I left [Technicon] they developed a chemical method. A professor [Donald J. Cram] at University of California, Los Angeles, who [got a] Nobel Prize [Chemistry, 1987], but I can't remember his name, [developed] these clathrate-type compounds. He developed the reagent. So, just at the time when he got the Nobel Prize, and he said that he was really enjoying work on this project, because it's the first time he'd ever [done anything] practical. But, so you know, I had a chance to see all these stages. It was fun.

GRAYSON: So, this instrument…it was, kind of, like a research instrument development at Harvard Medical School to measure these various things in blood, right?

MARGOSHES: Well, You probably do it in serum, because to get a blood analysis, you take into account what's in the cells, as well. That'll be different. All the medical correlations are based on what's in the plasma or the serum. These are different in composition.

GRAYSON: All right. Well, this is medical terminology [with] which I'm not familiar. So, maybe you could explain those for us?

MARGOSHES: If you spin down blood, you get the cell fractions and the plasma. If you first let it clot, then you spin down, get rid of, separate the clot, and you get the serum. The serum is after clotting, okay. A slightly different composition and all the medical knowledge is based on what you get out of those materials. So, the whole blood analyses have to take this into account or else you have to go through all the studies to correlate again.

Now, the blood gases are always measuring the whole blood, because one of the things you're interested in there is what fraction of the oxygen is taken up by the red cells. Okay. Or, really what fraction of the red cells…

GRAYSON: Are doing their job…

MARGOSHES: Oxygen form. Okay. So, all of these parameters are done in blood as quickly as possible. You can't do it in stored blood. Then […], one of the important things out of there is the blood pH, because that can't go too much off. The calculations that the doctors had to learn to do, too, were very complex and they were graphical methods. But still these were very difficult, but important, because if you made a mistake, you could kill a patient, if you did the wrong thing. Well, now of course, it's all computerized.

GRAYSON: Yeah. But […] in a sense, though, this is the beginning of an era when the medical profession is becoming <**T: 110 min**> educated or aware of the importance of these measurements, about the blood.

MARGOSHES: Well, the…

GRAYSON: Prior to this time, they didn't do this type of blood analysis.

MARGOSHES: Well, Ralph [E.] Thiers who Jerry [Gerald E.] Gallwas, knows…

GRAYSON: Ralph…

MARGOSHES: […] He and I shared an office in Vallee's laboratory. He's a chemist, spectroscopist, older than me by a few years, if he's still around. I don't know. Jerry would know. He was a few years ago. Jerry called him on his cell phone and gave me the phone, and talked to him. […] In his spare time, he ran a clinical chemistry lab at the Medical School. Pardon me, at Peter Bent Brigham Hospital, which is one of the main hospitals. […] It no longer exists. It's been merged in with another hospital. It was one of the main teaching hospitals at Harvard Medical School, right next to the campus. So, he was the…in his spare time, he ran the laboratory. But there wasn't much demand, because the lab couldn't produce a reliable answer very quickly. Their main instrumentation was a Klett colorimeter. You know how much sample those take?

GRAYSON: Yeah.

MARGOSHES: Yeah, five milliliters. Well, you can do a lot of tests with that. You can drain the patient. Okay. So, there wasn't a whole lot of demand. The AutoAnalyzer came out in 1957, and that was the last year I was there. They just bought one. There was an uproar in the hospital, because [we] couldn't afford it. Didn't need it. Couldn't work anyway. Well, they were totally wrong, but that was the attitude in the medical profession. It actually just changed the way medicine is practiced.

Now, the idea of profiling, Ralph did that. He'd left the lab not long after I left for the same reason. There was no future there. He went to Duke University. He came up with the idea that instead of analyzing samples for this and then for that, and then for that, [he'd] just gang AutoAnalyzers in parallel, and do all of them at the same time.

GRAYSON: Get all the information at once.

MARGOSHES: Get a profile. Yeah. Technicon picked it up, they say for another reason. Well, profiling really wasn't accepted then. Maybe they realized that for the user, doing all these standards tests on every sample, was in the end going to be cheaper than doing them individually, because they could be more efficiently done. They built first a six-channel instrument, then a twelve-channel instrument. The name "profiling " comes out of that, because the report came out on a chart, chart recorder, bar chart. It was called a profile. So now that profile is the general name…just for any set of related tests, is called a profile.

So that, again, changed the way medicine is practiced. But I want medicine to be cautious about accepting things like this. There is a tendency…a science fiction author who said that "anything sufficiently new and complex is considered to be magic."[6] That's true. I've seen analytical chemists do the same thing with new instrumentation. They think it doesn't have any problems. It's going to have a problem there, from first principles. They've got to discover it themselves, and they see it. Then, they do research it. So, it's not just M.D.s. Well, I want my doctor to be very careful about that <**T: 115 min**>.

GRAYSON: So, basically even though you had…I mean it's kind of prestigious, Harvard Medical School, what not…you just saw that there was no place, nothing really for you as a future. In 1957, you decide to change positions. Did you do a job search or did something show up automatically…

MARGOSHES: Well, again…well, something happened in between. Someone at Dartmouth Medical School [Geisel School of Medicine, Dartmouth College] who claimed that cadmium causes hypertension, [also known as] high blood pressure, and Bert Vallee didn't believe it. I had wrapped up this other project, and I had some free time. He set it up with the…to get kidneys from postmortems from patients, which [were] much more common [then] than they are now. I learned to dissect a kidney, because the main parts [are] the cortex and medulla, you [can] recognize once you know what to look for, and analyzed the two parts separately.

We found out for the patients we were looking at it didn't matter whether there was any history of high blood pressure or any kidney problems or not. The only [parameter] that made a difference was age. If you were looking at a child up until puberty, the cadmium content was increasing and then leveled off until about the age of eighteen or so. But, you know, the body's changing in many ways, and even I could, looking at the kidneys, see that these [have] a different structure than an adult kidney. The kidney is changing. So, that's [not] a big surprise.

So then Vallee said, "Well, maybe if we find there's a specific protein in there that the cadmium is attached to, that'll prove that it's there for a reason." So, we started looking for…human kidneys didn't have enough of that. We looked at various animals, and we find that horse kidneys are pretty high in cadmium. We could get horse kidneys, because at this time there were still cart horses in Boston and there was a racetrack which is still just up in the North

[6] Arthur C. Clarke's Third Law: "Any sufficiently advanced technology is indistinguishable from magic." See Jeff Prucher, ed. *Brave New Words: The Oxford Dictionary of Science Fiction"* (Oxford: Oxford University Press, 2007), p. 22.

Shore of Boston. When a horse—either a cart horse or a racehorse—died, the remains would be taken to a slaughterhouse to be cut up for leather and dog food. I'd get a call if they got a horse, and I'd go trotting over with a bucket, and wait around for the kidneys, and finally, we found a [horse] slaughterhouse in the West, slaughtering horses for horse meat, that would send us all the kidneys we wanted. So, they'd ship them by air freight. I'd go down to the airport in Boston, and pick them up. One time, a guy's coming out and, of course, they're all on dry ice and there's frost all over this cardboard box, sees me from the Harvard Medical School to pick them up. "Hey, Doc. What do you […] need these kidneys for?" I said—and I'm trying to give him an honest answer—"I'm trying to separate a protein." Well, of course, he wasn't going to believe that. I must be doing something nefarious. I know they transplant these kidneys…

GRAYSON: Yeah, right.

MARGOSHES: Yeah, right. They're giving horse kidneys to somebody. […] But, this was an interesting project, because it was all learning to me. We finally separated a protein and [when] it was taken apart, it contained quite a bit of cadmium, also quite a bit of zinc, not too much of any other metals. The protein had an unusual number of thionein residues—you know, thionein has a sulfur…

GRAYSON: You're right…

MARGOSHES: That's what's bonding the metals <**T: 120 min**>. Now, there have been five international …I left about this time, and another postdoc from Switzerland called Jeremias Kägi […] from Switzerland, took over for me. He made a career out of this. To date there have been five international meetings on metallothionein. The last time I scanned for metallothionein on Google, I got a million and a quarter hits. As far, as I can make out, they're still not sure what the function is, but it not only occurs in animal kidneys; it occurs in every type of animal and plant tissue in various amounts. There are different forms of metallothionein in [different organs [in] the human body.

GRAYSON: And does it have anything to do with diabetes?

MARGOSHES: Nothing to do with diabetes. But it may have something to do with detoxification. That's a popular theory, but they're still not really sure. But at any rate, it's generated an awful lot of research. […] It was supposed to be just a training exercise for me, hit something big. You never know in science…

GRAYSON: And fifty years later, it's still a big item…

MARGOSHES: There's still a lot of people busy taking it apart.

GRAYSON: Going to turn it off. You want to take a break […]?

[END OF AUDIO, FILE 1.1]

MARGOSHES: Biochemistry majors who never studied physics, so [we] might as well cover that, as well. That's an interesting thing. Something that came up when I was at Technicon: one of the biochemists had a manuscript he wanted to send out, and there was an internal review there, and I was asked to look at it. It involved enzymes and I've had some experience with enzymes. It was a discussion which apparently showed up in this paper, because it had been going on for some time, on whether an inhibitor of the forward reaction of an enzymatic reaction will also inhibit the reverse reaction.

I said, "The equilibrium is determined by the reaction rates for the forward and reverse reaction. Fundamentally, it's determined by the thermodynamics of the compound. [With] thermodynamics, how you get from A to B doesn't matter. But it does matter that, inherently if something changes the reaction rate in one direction, it has to change it in the opposite direction to maintain the thermodynamically-determined equilibrium." Apparently, this is a new thought to enzymologists. Nobody ever told them that fact of life. This is the danger of becoming too specialized. On the other hand, you can't know everything.

GRAYSON: Well, that's true. That's why we have people working in different areas to try and keep them on the straight and narrow. But, it is an issue, and it's a problem. So, you were…had you actually left Yale [University]. I mean…I'm sorry, Harvard, by this time?

MARGOSHES: Well, I…[help] again, from Fassel—Velmer Fassel. I got a job at the National Bureau of Standards, and went back to being a spectroscopist, but […] at Iowa State, Fassel's group did mostly common spectroscopy, but I was going infrared. So, I learned something by osmosis, if you like. Doing the flame work, I learned some more. The work I'd done on the processes going on in flame, where signal spreads to signal enhancers, that sort of thing, had gotten some attention. So, that landed me the job at Bureau of Standards. Bourdon Scribner was heading up that crew. Bourdon's father had worked at the National Bureau of Standards. When Bourdon graduated high school at seventeen, he took the civil service exam, and got a job in the spectroscopy group run by William [F.] Meggers […].

Meggers got him started on doing research so that with no college education at all, after one year [he] had his name [on] a publication, which is really something. But he did go back to school weekends and nights, and got a bachelor's degree [in physics] and a master's degree from the University of Maryland. And when the decision was made to set up another spectroscopy group, not in physics this time, but in analytical chemistry, Bourdon was chosen to run that.

GRAYSON: Oh.

MARGOSHES: So, he set up that laboratory, [which] not only did […] work for the Bureau of Standards, but developed a whole new series of standard samples and had to develop new techniques, because if you have samples for spectroscopy, if they're using spark excitation on metallic iron, say, alloy, and the standards have to be in the same form. Well, how do you make them all uniform? So, they had to develop a lot of techniques <**T: 05 min**> to do this, and also confirm it. He was central to that.

[It served] for other government agencies, as well, doing analyses. The FBI [Federal Bureau of Investigation] relied on that lab, until they finally set up their own, which they did, but pretty much copying what was used by the Bureau of Standards. So, it was a very influential lab, and Bourdon was very influential in spectroscopy generally, for the standard sample program […], development of techniques, and so on.

During World War II, he developed the method for analyzing uranium for impurities. It's a very clever one, because uranium has an extremely complex spectrum, emission spectrum. He took advantage of chemistry in the electrode, so that the uranium would be kept behind [but] the impurity elements [that] were more volatile [would] be swept out by…I think [it was] gallium put in there to volatilize and push them out. That was the method that Fassel used at Iowa State, in the Manhattan Project. It was used in other labs as well. And I really should have…but I guess I felt just too shy to say, "Thank you, because [you] shortened the war for me, [or you helped]."

GRAYSON: Yes.

MARGOSHES: May have saved my life.

GRAYSON: Yeah, a lot of people's lives.

MARGOSHES: We were down in Washington in February for a family function, the first time we've had time […] free to go to the big Air and Space Museum that the Smithsonian [Institution] has out by the Dulles Airport. Been there?

GRAYSON: A long time ago.

MARGOSHES: Yeah. Well, they now have a space shuttle in there, as well. I had no idea the thing was so big. But they've got a B-29 hanging up top, and not any B[-29]—it's the *Enola Gay*.

GRAYSON: Oh, my goodness.

MARGOSHES: The guy took us through, I said, "That's the plane that saved my life." That's the way we felt.

So, Scribner ran a very good operation, [but] he was not a boss who gave you step-to-step directions on what you should do. You [could] discuss things with him, and work it out. When I got there, he said that I could spend half [the] time on whatever research I wanted to do. Well, that's great. I had never had that opportunity before, so I thought about it. I decided that the excitation methods, the arc and spark, had been around since the 1920s, and really had been pretty much researched out. And maybe with the new technologies there's something there that [could be made use of].

In Vallee's laboratory, after I finished the work on the flame spectrometer, [they] realized that the limitation of the flame [is that] it's cool, compared to arcs and sparks, so it doesn't excite spectra of many elements well. They tried for a hotter arc…a hotter flame, pardon me. And after a search they settled on the cyanogen-oxygen flame. And Kei Fuwa, who I mentioned over lunch - I don't know if I can spell Keiichiro Fuwa, transliterated - he was put to work on it. My only part in that was, where do you get cyanogen? From [American] Cyanamid [Company].

GRAYSON: Okay.

MARGOSHES: I would go down to New York for weekends from time to time, because I had family and friends there. On the way back on Monday morning, I just dropped into Cyanamid and put a cylinder of this poisonous gas in the back my car and drive off. Imagine doing that today!

GRAYSON: Oh, yeah.

MARGOSHES: After I retired I found there was a group of retired chemists that met for lunches in southern Connecticut periodically, mostly people from Cyanamid, so I [decided] I'd join them.. And one of the guys there <**T: 10 min**> [is the] one who used to give me the cyanogen. I said, "Why did you bother? [Why] was the company involved?" He said, "Well, we thought we'd sell a lot of it." I said, "Even if we'd succeeded, for a company that big, you know, it wouldn't have mattered."

But at any rate, I thought and I said, […] the advantage of a flame, even though it's cold, is [that] it's very stable and if I spray solutions and I have a steady-state situation, my measurements can be much more precise. At the Bureau of Standards, this matters. Working with solutions, I can develop solution standards that are exactly the same composition as the samples. So, I can really get accurate sample analyses, more accurate, more precise this way. [Versus] how do you get an arc to do that?

GRAYSON: Yeah.

MARGOSHES: Well, here in Philadelphia they had just closed down the trolley system. The […] DC generator plant was still there and taken over by people from the University of Pennsylvania—physicists—to try to make a hotter arc by pinch effect, using something they called a "plasma jet." I said, "Well, I'm not trying to get that hot. Maybe I can do this on a small scale, and maybe I can spray solutions [into it]." So, that's what I did.

I remember the day a group of engineers from PerkinElmer came along looking for new things, and […] they brought in somebody to show them my work. The engineer says, "But you can't make it hotter, because you can't get a pinch for that low a current." I said, "Yeah, that's right." I didn't want to argue with him. But they missed the whole point.

On the other hand, the only other people I found that were working [along] similar lines were in Moscow, [Russia; they were only] publishing in the Russian journals, and getting translations was very expensive. Now you just push Russian text into Google. What do they call it, "translations"? You get it back in English. It's marvelous. It's not really good English, but you get the sense of it.

So, I had to take a class in Russian for a year taught by a White Russian woman who got to America by marrying a Navy officer, in […] Shanghai. There were a lot of…after the revolution, a lot of White Russians went to China. She would tell us about how in the good old days, everybody had a silver holder for their tea glass. I'm thinking to myself, "Everybody? Really?"

GRAYSON: Yeah.

MARGOSHES: So, but I learned enough to find out that the people in Moscow hadn't even thought of spraying water into their…solutions into there. They were still working with materials in the electrodes, so you can't have that steady-state set up, make it more precise. So, they missed the point [too]. Well, Spex Industries picked it up to basically copy what I had for this product. I don't know how many people bought it.

But, Fassel [then] got interested and decided to do me one better. He had fifteen years of graduate students working on it. He and I had an argument going on, still friendly, because I and another, and Stan [Stanley D.] Rasberry, came to […] Bureau of Standards about that time, and built an ICP just to see how well it works.

That's when […] we wrote a review, and one of the things I put in there was to comment that, [from] physical principles which I understood, but I don't think Fassel really did as well, he's not going to have thermal equilibrium. Now, thermal equilibrium, it's an interesting situation. In a black body…black body is in thermal equilibrium, because it contains no information except the temperature. Composition of the black body of a gas <**T: 15 min**> that's in there doesn't affect the spectrum at all. It's just the pressure…the temperature, so if you want to do analysis, you can't have a black body type situation. It has to be what they say, "optically thin," which means you've got energy flowing through, and you may have a stable condition, but it may be close to equilibrium temperatures, but it's not quite there. Okay.

Now, how do you reach this equilibrium? Well, mostly by collisions between free electrons and the atoms and ions that cause most of the excitation. Yeah. And I was using argon in my plasma jet. Fassel was using helium. Helium has a much higher ionization energy. It's very difficult to get enough electron flux there to have thermal equilibrium. Plus, there's some papers that he may not have paid attention to, that came out of Vallee's lab, work they did just before I arrived there. They were interested in using these inert gas atmospheres, because when you burn an arc in air, the carbon and nitrogen react to form CN radicals, which we call cyanogen but, it's not the same as cyanogen gas. It's a radical. Which has a beautiful set of bands, really good to look at. But it would cover up a lot of spectrum.

GRAYSON: Yeah. Not useful for…

MARGOSHES: So, one way to get around it, is to replace the air with some other gases, unreactive. They've done a lot of studies on what happens in the spectrum. They had shown clear examples of the relative intensities of lines being affected by the collisions with the excited gas atoms. (I was going to say molecules, but those are atoms.) Clearly, they were not in thermal equilibrium.

So, I knew that [had to happen] in this plasma. Fassel didn't believe it. Every talk he gave, he would quote half a sentence from this article that [Veillon] and I wrote, always ascribing it to me, of course. Then, he would talk about why it's wrong, [but] he didn't have any data to prove [that].[7] I said to him once, because the second half of the sentence, sort of, qualified that. I said, "Velmer, if you just quoted the whole sentence, you wouldn't have anything to talk about." But you know, he had a handle and I [didn't] get angry about it. You know, we [always] stayed on nice terms.

It's like, [there] was this famous—in the spectroscopy business before me—conflict with Dean [George R.] Harrison at MIT and the [Meggers] group at the Bureau of Standards [about how you] should make [measurements with] the spectra. At MIT, they had automated it. And at the Optical Society [of America] meeting, they would have these debates, but it was just for fun, and, you know, they're very good friends. So, it's one of these things.

Finally, Fassel had a student write a computer program to model the processes in the plasma, assuming it was in thermodynamic equilibrium. They published that. Then he had a student make the measurements and see if that's what they were measuring. I found this out, not, like…paper was published. I read it and [said], "Okay. That's the proof, I'm right." Of course, it ended the discussion. I never said anything to Velmer about [it]. I could have said, "See, I told you so." There's no point in that.

But [just] a few years ago, one of the people at Iowa State told me that the student saw the results. He was afraid to tell Fassel. You know, these little backstories I think are very interesting. But, you know, the point is, I think even if you're very good in your field, if you don't really understand what's going on in detail in there, you can be very wrong and not know it.

GRAYSON: Yeah. Well, these are not that simple situations, you know…

MARGOSHES: Nothing's simple. […It isn't]. And during World War II is when the technique of operations research was developed. From what I've read, they find that <**T: 20 min**> chemists were better at it than physicists, because chemists are trained to look at the complexity and work with that, not necessarily on a mathematical basis, whereas physicists are taught to simplify to the point where you can write equations. Like, how does a physicist capture a tiger in the desert? Well, you build a stockade with a tiger outside then you do an inversion. Okay.

So, [either] you come to it with that way of thinking, or you learn it. And I'm halfway physicist. In fact, at an international meeting, one of the spectroscopists from Europe said to me, "Oh, you're a physicist." So, fortunately Fassel was there to tell him, "No. He really is a chemist." Not a very good one, I wouldn't say that, but I think it's important to understand

[7] C. Veillon and M. Margoshes, "An Evaluation of the Induction-Coupled, Radio-Frequency Plasma Torch for Atomic Emission and Atomic Absorption Spectrometry," *Spectrochimica Acta* 23B (1968): 503-12.

[that]. Now, even to work with it, I found myself working with engineers at various places. You have to learn their language, their ways of doing things to make it work. Otherwise, first of all there's a language barrier. We use words with different meanings.

GRAYSON: Oh, yes, definitely.

MARGOSHES: We haven't gotten to the computer part of it, yet. But I have a computer we've written in BASIC at Bureau Standards. We were limited in the size of jobs we could run on a timesharing system, because you [had] 32K of memory to work with, period. So, we want to put it on a mainframe, which means you [had to] translate [it] to FORTRAN. And I got one of the programmers to take it over. The BASIC language system, I figured, that's pretty transparent and he should be able to figure out the process from reading it. [But] I also ought to explain to him what we're doing. I said, "What we do is, we analyze elements in a matrix" and it became clear I wasn't…he couldn't understand that, and I realized, he's probably got a math background, to him elements…

GRAYSON: Yeah, matrix is…

MARGOSHES: …has one meaning; to an analytical chemist it's entirely different.

GRAYSON: Yeah, different words.

MARGOSHES: Well, it turned out—he gave me a FORTRAN program [which] didn't work, so then I learned FORTRAN. But, sometimes you want the job done right, you have to do it yourself. Going back to Brooklyn Tech, when I was working on that plasma jet, I had to machine things, and otherwise make them. But, at Brooklyn Tech, because the nature of the school, I had every kind of shop, including machine shop. I had to learn how to make castings. I knew how to do all these things, whereas how many people get through high school and know that when going on to college.

GRAYSON: Well, it's not a common thing.

MARGOSHES: No, but very useful.

GRAYSON: Very useful.

MARGOSHES: Yeah, more useful than if I [had] studied French.

GRAYSON: I think so, perhaps yes.

MARGOSHES: I studied French. At Iowa State, I had to pass an exam to show that I could read scientific French, and I never studied French in high school or undergraduate. I studied German as an undergraduate; it was required, but the retired head of the language department at Iowa State taught a refresher class in the mornings in the summer, so I took that, and I learned enough to get through. Scientific papers are written with a very simple grammar. Except for the special terms, it's not a very complicated set of…dictionary you need. I can read it.

But In fact, I once found myself…you know, the University of Paris has a newer campus out in the suburbs. I was dropped after there…I was visiting another lab in the morning, and [in the afternoon] they dropped me off there to talk to a professor. […] I came to the office, and the secretary was there, but the professor was out. I just let her know who I was <**T: 25 min**>. Sitting there, and she answers the phone, and talked some very excited French I couldn't follow. Then she tells me, and somehow I understood it, the professor can't make it. There I am and somehow I managed to tell her: "If you could help me get to the train station, I'll find my way back." She gets me there; I got all the way back to Paris. I got to my hotel, everything, fine, but for months afterwards, I would have nightmares about trying to say anything French.

GRAYSON: I can imagine that.

MARGOSHES: Right. It's not so important anymore. Even the French will speak English now. Okay.

GRAYSON: So, this is…you know, at the Bureau of Standards you were developing, working on the plasma to…

MARGOSHES: Yeah. Then, the next thing is we [wanted] to do [was] study the nature of the source. We took some high-speed movies which showed [that], in fact, it was [not stable]. You could see the arc wandering around. But it, it was doing that in a sort of a regular way, because you had gas going in that I put in tangentially, and that was pushing it around. So, it wasn't a steady-state situation, but it was a stable situation. [And it was] fast enough so that during exposure time, things averaged out well.

So, in fact, later on, when I did some precision studies with a photoelectric instrument, and being very meticulous in how I measured things, that I was seeing changes over time in the

[…] line. That was shifting. What was interesting is that, the way this instrument was set up, there were two chromium lines that you were measuring there that were different intensities. But this had the same the same excited state, so anything [that changes the intensity of one line should change the other proportionally. But what I saw was they drifted independently. They] cannot be…the drifts cannot be in the source, they're in the instrument.

Now, these instruments are made [to be] stable, and [they're kept] in rooms at a very stable temperature, to within a degree. It's very expensive but it's what we had to keep this drifting from happening…but it's going on anyway, it's just we didn't have a stable enough source before to see it. And they didn't believe me. The engineers didn't believe me. I said, "Well, look. These two chromium lines, they change. One changes in one direction, it changes in the other direction. The spectrum is drifting. It cannot be anything in the source."

So, the problem is that these big instruments, they're in a […] stable lab, but all the heat is generated at one end. Unless you've got air flowing awfully fast around there, you can have temperature [differences] and it is going to cause these things. They designed them such that it [adjusts for] the temperature changes…it won't affect the spectrum, because things expand in a certain way to compensate. But they just never had to be as good as these new [flame-like] required. One of the advantages of the [echelle] is they're much smaller, inherently, so that this problem, as far as I know, goes away. […Tomas] Hirschfeld pointed out, the spectrum isn't too complicated. We don't have to read just one wavelength, where that line is, we'll read three, one on each side, too. Let it move a little. You still get the same answer. So, that's the benefit you get from that.

GRAYSON: Hirsh…

MARGOSHES: He comes from, I think it was Bolivia, and…

GRAYSON: Hirschfeld sounds German.

MARGOSHES: Many <**T: 30 min**> people thought he was a genius. I'm not sure about that, but he was a very smart guy. I learned a lot working with him about bridging different areas. The difference is, where I knew these areas in a somewhat shallow way, he knew them [in depth]. He just knew more than I did and was very good at putting things together.

GRAYSON: What part in his career, […] did you interact with him?

MARGOSHES: This was at Block Engineering, [Inc.].

GRAYSON: Okay. This was later on.

MARGOSHES: Yeah. At any rate, what happened at the Bureau of Standards about this time is Stan Rasberry had just come to us. He came to us first in his summer before his last year in college, as a summer worker. He was the only one in my time there who we offered a job when he graduated. He was that good. He never went to graduate school, but he became one of the Directors of the Bureau of Standards, in charge of the whole standard samples program. Very, very smart guy.

He and I did this study of the […] first laser probe, […Rasberry] worked with me on the laser probe, the Jarrell-Ash laser probe […].

The laser probe was developed by an Englishman who worked with Jarrell-Ash. Can't remember his name now, it may come to me. I knew him already, because he had made an attempt to convert the flame spectrometer that I worked on at Harvard into a commercial product, and never got it done right. Two or three times brought over prototypes for me, and they just [never worked]. So, they gave up [at that point], but I knew him. Fred, Fred, Fred…I've got the first name [Fred Brech].

Any rate, he had the idea of if you could vaporize materials from a very small area by focusing a pulsed laser on it—I guess people knew that—but he said, "But we can look at the spectrum from that laser plume." That's a weak spectrum and it's a dense plasma, so the atoms are close together and the lines kept growing [wider], so it's a not good spectrum. So, he rigged it up so that right above the exact place you were going to spark you had two graphite electrodes that connected to a charged capacitor such that they're close to the breakdown point. When the flame-like vapor reached there, [you get a spark through there].

Okay. He got a good spectrum. So, Scribner bought the prototype, and Rasberry and I evaluated it. We came to the conclusion—we already had an electron probe analyzer—that this had some possibilities, but it wasn't going to be as good overall as the electron probe. It wasn't worth it to us. We already made some improvements to it in the process of evaluating it, but it wasn't worth it to us to spend more time on it. It never really caught on that much, [people are still] experimenting, [and it has] some uses.

So, Rasberry and I worked together very nicely. I don't know which of us it was, one of us discovered…oh, meanwhile, in evaluating the plasma jet, one of the things you want to do is determine how the <**T: 35 min**> temperature ranges from the middle of this plume on out. There is a standard way of doing this. The people that…the spectroscopists in the physics division had a program to do it, so all I had to do was make the measurements and use the program, but it got me started on [computers, at least] comparable to making a deck of cards and going down there, and turning it in [and coming back], routine.

But, I remember it was Stan Rasberry or me, we found that there [were] other people in the Bureau of Standards that were connected to a timesharing system at Dartmouth University. That was the original one. I think it was [John C.] Kemeny and [Thomas Eugene] Kurtz. They wrote the BASIC language to go with it. It was a much simpler BASIC than he had later on. It was, I think sixteen statements, including matrix algebraic statements in there; which was interesting, it included that. But they said their whole intention was to make it so easy that even the divinity school would use it, but to prove a point, they didn't go to the divinity school, they went to a local elementary school and taught the third grade class how to use it.

GRAYSON: Oh, wow.

MARGOSHES: So, that's simple enough. Oh, one thing I didn't mention at Vallee's laboratory…got to get back to this. Because, a reference…

GRAYSON: Yeah.

MARGOSHES: We moved around too much. One of the M.D.s working in there was Warren [E.C.] Wacker. Warren's a very bright guy, but his interest was not in a future in research, but in medicine. He became good enough, eventually…he was the first physician ever to be on the board of the Peter Bent Brigham Hospital. At about that time, another [physician, Arthur "Art" Karman] who I now know developed a blood test that would tell you if a patient was having a heart attack, quickly […], based on the idea [that] the dying heart muscles release enzymes. So, he picked out a particular enzyme, and showed that, yes, we could tell. It was very important, because the EKG may not show it for some time. A patient comes in with chest pains, the EKG may still look fine, [but] this blood test will pick it up.

So, Warren Wacker, decided…well, one of the […] enzymes we worked on we were getting from beef heart, beef heart peroxidase The joke is to get that stuff, how do you get all those little bees to do the same thing at the same time?

GRAYSON: You said, "Bee…"

MARGOSHES: Beef heart. Beef hearts. […] But say it fast.

GRAYSON: […] Yeah, okay. Bee fart.

MARGOSHES: How do you get all those little bees to fart [at once]?

GRAYSON: Okay. [laughter]

MARGOSHES: [Any rate], he said, "Well, [there's] that enzyme in heart too, so let's check in there." So, he set up the test, and yeah, [sure] it worked. So, we made it available to the hospital, and it caught on.

But meanwhile, the [clinical blood] lab only had this Klett colorimeter You know, they really couldn't keep up with demand. We had spectrophotometers that we could use for it, so we were getting all this workload, but we had the spectrophotometers to do research, okay. So, it was nice to have so much attention, but it's [interfering with] what we're really here for.

So, we went into a dark room, […Ralph E. Thiers], who I mentioned before, [and I]. We said, "What can we do?" We decided we'd build a very simple spectrometer, just for this one [purpose], measure [just] one wavelength. Well, the first thing is, what do we use for a light source? Oh, but…it's 340 nanometers, [so an ordinary] light bulb, and the filter. But Sylvania had their research labs nearby, so we made an appointment to meet somebody there, and maybe they knew something. He put us on [to] these black light fluorescent lamps. They put out a band, that centered at 350 nanometers, close enough to 350. In fact, it overlapped 350.

GRAYSON: Yeah.

MARGOSHES: I mean, a measurement of 340, that band it overlapped also, so the two of them weren't [an exact fit] <**T: 40 min**>, but you're good. But it had to be very good so we got a light source. Now, the […] design we have in mind, we wanted a sample and reference measurements, so we needed two detectors and they had to be matched. This has to be cheap and simple. What do we do? Well, one thing we're doing with photo multipliers to match them. There was only one Radio Shack at that [time]. That was in downtown Boston. The owner, Mr. Cohen, really loved to work with people from Harvard, so I said we go down there and get all the sort of multipliers and take them back and check them and find out…take out the ones I like and bring the rest back. But for this, we decided to do something else. There's a light detector which is just solid metal. I can't remember the name of it [barrier layer cell]. I hope it will come to me. But, any rate, this thing's about yea long and about so wide. [Let's] say, three inches long, an inch wide, inch and a half wide, or something like that. Just take a hacksaw and cut one in half. Now you've got two matched detectors. The only expensive thing, we needed a very sensitive milliammeter, and that cost forty bucks. The rest of was really cheap, and it [worked]. It worked better than the DU for that application.

So, Ralph Thiers came up with another idea. We can do lots of other tests on this and we can package it for use in the doctor's office. […] All you do is put all the reagents and the dry material in the test tube. The test tube was a sample container for the instrument. Just […]

come prepared. All you have to do is add water, dissolve it and put in the sample and stick it in the instrument and take your reading.

Okay. Now, we got to find somebody. First of all, the first problem was we couldn't patent anything. Harvard had a rule that you could not patent anything in the field of public health. That broke down when somebody came and offered a twenty-million-dollar grant [not to our lab], to another part of the medical school in return for patents, so they changed the policy. Okay. For us they weren't going to change the policy.

What company wants it? We hardly knew Technicon. This is the time, just when the AutoAnalyzer is coming out and didn't know who they were. The leader in the field of electrocardiograms was in Boston, so we went to them. Said, "Here we have this machine [for] diagnosing heart attacks." "Oh," they said, "No, we only build electrocardiograms." This is a generality. Business don't really understand very often what business they're in.

GRAYSON: Yeah.

MARGOSHES: Right. The famous example in business schools is the railroads. They never went […] into airlines, because "We're in the railroad business." They're really in the business of moving people and things, but they never saw it that way.

So, it was a laboratory warehouse in town. It was a one-owner thing, not a big operation, but we used to buy our stuff from him, and he was looking for ways to expand, so we offered it to him. Just to prove how simple it was to operate, we wrote out instructions, took it over there with the prototype that we built. He called a kid out of a stockroom, never studied chemistry. We told him, "Go read the instructions. Here's a pipette, and here's how you use it. Go run the test." He did it. We said, okay. Simple enough to use and it sold for several years. Forget the name of the company, enzyme company, put out the…called Determi Tubes, that had all the reagents […].

Very popular until…the problem with it is, because of the size of the container…it was smaller than a Klett colorimeter, but still compared to later models of clinical analyzers, it was too much. So, it had a good run, but it couldn't keep up. Technology doesn't last forever…

GRAYSON: Did this have a model or a name or…

MARGOSHES: It was called a coenzymometer. Because you're measuring coenzyme activity. I have some literature on it that I saved that I could have brought down. I didn't think of it. <**T: 45 min**> All we ever made from it is a one-day consultant fee with this company. But, you know, it's nice to see something come to the market…

I see this with my oldest daughter. She's also a chemist. She has a Ph.D. in food science from Cornell [University]. She works [for] Proctor & Gamble. She's now doing a type of testing of how products taste: sensory testing. So she's doing that now. But, she has the exact same thing. She works at Proctor & Gamble, and she said, "I want to work near the market." She likes that stuff.

GRAYSON: Yeah.

MARGOSHES: I do too. There's a satisfaction seeing people use it. I have an example of something I worked on a little at Technicon…was used on me. I didn't get anything out of it going to market, except it helped me.

Okay. Any rate, as I said, Rasberry and I got along. He was really working with Kurt [F.J.] Heinrich in X-ray spectroscopy.

[…] But you know, we talked to each other a lot. One of us found out about these other groups having these terminals to the computer at Dartmouth. Well, we couldn't get…they couldn't handle any more. But, apparently, GE [General Electric] has part of the work at Dartmouth, and they use GE equipment. GE had set up a duplicate out in Phoenix, [Arizona]. They wanted people to use it, assess how it's working. We can do it free, but we have to pay for the phone line. Okay. Well, the government has leased lines. The trouble is government leased lines then were noisy. The computer system wouldn't work with it. The data got too scrambled.

So, we had to go on [the] commercial lines, eighty dollars an hour. I'm paying, like, thirty dollars a month now [to be] connected full-time, and transmitting at two megabytes a second. I got a fiber optic system, which is fabulous. But at any rate, we started automating all the usual steps you do in emission spectroscopy which were all done graphically, up till then. This involved a little basic research, because you really have to…to do the programming properly, you really have to get a good understanding of what's going on, including in the photographic emulsion.

GRAYSON: So, this was while you were still at the Standards.

MARGOSHES: Yeah, Bureau of Standards. We did that. It really made a difference. We weren't the only ones working on this. There were other people at the same time, because you had computers like PDP-8, so you could have in the lab, and that sort of thing. So, the idea was catching on.

One example, in a lab like the Bureau of Standards where we handle the whole diversity of stuff—it comes from all over if you're the government—some of the [analyses] we do enough so that we have standards set up, but others we have to improvise [standards]. When you plot them, you can see very clearly that some of these points don't fit on a line. How is a computer going to recognize that? These were not necessarily straight lines, and they have curvature. Okay. Let's use polynomials, but how far do we go? Well, one rule is, if you have as many terms in the polynomial as you have…

GRAYSON: Data.

MARGOSHES: Factors, you can get an exact fit, but it doesn't apply to anything else. So I made the rule you can't go a polynomial higher than half the number of standards, pulled that out of the air. Then how do you know which ones to throw out? Well, let's systematically go through here, take out one of the standard's results and see how much it changes the result. If it improves it…[you know], you get an R-value back. If it improves the R-value by a certain amount, we'll say that one doesn't fit [with the rest of them].

I taught…<**T: 50 min**> at the Bureau of Standards, if you have any statistics in a publication, you're not going to get it out there to a journal unless statisticians go over it, so I thought I better to talk to a statistician first. He said, "Statisticians are all up in the air. The statistics are small numbers, if yours works, fine. We won't tell you no."

GRAYSON: Interesting.

MARGOSHES: So, it's okay, and it worked. It worked to the point when I turned it over to a technician, who all the time [was telling] me couldn't possibly work, he comes back to me…one thing we always did. We had printouts of the fit so we [could] eyeball it. We [didn't want it be doing] something really crazy. So, he brought that printout with his own graph paper plot, and he says, "They're not exactly the same, which one is better? Which one is wrong?" I said, "I don't know. I can't say one's better than the other, but I can say this: the one with the computer is more reproducible." Now, he'd gone from telling you it can't possibly work to assuming it was working, maybe even better than his usual method. Quick turnaround, interesting.

I remember at Pittcon one year, there was a whole session on computer things, because of the hot subject. […] An engineer was talking about their programming. There was something about what he was saying that didn't seem quite right to me, so I went to him afterwards, and I said, "Could you send me a set of your data? I want to try it on my software." What I really [wanted] to do is get a plot of it, which he didn't [give]. I got a plot curve, decreasing concentration across here, [went] like this. Flat. Half of his points were below the detection level. […] He didn't know that. He was fitting straight line. You know, people [were] doing things like that, because they didn't understand both sides of it.

GRAYSON: Yes.

MARGOSHES: The other thing I did was I said, until this time, when we report results, we estimate errors based on how well we can duplicate the measurements on separate runs of the same sample at precision. But there's another uncertainty that, every time you run a calibration curve, same standards, you get a slightly different calibration curve. That's a source of error also. So, I look at that, and I said well, when you pick out standards, [the assumption] is they will behave like [the] samples. Basic. If they do, I can take the scatter around the calibration curve as my better estimate of error.

Now, Scribner got bothered by this. Why are results less precise? I said, they're not. We just never realized. If we'd realized [we didn't] have to take into account this other error source. Well, an interesting thing happened. The Bureau of Standards…particularly in developing standard samples, different groups would analyze the same materials and then fight about who was right. Those fights disappeared, because I had them [all] using the same software now and taking into account this other parameter. People were fighting over an unreal issue. The real issue was that we really didn't understand the precision. And I think that's still the general theme, as far as I know.

GRAYSON: This whole business with statistics and precision and errors and what not is…I think, not many people really understand it very clear or very well, you know; as well as they need to.

MARGOSHES: Yeah. Well, in the medical field the rule was, you calibrate your instruments at different periods, different intervals, and you always forgot about the old calibration. Some of the ASTM [American Society for Testing and Materials] methods I was familiar with said unless the change exceeded a certain amount, you should average out, because that data is still valid. Okay.

The medical people…at the same time, you'd have hospitals in the same city, two blocks apart that had different normal values. How could this be? There's something wrong there. They're dealing with the same population <**T: 55 min**> [with] the same diseases [and eating the same diet], everything. Why are their normal values different? Well, finally, under federal urging, they've improved their operations, and they're much more precise now.

These home blood glucose analyzers, I use one of those. I know that if I sample my blood and I get a reading of, say, [one hundred and twenty] and I daily sample my blood again, and it may come up to one hundred and twenty-one but it's not going to come up [one hundred and thirty]. It can be very close. It's good [reproduction]. That doesn't…the accuracy, I only have one standard to go by, it's a one point standard, and it's a pretty broad range. In blood pH, there's only one standard, that there's only a narrow range that it can possibly have, if you're alive. So, one standard is okay, but here I've got a range can go eighty to two hundred. That's a big range, and only that one standard. That's not good enough.

GRAYSON: Yeah.

MARGOSHES: But it's good enough for me to…I really feel that I have good control.

Now, getting back to instrument companies and that was a new idea we had in R&D, sort of, technology to make [a home glucose analyzer]. Couldn't convince the company to do it because there was no market. I had…you know, this again carries in with this instrument development. When I came to Technicon, I saw some work that had been done at the University of Illinois, a very simple Raman spectrometer. How you could build one which would not be what the physicists want in studying Raman spectra, but it would be capable of doing good work in analytical, and that's what they're making now.

So, I got to do a presentation and final question: "Such a good idea. Why isn't PerkinElmer doing it?" I don't know. Years later, here on our instruments and artifacts committee, we had the guy from PerkinElmer, remember? I told him about this. He said, "You know, I had the same idea. And I gave a presentation. You know what they said to me? Such a good idea, why isn't somebody else doing it?" The nature of the instrument companies when they get big enough, they're not innovative anymore.

GRAYSON: Yeah. They want to be with the crowd or something.

MARGOSHES: My project's going to take away from their R&D budget. Plus they really believe in their instruments, even when the competition was outselling it.

GRAYSON: There's always the "not invented here" saying. That comes in. […] So, did you…

MARGOSHES: We got into computers then.

GRAYSON: Yeah. Was this at Standards that you started the computer…

MARGOSHES: Yeah. Bureau of Standards. […] Finally, GE set up a computer in New York, and they would provide for the phone line, and it was five dollars an hour.

GRAYSON: So, this was always…you were always doing this at remote location over a phone line.

MARGOSHES: We were doing it over the phone line, either from Phoenix or later from New York. Okay. We didn't have our own computer. Just the time I was leaving the Bureau of Standards, I was part of a committee that was looking into what computer to buy to automate all the instruments in the analytical chemistry division. They went ahead with that finally. Not [for] the [NBS] computer lab, because they didn't like any of this stuff, you see, because they lost control.

GRAYSON: Yeah. So, what year would this be in?

MARGOSHES: That was…well, I left there, it was in 1969.

GRAYSON: So, you had a pretty fair stretch of your career there, twelve, almost twelve…

MARGOSHES: Yeah, about twelve years. 1957 to 1969.

One of the…now what happened was that this success got me thinking. It was known by a lot of people—I wouldn't say generally—that there's a lot of information in the atomic spectrum that we're not using. We could do very simple things like, why measure one line pair for an element? Why not measure several? And if one of them suddenly disagrees with the others, then you can know that's a false result and get rid of it. Otherwise, you can <**T: 60 min**> average them, and do better. Plus, there's a lot of other things you could do with it. But to make this work, you had to have a lot of data, a lot of wavelengths with [a type of] precision you can only get photoelectrically.

How do we do this? I was thinking and thinking and thinking, and all sorts of complicated optical systems, and couldn't come up with it. One of the things I did at the time, is I'd take myself to the library and sit down with the astronomy journals, because they do very difficult spectroscopy. Maybe I can get ideas there. And one of the articles had a photo of the planet Venus taken at two o'clock in the afternoon. It's the planet Venus against a black background. I said, if they can do that…that's the detector I need. What is it?

So, I read the fine print. It's a particular type of TV camera made by General Electric, again, which [has] another property which was very favorable, that it was a perfect integrator, like photographic emulsions. Even better, because photographic emulsions, when you go down to the very low intensities you can get what's called reciprocity failure. A silver chloride particle, or bromide, whatever it is, […] needs to absorb two photons in a short time in order to become subject to…in the chemical treatment you do later so if you have very low light intensity the second one might not come on fast enough and you lose the linearity. If you go too high it all gets saturated, so you've got this range. When you think about it, what you're doing when you measure the transmission through the developed emulsion, you are in effect counting the number of silver particles in that area that you're measuring. So, the best you can do is what you can do by counting statistics. You could do worse. That's the best that you can do.

So, [there's limits to] what you can do with a photographic emulsion. You can go to fine grain emulsions, which are less sensitive, and [a lot of] things. But you really [want to] do it photoelectrically, and [now] here was a detector. Now, [fine], how do I get the light onto this thing which is like an inch in diameter?

GRAYSON: Yeah.

MARGOSHES: That's when I saw Bill [William G.] Elliott's SpectraMetrics unit at Pittcon. I said, "That's it!" He had hooked it up to work with Polaroid film, but he's still got photographic, you see. He didn't have any way to take photoelectric. But it was that type of spectrometer. That's what we needed. Okay. […]

GRAYSON: SpectraMetrics.

MARGOSHES: Yeah. The company was eventually acquired by Beckman, and so it [sort of] disappeared. Okay.

Now, how can I do this? I need people with various skills. Plasma jet I could do it by myself. This [really] calls for a team. How do I get the budget? Well, at the time, the emphasis was that our research should be for the aims of the Bureau of Standards. I said, "Look. This is something […] not only [will] help the Bureau…and just for that it's not worth the cost." I said, "Labs all over the country will be using this. It'll help a lot of people." "That's not our interest." Plus the head of the division by then, was Wayne [W.] Meinke and I didn't get along with him, and there were several others. He was a very controlling guy. I had a budget in paper, but <**T: 65 min**> in practice I had to go to him, maybe chat with him.

Not even Scribner…Scribner was easy to deal with. [Meinke's] not a boss I could get along with. When I finally left, there were others leaving too. Dr. [Allen V.] Astin who was head of the Bureau of Standards, came to my retirement party, because I think he was trying to figure out what's going on there. Why are all these people leaving? People don't often leave someplace like the Bureau of Standards.

GRAYSON: Yeah. How do you spell that name? As, Astronoff…

MARGOSHES: Pardon? Astin. His son is a movie actor.[8] Played in that comedy movie about the family [up] in Boston.

GRAYSON: Oh.

MARGOSHES: You know, 1900s type of…[…] John Astin, or Jack…well, that's his son. Allen Astin was the father.

GRAYSON: I see.

MARGOSHES: He was fired by Eisenhower. Do you remember the battery re-treat incident?

GRAYSON: No.

MARGOSHES: Okay. I don't know…we can talk about that some other time.

But any rate, I needed this [team], and I wasn't going to get it from there. You know, this is an idea that…this is a one-of-them-in-a-career of an idea. What can I do? So, at that time, I was one of the two editors for *Spectrochimica Acta B.* I replaced Fassell.

In fact, it was on my volition that *Spectrochimica Acta* was divided into two journals, because it started as atomic, became almost completely molecular. I felt as an editor, I [was, sort of], out of place there.

GRAYSON: Spectra…

MARGOSHES: *Spectrochimica Acta*…

GRAYSON: Oh, okay. *Spectrochimica Acta*. […]

---

[8] Dr. Astin's son John is best remembered for his role as Gomez Addams in the television series, "The Addams Family" (1964-1969). Dr. Astin's grandson, Sean Astin, is also a well-known actor.

MARGOSHES: So, I wrote a paper for two audiences.[9] The big audience is: "Here's what we could be doing if we had a way to measure all these spectra well enough. Here's the things we could accomplish with this." The other part was, I threw in a little bit of a hint what I wanted to do that would be recognized by anybody else thinking along the same lines. Tomas Hirschfeld bit. He told Myron Block that they better hire me before…but I was going to do it anyway at the Bureau of Standards. So, they hired me to run the project.

GRAYSON: So, that's when you went to Block Engineering.

MARGOSHES: Went to Block Engineering. Okay. They were just in the process [then] of finishing up the development of the FTS-14, which was as far as I know the first commercial instrument that was designed around a computer. It was not a computer, [it was] not an attachment. You cannot run the instrument…

GRAYSON: This was in 19…

MARGOSHES: 1969 was when I went there.

GRAYSON: That's kind of early for approaching an instrument design that way…

MARGOSHES: Yeah. Block Engineering had been working in Fourier spectroscopy. Their main line was the spy in the sky sort of stuff for the military and the aerospace people and did a lot of contract research for them. The way they would…they realized with an interferometer you were essentially making a Fourier analysis, Fourier breakdown of the spectrum. When you do a Fourier analysis of that product, you get back to the spectrum. But doing it that way, you could measure the whole spectrum all at the same time, plus you had a larger optical aperture to work with, so you [had] those advantages. But the problem was doing the Fourier analysis, which they were doing via analog method. Remember, it's a series of sine waves, just different frequency.

GRAYSON: Sure, yeah.

---

[9] M. Margoshes, "Data Acquisition and Computation in Spectrochemical Analysis: A Forecast," *Spectrochimica Acta* 25B (1970): 113-22.

MARGOSHES: So, if you just have a series of electrical filters and play the signals back, you get the intensity at each of those frequencies. That's the way they did the Fourier transform. But it's slow.

You get a tape and you keep playing through and get different parameters. You need high resolution. That's an awful lot of play-throughs [that you've got to] do. You can try doing it in parallel, and you [can have] much more expensive instrument then. The computers at the time, [the] ones that you might use in building this one, like the PDP-8 <**T: 70 min**>, didn't have enough precision.

GRAYSON: They were what, eight bit words, PPA…

MARGOSHES: PDP-8 was the most common—it was not the mini—what they called minicomputer, smaller computers that were used in laboratories for various things. But you really needed a lot more precision, and it would help if it was faster, because you can only scan as fast as the you get the data into the computer. Just at that time, Data General came along with a new product, which had 16-bit words, instead of 8. That was a lot better. More than that, in most computers you're feeding in data. It had to go through this central process to be digitized, and then sent to the memory location.

With Data General, you could go to feed the data directly to each memory location. The detector had a fast data reconverter, but you didn't have to go through the CPU to put the data in. [It would] co-add. You could do the addition right in the memory location, directly, without the CPU, which speeded things up a lot. So, they were the first OEM [Original Equipment Manufacturer] customers at Data General for that. It made it possible. There were those in the infrared line. I came there. I was not involved [in] development. I had my own product to work on with Hirschfeld, which was great. I learned so much working with Tomas. I know a lot of things that I didn't know anything about, […] he'd take over and do it. If it was something neither of us could figure out, we had other people there who were really good. They had excellent technical people. The trouble is, they were not good business people, and they ran out of money.

GRAYSON: Where was this located? This was in…

MARGOSHES: They were in Cambridge.[…] They finally sold the company. Myron was an interesting guy. That's another story for another time.

So, I could have stayed on and do some of the spy-in-the-sky work. I was a little involved with it there. I was involved in some spy work at the Bureau of Standards. A group at the Pentagon were involved in espionage and they had certain materials they needed analyzed. For us to work on, I had to [get] security [clearance]. That was funny, because first [I'm very busy and] this form comes down, security form, filled that out. Yeah. I don't know what this is about. I'm busy. They asked me again, after a while: "Why didn't you give it to me?" Okay. Better do it. So, I turned it in. So, then they sent out an FBI agent. My wife was at home. She answers the door with these two little kids, hanging onto her, you know. The guy showed his badge from the FBI. You know Dr. Margoshes? Yes. Can I ask you some questions? Yes. Goes through a whole series of questions, fine. Finally, he says, "How well do you know him?" She said, "I'm his wife." He said, "Oh?" He thought he was talking to a neighbor.

GRAYSON: Oh.

MARGOSHES: So, but, I knew a little bit about that. But, it's not where I wanted to spend my career, really. Some of it was interesting, but…

So, I went back on the market looking, and […] at the same time, I was still doing some consulting work at Block Engineering, mostly writing up proposals. They knew I could do that well. One of the things I wrote up was very interesting, in that Block Engineering made a mistake of printing up some marketing literature with a spectrum [from] the FTIR [Fourier transform infrared spectroscopy], which had a glitch in it. It wasn't entirely obvious, but if you looked at the data—the spectrum—carefully enough, and compared it with some others, you'd notice it. And the people at PerkinElmer did. Okay. They start, [of course], using this as evidence against it.

So, what we decided we'd do is, we'd write our own house organ <**T: 75 min**>, publish our own house organ, and I would write the first article. Now, when I was still at the Bureau of Standards, Jim [James D.] Winefordner at the University of Florida [started] doing signal-to-noise analyses on instruments. It was a brand new thing. He's sending [these] manuscripts to *Analytical Chemistry*. They couldn't find a reviewer because what he was doing was so unique in analytical chemistry. They asked me if I would do it, and I said, "You know, I know Jim. I'm going to learn something out of this." So, I did. You know, I spent the time. I remember once, in one of them, there's an equation in there for noise in the photomultiplier. I was reading very carefully, so I picked up one book I had on my shelf. I looked up the equation, it was a different one, and they were not compatible, so I sat down, and I derived the whole thing, and I got Jim's equation. But, more than that, I learned about signal-to-noise analysis.

So, what I did was, we took the published data on PerkinElmer's top-of-the-line infrared spectrometer, and said, "How does it compare to a spectrum that the FTIR…in precision and resolution, to an FTIR spectrum? We [got the spectrum in] a few minutes. How long [would] it take [P-E's] instrument to duplicate it?" The answer was nine months, 24/7. The instrument's not going to run that long. Okay, no way you can do it. And there are people in the field…there was a fellow from the University of Minnesota, whose whole career was built on very high resolution infrared spectra. He realized [he's] got to have this, but not just this; the best possible. So, I worked with them to spec out and estimate the cost and what it would take to build one, absolutely state-of-the-art. He couldn't…at that time, everybody, you know […], so many people like him were going to NSF [National Science Foundation]: “I gotta have it.” He came in with a very expensive proposal, because he […] didn’t just [want] the one that he could buy, he wanted the best one…

GRAYSON: Yeah.

MARGOSHES: So, he never got […] it. But now, I don’t know if they [even] sell the other type of infrared spectrometer anymore.

GRAYSON: Without the FT part of it?

MARGOSHES: I don’t think so.

GRAYSON: Why? Why would you, you know…

MARGOSHES: It doesn’t cost that much.

GRAYSON: Well, yeah.

MARGOSHES: And I worked with the students at [Sarah] Lawrence College. I used to have to give them…spend a lot of time in teaching how to make a Nujol mull. You don’t make Nujol mulls anymore. You just grind the powder. I still have to get them to grind it fine enough.

GRAYSON: N-U-J-O-L.

MARGOSHES: Yeah. Brand name of mineral oil. […] It’s just one brand of mineral oil, but that’s the one the first people used in their method, so that’s what everybody used. […] With those students every year it’s the same thing: get them to understand how fine that stuff has to be ground to get a decent spectrum. Until they run one themselves, they get a terrible spectrum.

GRAYSON: It doesn’t make…

MARGOSHES: It doesn't get through. Yeah. But these are budding M.D.s working here. Nobody serious about science, because it's Sarah Lawrence, it's the wrong school.

GRAYSON: Now this is something you did in the past, or you're doing now, or…

MARGOSHES: I do this now. Yeah. It's gotten harder, because […] my hands aren't steady. My vision's gotten worse. Some things I just can't do, but the students really respond to talking this in a historical sense. […] That chart there, they've got in their textbooks. "The guy who developed that was just out of college, not much older than you. The first commercial infrared spectrometer, we have a prototype here, designed by a guy just out of college," and they love that.

I also try to get them to understand that a theory is just [our best] approximation. It's subject to change. I point […] out in spectroscopy when we're dealing with the atomic spectra and non-vibrational molecular, electronic molecular spectra, <**T: 80 min**> we use quantum mechanics. Well, [as soon as] we get in the infrared, you have a classical mechanical system. Do you think the molecules are in there banging around and shoving, and giving these nice spectra? Do you really believe that? Well, that's a new thought for them. Now maybe it will catch on in [time].

We had this one…Rasberry and I taught some short courses on computers in the laboratory. The first time we did, it took us a long time [that] we had to spend on the idea that computers can make decisions. They [don't just do] arithmetic. Just to get that to sink in. The second time…"Oh, yeah, we know that." It had gotten through. Really, the computer is not just a calculating machine. In fact, [I read] somewhere in the typical computer language more than half of the commands are decision commands, "if…then," that sort of thing. I guess not anymore, because they change these all the time, but I gave up on that. I built websites, but I haven't learned HTML, because they keep changing it. If you don't work at it full time, you can't keep up.

GRAYSON: Yeah.

MARGOSHES: Okay. So, I hired a headhunter and he found me a job at Technicon, because they were starting to set up a basic research lab.

GRAYSON: Where are they located?

MARGOSHES: In Tarrytown, New York.

They just reached a hundred million dollars a year in sales. They had a new VP of science, who was the chair of the physics department at New York University, Morris [H.] Shamos. […] He had done some consulting with Technicon, while he was at NYU, and he just switched hats, and came to work for Technicon, [still] kept an office at NYU and had a few students there. But now, I was working with a good scientist. He could appreciate my background which…[both] analytical chemistry, some clinical chemistry, instrument design. Also, I [had] learned some medicine working [at Harvard]. You know, I'd go to lectures and go and sit in on some classes, go to grand rounds, even got to go give a patient an examination once. The patient knew how to do an examination better than I did. He'd been used as a guinea pig [by too many] students already. But he…after I'd worked there a while, [my] idea was to expand the company's basic knowledge.

We were pushing the company in new directions, but the economy got bad, and they had to cut somewhere. But Shamos recognized that I'm the kind of guy who likes dealing with a lot of diversity. Also, he could see the way I interacted with the people in other parts of the company. I knew how to talk their language and talk technology with them, so he essentially created a job for me. The first thing he did—and this was as far as I know a real first—he set up a research grants program and had me run it to advertise we would give grants up to [one] hundred thousand dollars a year for up to three years for subjects that could have commercial value for us, which we did.

GRAYSON: So, this was something that was advertised in the scientific community.

MARGOSHES: Yeah, right. We got a lot of responses. Some of them good, some of them just stuff that took…sometimes we'd get almost the same…stuff's floating around. I remember we got three or four one year on having microphones listening to the sound of urine hitting the urinal [because you] could say something about the urinary tract <**T: 85 min**> from that. Well, yeah, [you can], but is it something people are really interested in? I guess not. But some of the things [looked] very interesting. We could put money into them. The other part of the problem is that…well, first, my feeling is that if half the programs were successful, I'd be very happy because it's research.

GRAYSON: Yeah.

MARGOSHES: The other thing that happened is that, there are some people used to dealing with government grants, [where] you get a grant to do something, you do something else, and that's okay.

GRAYSON: Oh, yeah.

MARGOSHES: It's not okay with the company. We're paying you to do something that you said you would do, not…but we didn't write the plan. You did. I thought you wanted to do that. On the other hand, one of them said, "Can I take a few dollars out of this to try something else out?" I said, "Fine. If it looks promising, let me know about it." That's all. I'll do that. I'm flexible. But I knew the mindset of people in business and the mindsets [of] the people in [research]. It was very interesting. There's a company called Licensing Executives Society [International].

GRAYSON: The what?

MARGOSHES: Licensing Executives Society. These are people that deal with trading in licenses between inventors or other institutions and companies. I [was invited as] speaker two years in a row, because [there's nobody else doing this], which was nice. It was interesting. You know, I got into a lot of different subjects. It was a wonderful job.

Now, one of the things I did there…the one thing I did for the company that was really worthwhile, at least short term…Technicon was from the start a medical company. But when they realized that the AutoAnalyzer had non-medical uses as well, they set up an industrial division to serve that market, which [amounted to] about ten percent of the company's net sales. They were very successful, because there was no real competition in automated analysis. The biggest sale […] the company ever made of AutoAnalyzers was to one of the big brewery chains. They realized that just tasting what's in the vat isn't enough. They wanted to do chemistry.

It was good, but [after a time particularly] chromatography took over and they were losing their market. The head of that division somewhere read about this guy at the Department of Agriculture was doing [near]-infrared analysis. Since that was my job, and I knew infrared spectroscopy, I'd go down. Well, fine. All [those] sorts of people in infrared know [that near]-infrared is garbage. Forget about it. But I wanted to go down to Washington for a different reason. I could do two things in the same day, fine. Do that. It turns out the other thing is a big bust.

This one, the inventor [Karl Norris] actually—having trouble with names again—turned me around in one day. Yes, [near IR] really works. The difference is that he didn't know it doesn't work, so he went and did it. Now, he was using a technique to do the data analysis, a matrix technique that was tried out in the synthetic rubber program and did not work because the measurements were not precise enough. The computer was…all they had was analog computers then. They weren't precise enough. But, now with better measurements, and better computers, it works. I don't know if he reinvented it independently or somebody told him about it. I don't know. He was the Edisonian type, really. The last question I asked on the way out, "What are you going to do next?" "Well, I'm going to try using tunable light emitting diodes."

I said, "You tune them by changing the current. Do you think you can change the wavelength enough to be of use without destroying the diode?" "I don't know, but I'm going to try it."

So, I got back to Technicon. I went into the library, pulled out some books, and found out, well, it wouldn't work. You just destroy them before you've [covered] enough wavelength to make it worthwhile. But, that wasn't the way he worked, you see. I wasn't going to tell him not to work <**T: 90 min**>, because what he did worked fine. He created a whole industry.

At the time, there were two small companies, one in Maryland, and one in Illinois that were making instruments based on the work at the Bureau of Standards…at the Department of Agriculture. The question at Technicon, [and once] they decided this was something they should go into, was to build or buy? [Should] they make their own instrument, or market to one of the others? Well, [they] made a marketing deal with the company in Illinois. I was involved in that also, went out there. [It was interesting]. They took me to some plants that already had one of their instruments. They were making agricultural instruments, very intelligent ones sometimes. For example, count the number of kernels of corn you plant so you can figure out how many plants you'll have next season, [that] sort of thing. But they didn't have the marketing. Mostly they sold [through] farm supply.

So, they take me to one lab at the University of Southern Illinois. The guy has a very nice lab there. He's got three near-infrared spectrometers. How did he get three? Well, they get a lot of support from a local farmers' bureau. That's good. You know, they're raving about it. He was talking: "I can measure proteins to one percent." I said, "Standard deviation?" "I don't know those funny words." Okay. I'm dealing with a different type of customer than I usually deal with.

GRAYSON: Yeah.

MARGOSHES: So, the nice thing about near-infrared instruments is they're so rugged and so simple to use you can […] give one to the guy who buys wheat from a farmer, comes in with a truckload of wheat. He's got an un-air-conditioned room with all [this] dust around there, and he can use what's called a thief sampler to take a good sample out of what's in the truck. Go back into his office, grind it up, put it in the instrument, and get a reading in a few minutes, and the computer will tell him how much that is worth in terms of the protein, oil, and moisture in it. If it's not…so, if it's good stuff, [he'll] offer him a good price. Otherwise…and it works. It's reliable. If you give him a low price, he's going to go over to the next guy who doesn't have a machine, [who'll] offer him more money. Well, that next guy pretty soon […] catches on. He will have to buy a machine himself. The processors have these machines. It's not just in the United States. The Russians were buying wheat from us which they were feeding to cattle and complaining it was low in protein. Well, the farmers were growing to get the maximum yield in bushels. They didn't care about the yield in protein.

But now you give them some incentive to worry about the yield of protein, it changes it. When I gave my report to the [head of the] industrial division, I had put in at the end, “Someday all grain will be bought and sold on the basis of this.” It took about three, four, five years, a very short time. Amazing how fast.

The other thing they did…and this is another one that […] you really can’t do without computers for different reasons, not the calculations are so complicated, but if you want to do it fast, and accurately. But the computer chip in there, you know, you’re talking of eight dollar unit. Your car probably has several chips in it.

GRAYSON: Yeah. Oh, yeah, nowadays.

MARGOSHES: They’re cheap. Yeah. They’re putting them now in devices for artists with software so you can make programmable art.

GRAYSON: I’m not sure about that one.

MARGOSHES: I’m not sure either

GRAYSON: Yeah, right. So, the near-infrared gives you a better…near, by near-[IR], okay <**T: 95 min**>, we’re…

MARGOSHES: We’re talking from the end of the visible region to the two- nanometer start, where glass cuts off.

GRAYSON: So, basically, as a field tool, the product to be measured has to be ground up, or some…

MARGOSHES: In this it is, yes. It’s ground because the infrared doesn’t penetrate all the way through.

GRAYSON: Right. So…

MARGOSHES: Same reason that you ground any solid sample in infrared spectroscopy. It’s a little better…the near-infrared is more penetrating than the mid-infrared.

GRAYSON: Okay. So, you've got your ground-up sample, and then, you just…[is there], like, a cuvette or something that you put the sample in, and stick it in the machine? Or…

MARGOSHES: Yeah, push the button.

GRAYSON: And push the button, and…

MARGOSHES: And the report comes out.

GRAYSON: And it comes out with an answer, and the guy says, "I'm only going to offer you five dollars a bushel."

MARGOSHES: Yeah.

GRAYSON: He says, "To heck with you. I'm going to down the street and sell it to this guy that doesn't have this machine." Until he decided he'd better get a machine too. So, all of this came out of one of your grants through Block?

MARGOSHES: No. This was not…. […] The grant program at Technicon just made me what I [called] the company expert in everything we didn't have an expert on, so I got called on for all sorts of these things.

GRAYSON: I see.

MARGOSHES: Most of them turned out to be nothing. People have ideas. One guy is going to build an electric car. Instead of batteries, he's going to use a fifty thousand volt, one-farad capacitor. You figure out how much then he can factor that. Well, when you were working with fifty thousand volt capacitors, in the spark sources that [were] used, it's spectroscopy. But those were microfarads. Okay. Now, maybe something's happened. So, I called up the company that makes specialty condensers. I said, "What would it cost for a fifty thousand volt, one-farad capacitor?" He starts laughing…

GRAYSON: Laughing.

MARGOSHES: Right. He knew this was a crazy idea.

GRAYSON: Yeah. Well, I mean, a farad, you know, I don't know if anything comes in farads, it's all in microfarads or mini-microfarads or whatever, yeah.

MARGOSHES: You know, one of the things…I mentioned Warren Wacker back from Harvard. He had an interest in Civil War. He was reading all the unit histories, and a patient was admitted to the hospital with some unusual symptoms. His attending doctors were having trouble figuring it out. [Do what they do] in the hospital, and then they start asking others, and it goes around the hospital, and it finally came to Warren Wacker. He remembered […] reading a unit history of a Massachusetts unit that mentioned someone with the same family name and the same symptoms.

GRAYSON: Oh, wow.

MARGOSHES: That's the clue. They figured out what the guy had. What I got out of that is there's no such thing as useless information. Sometimes it's going to come out in really be useful. So how do I know so quickly, you can't make a car work on capacitors?

GRAYSON: Yeah.

MARGOSHES: Of course, I wouldn't want fifty thousand volts in my car.

GRAYSON: No, sir.

MARGOSHES: And I'm not crazy about having hydrogen gas in my car. I mean, look what starts the reactors. Think gasoline is there?

GRAYSON: Yes.

MARGOSHES: Yeah. Okay.

GRAYSON: Yeah. So, this whole business of setting up this mobile machine or whatever that you could use in a…

MARGOSHES: This is […] now getting into the area where you may [have] a sophisticated machine small enough so you can put it in the back of your truck and take it where you're going. You've got a trailer lab. Stick it there. It's not a big monstrosity. It's even got a computer built in, but it's small.

GRAYSON: So, what time frame is this type of technology, that we're…

MARGOSHES: Well, this must be about the mid-1970s, somewhere…

GRAYSON: Oh, okay. So, fairly far back.

MARGOSHES: Yeah. Now, the question…now there were three companies selling near-infrared instruments; two making them, three selling them, because the Illinois [company] could still sell theirs. But we were selling theirs. Eventually, we built our own, and then went our separate ways, because the market got big enough to do that.

Technicon was the only one that's big enough to carry it to the next stage. This works as well in agricultural products, what next will it work on. And by the way, how come it works? Okay. Because if you're going […] to the industrial world, you're offering this to the infrared people <**T: 100 min**> like me, knew it can't work. It may not change their minds so easily. So, out of my grant program, we gave an instrument and funding to Indiana [University], to Gary [M.] Hieftje and Tomas Hirschfeld. By this time, Block Engineering had been sold. Tomas Hirschfeld went to work at the Lawrence Livermore Laboratory and gets some time to spend at the University of [Indiana] doing different types of science.

GRAYSON: I mean, he was at Indiana at the time that…

MARGOSHES: Yeah. I think […] he's got to be emeritus by now.

GRAYSON: Yeah. He's still at Indiana, because I was there a while back and he was…as a matter of fact, think he just published something…

MARGOSHES: Still working? Good. He's a very, very smart guy […].

Well, they came up with the answer to why it works and showed that it'll work in a lab indication. As Tomas pointed out, it can even work with things that have no infrared spectrum, because […] that material affects other things that you're measuring. So, indirectly you get a measure, say, of potassium…has no infrared spectrum, but it will affect other things.

GRAYSON: The presence of potassium will affect something that has an infrared spectrum…

MARGOSHES: Yeah, and that gives you a handle. So, it's a big field now. Now, we're getting into smaller instruments. Okay.

GRAYSON: You had a pretty long tenure at Block Engineering.

MARGOSHES: No, Block, I was only there a couple of years…

GRAYSON: I mean, I'm sorry, yeah, short. I'm sorry. Technicon…

MARGOSHES: Technicon […] I was there […] about eighteen years. Something like that. Yeah.

GRAYSON: So, I mean, did you do this kind of grant business all during most of that time?

MARGOSHES: No, because eventually the company went into the hands of other companies. And their finances got worse, and so on. We still talked to people in universities and so on, but they weren't so eager to give out grant money anymore. But see, what I was doing, by this time I was working across the company. We weren't advertising the grants program, but we still had people coming to us. We had some people come once from Technion [Israel Institute of Technology].

GRAYSON: Okay.

MARGOSHES: This is after Jack Whitehead sold the company, after Revlon [Group, Inc.]. They were microbiologists, and they had a brilliant idea for microbiology. There are viruses that work on bacteria, bacteriaphage, they're called. They can be more or less specific. Some were very specific to [only] certain categories [of] certain species. Some of them were pretty broad and so on, but you pick out the ones that you want to use to detect the presence of, say, *E. coli*. You engineer it to put in the DNA that makes luciferase, bacterial luciferase You get bacteria that glow. You have the picture.

GRAYSON: Mm-hmm.

MARGOSHES: Okay. They had filed a patent application in Israel, but not yet outside of Israel. They were very concerned about this getting out, because in many [countries] it's the first to file, not the first to invent.

Now, in the U.S., it's the first to file. They changed that to be in conformance with the rest of the world. In my experience in looking through various things, I've seen examples where somebody got a patent he stole. I know that. But I didn't do anything about it, because it wasn't my business. It was…you know, this was a case where…well, I better not get into […] <**T: 105 min**>

GRAYSON: Yeah.

MARGOSHES: But we had patent lawyers in Washington, by the Patent Office. We used to do examinations. See just what's the prior art on this, and if somebody had already patented or not. But, they didn't even want us to do that. You know, they're all working…we understand it's all confidential information. Lawyers know that. I went down to the Patent Office, and to the lawyers that we worked with. They led me over to the examination room, got me settled there. I did the examination. I found out [that] the closest art was clearly distinguishable from this, so this could be patented, and it was patented. I got the right answer, but, you know, it was an interesting experience.

I did a lot of other work with them, again where I used my general knowledge. Some people in England—I think it was there—developed a technique. A lot of the enzymes we [used as] reagents were fairly expensive. They developed a technique of immobilizing enzymes on the inside of the tubing so that it would operate on the sample as it passed through there, but it would still be there for the next sample, so you weren't throwing the expensive enzyme away. The trouble was, there was an English patent on it. They didn't want to talk to us. They wanted to sell it, market, license it to an English company, the English government.

So, I questioned the patent value, but see what prior art you can find. So, I think about it a while, and I said, "Does it have to be an enzyme or could it be something else that works like an enzyme, but it's just a catalyst." "Sure." Because I was thinking, in chemical engineering, they have catalytic beds. Maybe they have catalytic tubes. So, there was a chemical engineer we had given a grant to. So I called him up. He said, "Well, the people at the Bureau of Mines in Pittsburgh, have done that on heat exchanges." I said, "They put the catalyst on the inside of tubes?" Said, "No, they put it on the outside." Because the bulk of the material is on the outside so it makes sense. They're heating from the inside.

GRAYSON: Right. Okay.

MARGOSHES: Okay. So, I go back to the Patent Department. I said, "Does it matter whether they [coated] the inside or the outside of the tube?" No. So, we had it! It's been done. All it is [by] using a different catalyst.

GRAYSON: Yeah. Yeah.

MARGOSHES: […Your] patent's no good. That's the sort of thing that I find a lot of fun, because it's almost like solving a puzzle. I don't know if you do the [New York] *Times* crossword puzzles, but the ones on Friday and Saturday…

GRAYSON: Yeah, right.

MARGOSHES: The questions are very tricky. […] You've really got to have some depth of knowledge. I wonder how this new computer at IBM would do one of those puzzles. It probably would do very well on them.

GRAYSON: You have to be a little bit insane to try. My wife and I start out on them. By the end of the day…we start out Saturday. By Sunday night, we've got about a third of it done. But it was a challenge. But we enjoy trying the challenge…

MARGOSHES: Yeah. They're easy earlier in the week.

GRAYSON: Oh, yeah. I can do them on Monday.

MARGOSHES: It's the sense of challenging problems. The other part of this is there's a lot of money involved.

GRAYSON: So, now that you solved this issue with regard to the patent, did you do…

MARGOSHES: We used it, yeah.

GRAYSON: You went ahead and…

MARGOSHES: Yeah, and actually did a very good job. We had an expert chromatographer from Yale University, who was working on the methods of immobilizing the enzymes and optimizing them. He had a background in chromatography. We had…came to Technicon, at the same time - Lloyd [R.] Snyder, who got two ACS [American Chemical Society] awards in chromatography and wrote the standard book on the subject. So, they looked at it with the eyes of a chromatographer. […] If you can get more enzyme in there, by a thicker layer, this could be better, but at the same time it's going to spread out the sample more. So, you've got a tradeoff there, between how many samples an hour you can put through and all of these parameters, but the chromatography background was very important to that.

GRAYSON: Oh, yeah <**T: 110 min**>.

MARGOSHES: Yeah. You know we had people in our company who were experts in a lot of fields. I got to be known outside the company, I realized one time. Somebody came from a small company outside, [we] set up a committee to meet with him, and talk about it. I walked in. He looks at me. He says, "You're the company skeptic, aren't you?" I said yes, okay. I was thinking, "You're the kind of guy that made me so skeptical, aren't you?" [laughter] I didn't say it. It was very interesting work. It depends on who you are.

GRAYSON: Well, it sounds like a jack-of-all intellectual property type of a job.

MARGOSHES: You know, I got into the business side of it and so on. How are we going to market this? Well, this is…it's challenging. If you don't like to keep learning things, you shouldn't be a scientist.

GRAYSON: Oh, yeah, definitely.

MARGOSHES: If you do like to learn things, well, then move out of this immediate subject and…

GRAYSON: Keep moving.

MARGOSHES: The first thing you have to do is to learn the terms, like the Michaelis-Menten equation. I knew it. I just didn't know it by that name. I knew it another way. This comes up all the time.

GRAYSON: So, in those seventeen, eighteen years, you, kind of, had a jack-of-all-trades position inside of Technicon.

MARGOSHES: Yeah.

GRAYSON: What did you end up towards the end of your tenure there? What were you doing at the end of the…

MARGOSHES: Mostly spinning my wheels, because the company came under new management that had a well-established pattern of buying high tech companies and mismanaging them. That was really a low point. They had bought the company with junk bonds. I knew what the company's profits were. I got access to all this information. I had the monthly financial reports of the company. They went on a hiring jag, hiring people. It made no sense at all. So, I finally got to know one of the people well enough to ask him, "What's your plan?" I said, "You're expanding so large, where's the money coming from?" He said, "Oh, we are going to double sales in five years." That's wonderful. "How?" I said, "I got to know." […] He says, "We don't know." Well, that's not a plan. Well, pretty soon, the banks got tired of them and Bayer [AG] bought the company. It was more a rescue than anything else. We knew that there had to be layoffs.

GRAYSON: Yeah.

MARGOSHES: Okay. And the question was do I want to stay? One of the problems I had was that I understood…Bayer, if you want to go back, this is one of the companies that supported Hitler. You know, one of the big industrial companies. Now, that was a long time ago. I don't hold it against them. But, modern Bayer would not do business in Israel.

Technicon was owned by Revlon. If you've ever been in Israel, Revlon signs are all over there. Technicon never had a bit of a problem selling in the Arab countries. But, they killed the…we went ahead with the two microbiologists in [the] Technion. But Bayer killed it. It wasn't just us. Another company they had acquired had a citric acid plant using technology out of the Weizmann Institute that Bayer killed.

Now, I was brought up…my parents were very strong Zionists. I don't know if I can work for that company. So I checked with an Israeli friend who has very good connections to both the government and the business world in Israel. He's an economist and I asked him, "Is it true about Bayer?" He said, "Yes." So, I put my name on the list. I got the package [and got out]. It was a good move, because I would have just kept tearing my hair [out]. They just kept getting worse and worse. Now, […] they sold it to Siemens [AG], and I don't know how things going there. I don't know anybody there anymore.

GRAYSON: I don't understand it. […] You know, people buy and sell these companies <**T: 115 min**>. They don't really do anything with them. They just keep…

MARGOSHES: They do it because it's the thing to do.

GRAYSON: Yeah. It's like…

MARGOSHES: It's like the banks. The *New York Times*, I think it was last weekend had an article about one of the fairly big banks that the government had to rescue. The government, you know, they're looking into this because there's some malfeasance behind it. They found documentary evidence that the president of the big bank knew all along that these loans were crazy, but I have to do it because the other banks are…

GRAYSON: Everybody else is doing it.

MARGOSHES: Yeah. I'll lose all that business, which makes a lot of money. He knew it was crazy. He knew those were no good, but he's following the mob mentality.

Scientists do that too. They hop on. Why was it that nobody, until me, took another look at the excitation sources? I just said, "Gee, nobody's looked at this in some time. Let's see what we can do with it." There's got to be a lot of this stuff that can be done. You know some of it they're-mining now. I just finished reading a book called *The Dance of the Photons*.[10] It's about the quantum theory of photons, the strange part of it. Now, I studied quantum mechanics—this wasn't important to what I was—the reason I was interested in it at all. So, then I'll look into that. But they're talking about there'll be computers on the basis of this. Suddenly, it may have practical application.

---

[10] Anton Zeilinger, *The Dance of the Photons: From Einstein to Quantum Teleportation*, 1st ed. (New York: Farrar, Straus and Giroux, 2010).

GRAYSON: Yeah. Some of that stuff, I catch through news, science news articles. Some of it seems kind of hokey-pokey to me.

MARGOSHES: Well, this book is written by one of the apparent leaders. I don't know who they all are, but apparently he runs a large lab in Vienna, [Austria]. I think he intended it for the layman, but I think [if I] didn't have some knowledge of quantum mechanics and optics I couldn't have worked my way through this. But you might try to read it. It's called, *The Dance of…*

GRAYSON: *Dance of the Photon*s. All right. I'll jot that down.

MARGOSHES: It's interesting what […] they're actually doing it experimentally.

GRAYSON: Yes. Well, there are some strange things that are going on. I mean, it just keeps getting stranger and stranger all the time, if you ask me.

MARGOSHES: No. Their experiments, the ones he described…and I had to go through it about three times before I could really get it, what they are doing, using polarized photons. He says nobody really knows what makes a photon polarized, but they act like they're a light wave that's polarized, so they call them polarized. But he describes an experiment that…results make no sense at all in a wave theory, but they're predicted by quantum. That's the first time I've ever seen it like this. I've always said, "Well, you could go either way in optics," because most of the times, you can. But here's a case where you can't.

GRAYSON: That's interesting.

MARGOSHES: Yeah. It is very interesting. Now, what effect that can have in chemistry, I don't know.

GRAYSON: Well, how do we know what ends up affecting…you know, when the first maser was discovered, who would have known that type of technology, the type of impact it would have in the world, and everyday products, like this little…

MARGOSHES: Like [in] genetic engineering, which physicists thought this was something that nobody would ever object to. Now they've got lots of people objecting to it.

GRAYSON: Definitely. So, you basically looked at what was happening with the company, and it was not what you liked…

MARGOSHES: Yeah. So, I just took the buyout.

GRAYSON: To heck with it. So, I trust it was a generous enough one for you to…

MARGOSHES: It was enough. You know, we saved money. Technicon had a very good profit-sharing plan. Jack Whitehead became one of the *Forbes* 500 on that company. He was delisted when he gave the money for the Whitehead Institute, because of this, the *Forbes* magazine said, "He's not worth as much as he was. His choice." Okay. But that was a good choice. He was a generous <**T: 120 min**> boss. We had good profit-sharing plans. I know—he never talked about it, but through the grapevine—knew people there had big medical problems in the family, and he paid for it.

GRAYSON: Did you have a personal interaction with him?

MARGOSHES: Oh, plenty of times.

GRAYSON: Yeah. So, how big was Technicon when you were…does it have a number of people employed…

MARGOSHES: I guess in the Technicon times, I think, we had a couple thousand. Yeah.

GRAYSON: Okay. So, you were…I mean, there was an instrument production operation.

MARGOSHES: The manufacturing wasn't done there, because [of its] high manufacturing costs. It had manufacturing plants in Puerto Rico and Ireland. They had marketing in various countries. The reagents, they set up a plant in the mountain area of Virginia, because freeze-drying uses a lot of electricity. They get good tax benefits there also. They're close enough to TWA to get—no, what's it called the] Tennessee…TVA [Tennessee Valley Authority]—to get power from them cheaply. They, for a long time, dominated the clinical chemistry market. They had no real competition. From the company's point of view, it was wonderful because their customers were the people who ran the labs. If you raised the prices, they just raised their prices, and everybody was happy, except, eventually the insurance companies and the federal government…found they were spending all this money, and looking for ways to save. They started saying, "Well, we're not going to [pay] for that, or pay for that," and brought the prices down.

Technicon was not a well-managed company, but they didn't have to be because they owned the market. Jack Whitehead had a very good feel for the market. He finally hired a market researcher and I worked with that guy. His first project he needed some technical people along with him, so big chance to give the presentation. I'm there, Jack Whitehead starts it out by saying, "The purpose of market research is to confirm what I already know." [laughter] You can't…you know, he could drive you crazy.

GRAYSON: I guess.

MARGOSHES: But he could be very nice. He had a family history. He and his father, and he and his son, fought bitterly. His son, John, who was head of marketing, [then] head of research, kept his hair long…

GRAYSON: One of those guys.

MARGOSHES: Because he told me once, "Because I know it bothers my father." So, I felt I had to tell him something that he has to realize about people working under him. I said, "You know, John, I will argue with you and your father up to a point. Then I remember, I have a wife and four children." Because he could argue with his father, but he was still his son.

GRAYSON: Yeah, right.

MARGOSHES: That doesn't apply to me. I could argue with Jack up to a point, and Jack could call me names. I couldn't call him names. But what really bothered a lot of people…he was an excellent boss in the sense of seeing and being seen. He didn't sit in his office and wait for things to come to him. He wandered around. He'd ask questions. But then, if he found something that wasn't right, instead of talking to the guy who was higher up in the ladder and say, "Here's a problem. You gotta take care of it." He would directly intervene, so he's undercutting the guy who was…

GRAYSON: Yeah, his middle management.

MARGOSHES: Yeah, middle management guy. That wasn't so good. But he was a guy I liked. He [had a lot of] very good [things about him]. It was a company I liked working at—[…] except when it went really bad—because we were doing good things; making good money by doing good things. The job I had, it was made for me. And new hires, I mean, sometimes established ones, sometimes would come to me, "How do I get your job?" I said, "Try to take it from me."

GRAYSON: Yeah, right. Beat it, kid.

MARGOSHES: Right.

GRAYSON: But you did leave, and…

MARGOSHES: I left because I really couldn't do my job anymore. The company doesn't know where it's going.

GRAYSON: Yeah. Well, this is the story you told about the guy doubling your sales and didn't know how. That's doesn't seem like they had a very good plan.

MARGOSHES: I don't think Bayer knew, either. With Revlon…Technicon, Jack Whitehead first sold the company to [Revlon], because he was coming to a point where he [had to] start worrying about death taxes, a lot of money there. You can bankrupt your company by this, [because] he and his family owned so much in shares, including most of the preferred shares. So, he…I don't know how much shopping around he looked, but he [wound] up selling the company to Revlon in exchange for Revlon stock, which gave him a seat on the board.

The trouble is, as an entrepreneur, he can't take a backseat. [Michel] Bergerac, who was the head of Revlon, couldn't put up with this. Same thing happened with General Motors and the data processing company out in Texas they bought. They had to get him out. They had to get Jack Whitehead out of there, so Revlon took over [completely]. That was pretty good. I had some contacts in the central office, head office, a guy who worked directly to Bergerac […]—he was the head of Revlon.

GRAYSON: Is this the same Revlon that we think of as cosmetics Revlon or…

MARGOSHES: Well, they were a cosmetics company, but his plan was the cosmetics…part of the cosmetics, that business they were in was not very profitable. He wanted to go into health care. It was more profitable.

He had some other companies. Technicon was the biggest one of them. Of course, when […] Revlon took us over, they gave us the usual story, of how different sub-companies were all going to work together. Never happened. I got to talk to some of those people in those companies, but nothing ever came out of it. When we [wanted] to work with other companies, we went outside of the group. They were doing the same thing. There was never any real synergism shown there, really.

GRAYSON: That's too bad.

MARGOSHES: What happened finally, is that the present owner of Pantry Pride—I'm trying to think of his name…of Revlon. He had Pantry Pride, which is supermarkets. He wanted to go into the cosmetics business. Bergerac wanted to go into the health care business. You'd think two sensible individuals [could] make a deal, but you had two egos, okay, and two malleable boards, so they weren't getting anywhere. The Pantry Pride people went to court in Delaware, because […] Technicon was registered there like many corporations are, and convinced the judge that Technicon's board was not acting in the best interest of the stockholders, at which point the board collapsed, and Revlon got what they wanted. They got more than they wanted. They had all the stuff—soaps, and smells, and what all, that stuff—but they also had all this medical stuff, which they turned around and sold to anybody who would buy it for the highest price. They even [split] Technicon up; they sold the industrial division separately. I guess Bayer wasn't interested in the industrial division, maybe. I don't know. No. They sold first to a couple of other companies that were before Bayer. But any rate, when this other company split it up…you know, let me get this right.

Revlon took over all of Technicon from Jack, what it was, without selling anything off. Okay. Industrial division continued. […] I think Jack held out of that one of the aircraft companies. The aircraft companies had developed a <**T: 130 min**> hospital data system, and they didn't know what to do with it, and Technicon bought it. It was a separate division. We [really] had nothing to do with it. Jack held that out as something for John to run.

But meanwhile, without being involved, I […] saw evidence that something was very wrong there. One of the ways I kept up in the field was by going to scientific meetings. Computers become bigger and bigger in medicine. I knew we had [that] one hospital system, but I wasn't going to bother with that, but there were other applications I wanted to learn about, so I went to a meeting down in Washington. When I got the program, I found…I knew that one of the places that hospitals that had Technicon's information systems installed was the clinical unit at NIH [National Institutes of Health]. That's an important hospital. One of the features of this meeting was a report on that system. The contract was up for renewal. NIH had hired some consultants to help them decide whether to just renew the contract or look for another system. The report was being given at this meeting.

You couldn't—Technicon couldn't have written a better report. The only complaints they […] found about the computer system were things that Technicon was already working on. There's nobody else there from Technicon, except me. Now, didn't the marketing people know this was coming [up]? Didn't they know they should be there? No. If it was a bum report, they could pack their bags and go very quickly, [but] otherwise they've got an opportunity to make some sales. I couldn't do that. I don't know enough about it.

So, something was very wrong there. Well, I don't think that…I don't know what ever happened to that system. I don't know. There were problems that early on, and differences when the PCs came along, and the mantra was that "managers don't type." […] Remember that phrase?

GRAYSON: Uh-huh.

MARGOSHES: Yeah. […] They put in a system at Technicon, and they could send messages. At the time, what happened was that I put it on the system, it landed in the typewriter of his secretary, […] she would press the print button. The printer was in another part of the building. She would walk over there eventually and pick it up, put it on his desk, but putting it on the interoffice mail, it got to his desk faster. Doctors were the same story, and it was compounded because many doctors, they just scribble something in the chart, because then the nurse knew what to do anyway. But now, they couldn't do that anymore. They had to be very specific. They didn't like that.

So, it took some time to get that accepted. But you know, I now use a very successful medical group. It used to be Kaiser Permanente. They were in White Plains, [New York]. Kaiser Permanente pulled out of the East Coast. They just weren't making money. Instead of closing down, this just got taken over by [the] physicians, and [it's been] expanding like mad. I'm using it, my wife is using it, my son…all my relatives in Westchester County are using them. They've got locations all over the county. They're all connected on the same computer system.

I was there a couple of days ago. I had to see the eye doctor. The guy was taking some measurements to add into the computer, and was complaining [that] was working slowly. I said, "Well, I figured it's because you've outgrown the present system. You've got to add on to it [some] more." So, I […] got here a medical ID device. The heart of it is a one-gigabyte memory stick. They've got my whole medical history on there. […] If you were a doctor I'd just stick this thing in your computer, and you'd know everything you needed to know about me.

And if you [don't] want to do it this way, <**T: 135 min**> there's a system, I think, Microsoft is behind it, but with a central computer. You could load your [information] there. Give the doctor a code number to get access. He can look up all your medical history.

GRAYSON: Interesting.

MARGOSHES: It's another way of doing it. I figure this one, even in the ambulances—they have a computer.

GRAYSON: Yeah. […] Can you look at your data?

MARGOSHES: Oh, sure. Yeah. I replace it. I get a new set of lab tests, I go in there, and take out the old ones, put in the new ones.

A few years ago, in a visit to Israel, we visited […] one of the Hadassah hospitals in Jerusalem. There are two. This one…we visited their brand new emergency room, which is bomb-proof, and very computerized. […] And some of the techniques they developed now are being picked up by others. Not necessarily the bomb-proofing, but, for example, every ambulance is equipped now with a digital camera, and even before they get to the hospital, the doctor could be looking at pictures of whatever part of the patient that needs attention. I don't know if they take the EKGs and broadcast them, but it's certainly very feasible.

GRAYSON: Yeah. Well, it's the wireless networks and all that kind of stuff. You can move data around like crazy. It's…

MARGOSHES: One of my [sons-in-law] works for one of these companies that takes imports from the dock, warehouses them, [then] delivers them to stores. He developed a computer system. He's working with a lot of the big chains, his business does. They've got offices in Los Angeles and New York, which are main ports, maybe some others some places I don't know about. Then they've got branches around the country, so they can reach all the stores, a big operation.

His computer system, when they deliver to a store, each box has a bar code which the driver scans. As soon as they're all delivered, he goes back to his truck, and transmits the data to the company headquarters. They in turn pass that on. They have to reformat it for the other guy's computer. [They pass the] information on to the company that they move these goods for so they know in real time what goods are where. It's all possible now.

GRAYSON: Yeah. It's crazy. So, […] after Technicon you went to TechTransfer Services, [Inc]. What's this about?

MARGOSHES: Well, I thought I would sell myself as a consultant on finding new products and marketing products for the universities, because I built up all these contacts. I already knew people in the marketing executives association. My trouble is that I can't sell myself well enough. That didn't work. I finally decided I financially didn't really have to kill myself. I could just retire.

GRAYSON: So, which does raise a point: when were you born?

MARGOSHES: I was born in 1925, May 23rd. Next month I'll be eighty-six.

GRAYSON: Okay. So, in 1990, you were what…You were fifty-five.

MARGOSHES: Sixty-five, when I retired. […] I would have liked to work another five years.

I heard of a job opening, and it was one of the big New York hospitals, somebody to license all their research results. I interviewed with them. I said, "I can commit to be here for five years and in that time, I'll get the operation going well, and I'll train my replacement." But they were looking for somebody who would hopefully stay longer [than five years], but may not. I thought five years was a good time.

GRAYSON: So, do you think that we've kind of covered […] the era of instrumentation in the way that you wanted <**T: 140 min**> to when we started out? Or did we get…

MARGOSHES: Well, I want to talk a little more about the little ones.

GRAYSON: Okay.

MARGOSHES: We haven't really seen the outcomes of this yet.

GRAYSON: The miniaturization.

MARGOSHES: Miniaturization. I got into this at Technicon. Flow injection analysis came along, and they were making some claims about […] segmented flow which were all wrong. I got looking into this, and the first thing I discovered, they had patents. However, in 1957, when the segmented flow system, the AutoAnalyzer was put on the market, a non-segmented one was put on the market also. So, there wasn't really [anything] new about it except some details. So, their patents weren't really good.

But as I looked into this and I got more familiar with it, I realized there [were] some specialized markets that could be interesting. The industrial division was putting automated analytical systems on production floors, operating unattended. They were soaking up large amounts of reagents, putting out large amounts of waste. I said, "Maybe we can shrink everything down, so it uses very little…" Industrial analysis, you don't need to do sixty measurements an hour or anything like that. If you do one every five minutes, that's pretty good. It depends on what you're monitoring, how fast it can change.

When I ran through the math of the hydraulics, I realized that what you have to do is what they'd done in chromatography. Take it down to very narrow channels, so you could have an AutoAnalyzer on a chip like they have chromatographs on a chip. Hirschfeld by this time wasn't working at Indiana anymore, because of a stupid quirk there. He was handling his expense vouchers. She thought he was spending too much money on meals. I don't care how much he spent on meals, he's a value to the university, but he just walked away. He moved his operation to the University of Washington in Seattle, not Washington University…

GRAYSON: Right, yeah. I know there's a lot of Washington U's. I know about the differences.

MARGOSHES: By the way, speaking of St. Louis, is Tony's, is that restaurant [still there]?

GRAYSON: Yeah.

MARGOSHES: Yeah. We were there once. It was nothing for blocks around, except Tony's, because it was too important to tear down. It was the best Italian food I've ever had. No question, even Italy. It's great.

GRAYSON: It's topnotch that's for sure, top prices too.

MARGOSHES: Any rate, University of Washington had set up an operation especially to work with industry, research for industry. They have another Gary there, not Hieftje, Rechnitz? Yeah, Garry [A.] Rechnitz is at the University of Washington. Thought he and Tomas would make a good combination to work on this. They got it off to a good start, but Tomas had a fatal heart attack.

GRAYSON: Oh, my.

MARGOSHES: He was very obese. Myron was trying to get him to lose weight, but it was impossible, and it [caught up with him].

So, we renewed it to give Rechnitz a chance to do it on his own, and it just wasn't going anywhere. But people are using this technology now, a lot of the medical types. The other one I spotted when I was trying to run a little business and had a newsletter I put together. So, I found out…I think, it was New Mexico, they were working on the miniature spectrometers. I [started seeing] some of the possibilities of it. What's coming onto the market now, are instruments where you used to have a photodetector, now you have a little spectrometer. You get the picture?

GRAYSON: Mm-hmm <**T: 145 min**>.

MARGOSHES: Your detector takes care of what hadn't been finished [yet] by the main spectrometer. You've got all these working at the same time. Where that will go, I don't know. Just how small is it useful to make instruments? Even when you add these things up, [it could] still be…you know you add on light source and all this, and they'll still be the size of a deck of cards, light emitting diodes, real tiny, cheap. I don't think we've begun to see the outcome of this.

GRAYSON: I come from a mass spec business, and there's one problem. You can […] design a lot of small analyzers, but you still need a vacuum system, and those aren't so small. I mean they can get smaller, but not small enough to make a really miniaturized…

MARGOSHES: Well, if you have less cubic footage to pump out that helps.

GRAYSON: Yeah, that helps, but you still got to evacuate…

MARGOSHES: So, it's still not something that you can run from the back of a truck.

GRAYSON: Yeah. So, the miniaturization is…I went to Ocean Optics, [which] is apparently a company that does a lot of this kind of stuff. Is that…

MARGOSHES: They were one of the early companies. They used to be in Connecticut, in one of the shore towns, that's why they've got Ocean Optics.

GRAYSON: Okay, right.

MARGOSHES: A little setup.

GRAYSON: Do they have anything to do with the ocean? Or is that…

MARGOSHES: Well, I think…not that I know of, except that they were near the ocean.

GRAYSON: Okay. I guess they [making that] name for themselves in miniaturized spectroscopy thing, business on what…from what I gather…

MARGOSHES: I think they're getting known more widely, because more people are getting interested in the possibilities there. Computers are heading in the optical direction also and how that will play out, I don't know.

GRAYSON: Well, the whole business with the translation of the electronics into the transistor, and then, into the PC, you know the microchip or chips is just totally crazy, the way things are evolving down into smaller and smaller sizes. I mean, you can go into Walgreens and buy for twenty-five ninety-five, two gigs of memory to stick in your camera. I mean, two gigs of memory, can you…well, I mean, you know, and it's the size of a slice of cheese or part of a slice of cheese. The whole technology's just gone totally…

MARGOSHES: When I was at Block Engineering, memory cost a dollar a word. Okay, memory's four thousand dollars.

GRAYSON: Yeah. Today you can buy enough memory…

MARGOSHES: I've got three gigabytes. Core of my computer now. It's seven hundred fifty gigabytes on my hard drive, and I know I'm going to fill it up.

GRAYSON: Yeah. It's amazing. It's absolutely, totally amazing.

MARGOSHES: When we moved into our apartment eleven years ago, and we bought a new file drawer. We now filled it up. The question is, do we want to buy another file drawer? No. I just get everything from the computer. It takes up much less space.

These handhelds, or even the things like the iPhone, the only problem I have with them is the size of the screen. Otherwise, it's got all the computing power I need for most of what I do.

GRAYSON: Sure, yeah. Certainly, there's some things, the size gets to be an issue, when in use. Something like this recorder is not a big deal. You only have a couple buttons, but when you're trying to type, I see these guys and it's [doing] these little thumb things, and…

MARGOSHES: I had a little thing even smaller than that. It's thinner than that. It's […] got about the same area. It's all on one side, little tiny buttons I can just [about] work. My son got it for me my last birthday. It plugs into my hi-fi sound system. It picks up my Wi-Fi signal. It connects me to every source of music on the internet.

GRAYSON: Crazy. Where it's going, it's hard to figure out. You have dealt a lot with patents. Do you have any patents of your own?

MARGOSHES: Yeah. I sent you a list of my publications and patents are on there. <**T: 150 min**>

GRAYSON: […] Yeah, there's three, I think. So, those are…

MARGOSHES: Yeah. Two from Block Engineering. Incidentally, when PerkinElmer came out with their echelle spectrometer, the engineer in charge of that project came to talk to the New York SAS. At the end, I went over to him. I said, "One of the things you're doing there is covered by a patent owned by Block Engineering. I'm one of the inventors on it." I said, "It's okay. Don't worry, because that was a long time ago. [I think] it's expired by now." I went home. I looked up the patent. It took them several years to get through the Patent Office. So [it still had] a few months to go.

GRAYSON: Oh, wow.

MARGOSHES: I didn't tell them that. I think he went and looked at it, and figured it out himself. I didn't tell Myron Block. I don't [even] know who owns that patent now. I don't. So, that's found use, but not to Block Engineering…

GRAYSON: Not to the point where you would…so that's another patent issue. You never derived any significant…

MARGOSHES: I never owned any of these patents, no. You know, you get a small award from the company. And the ones from Technicon, which came from talking to another chemist there, came to Technicon about the same way, from the industrial division. The industrial applications, you don't want to have an instrument at every place in the plant where you're analyzing a sample. You want to move those samples and flow them through to the instrument. How do you label them so the instrument knows what sample number that is? We came up with the idea of using air bubbles in the stream to make a bar code. So, I don't know if that's ever been used.

GRAYSON: Interesting. Yeah. Apparently, you have one with Hirschfeld.

MARGOSHES: Yeah, which one was that?

GRAYSON: That's digitally controlled electro-optical imaging system.[11]

MARGOSHES: Oh, that's the idea of digitally controlling the readout. Up to that time, the video cameras all also did the same scan as for a picture, and then by timing you could pick out what you want. We wanted to have different pixels integrate different periods of time. So, we wanted to move the read beam to a point anywhere on there, take a reading then jump to a different point anywhere on there. So, this had to be digital control.

GRAYSON: This would be a more efficient way of sampling…

---

[11] T. Hirschfeld and M. Margoshes, Digitally Controlled Electro-Optical Imaging System, U.S. Patent #4,335,336; October 19, 1982.

MARGOSHES: Well, it let us extend the dynamic range, by doing this sort of thing. We had written out the detailed specs for the camera and gone to a company that specialized in scientific video cameras. Then we had to cancel that. But they went ahead and built the first commercial digitally-controlled camera. But this was [tied] specifically to spectroscopy, this patent.

GRAYSON: Right.

MARGOSHES: That, so it wouldn't cover [other possible applications].

GRAYSON: [I was] looking through your publication list, and I saw a couple of publications that I wanted to talk about. What's this business with dietary, bananas as a low sodium dietary staple?

MARGOSHES: Okay. That was fun. That keeps coming up…

GRAYSON: This is 1958, so this is for your earlier career.[12]

MARGOSHES: Recently, I heard someone…my daughter-in-law had a question about bananas, so I got the question from her, because I was supposed be a general expert in bananas, which I'm not. Go back to that time, people on a low salt diet had a very limited choice. In fact, with some of them, all they could eat was plain boiled rice, never anything flavored. The United Fruit Company already analyzed some bananas, and found they're low in potassium…no, low in sodium <**T: 155 min**>. They didn't ask who did it or any of that, but they wanted confirmation from a prestigious lab, like the Harvard Medical School. They were willing to pay a nice grant, and [give the lab] some profit out of it. It became my job because I had finished building [that] instrument, and basically it was my instrument. It was a fun project, because they kept sending us whole, not just bunches, but whole stalks of bananas of every kind. […] Things you [don't] see in the market…

GRAYSON: Sure, yeah.

[12] W.E.C. Wacker, M. Margoshes, A.F. Bartholomay, and B.L. Vallee, "Bananas as a low-sodium dietary staple," *New England Journal of Medicine* 259 (1958): 901-4.

MARGOSHES: You know, we only needed two or three out of these analyzed, and everybody got to take home the rest. It was just as easy to measure potassium at the same time, so that's what we did and confirmed this.

GRAYSON: Usually they're considered a good source of potassium, aren't they?

MARGOSHES: Well, the thing is with…plant cells use potassium the way animal cells use sodium and vice versa. So, potassium…in the human body, main function has to do with some of the neural cells. It's important in that respect. But plants, they have something like neural cells. But I don't know about sodium, but they use potassium in the neural cells, instead of sodium. So you can eat almost any fruit, but bananas are good nutritional value, in several respects, more than most fruits. But the potassium part of it was sort of an extra throw-in because, what the hell, I might as well.

It turned out to be more important in the long run to the point where the first astronauts that stayed in space for some time, they came back with [their] muscles [very] weak. One of the things they found out is that [their] bodies were depleted in potassium, so instead of sending up potassium pills with the next ones, they sent [up] dried bananas.

GRAYSON: So how do you prepare banana for an emission spectroscopy?

MARGOSHES: Well, we just had to ash it in a hot oven, because sodium and potassium are not that volatile; they don't temperature that high. We […] didn't have to use platinum containers, because the only contamination we were concerned about is, like I was saying, [sodium or] potassium, and if you use some other metal that's good enough. You're not going to find sodium potassium in there. It was just a little side thing. It's funny about how things are trivial scientifically, somehow become important.

GRAYSON: Well, it's just an unusual title for a paper that…

MARGOSHES: Well, what I brag about is, I have a publication in the *New England Journal of Medicine*…

GRAYSON: There you go.

MARGOSHES: Not many chemists can say that.

GRAYSON: Not many people can say that who aren't […] a medical professional. So, I see that you got saddled with this annual review job for *Analytical Chemistry* for [a couple] years.

MARGOSHES: Yeah.

GRAYSON: So, that was—that must have been a lot of fun. How did…

MARGOSHES: Well, for one thing, it gives you a publication for another short period of effort. The system Scribner had set up was that I would scan every issue of *Chemical Abstracts* and make note of each of the items, any relationship, and the secretary or part-time worker or have a summer worker doing this, would once the Xerox came in they would Xerox a copy, otherwise, it wasn't that expensive, you just had a secretary typing […] them over. Any rate, got them on […] cards. The Xerox machine speeded that up.

GRAYSON: So, just have Xerox of the abstract.

MARGOSHES: So I had to go through those, and pull out the ones that look interesting and put them in. You know, figure out how they should…

GRAYSON: How to organize them…

MARGOSHES: Then start writing. One year, an author of the one on flame photometry, was a guy from Beckman, and I can't remember his name. He wrote one that was much too long <**T: 160 min**>. You know, they tell you how many pages they want. Came up with one that was much too long, and refused to cut it, so they asked me not to rewrite his, but to write one. One week later, I delivered the manuscript. Now how many publications [do] you get out of one's week work?

GRAYSON: But that…still, you got to plow through all this literature. Of course, I don't know how much literature…

MARGOSHES: We do it anyway.

GRAYSON: Yeah. But I mean, if you're on your game, you should know what's going on in the primary stuff that's going on in the literature.

MARGOSHES: Right.

GRAYSON: But, I mean, you know […], I guess if you do it for a couple of times around, you, kind of…it's not that big of a deal. But I've always been impressed by the amount of material that's covered in those reviews. It's…

MARGOSHES: But there's got to be a resource through people here who are trying to do research on when these things came out, so…because you go back through these annual reviews, you can find out…well, that's when it was brought to market.

GRAYSON: Yeah.

MARGOSHES: And you know which publications are about what you got to look up.

GRAYSON: So, you did these for almost a decade, I guess.

MARGOSHES: Yes. Also, while I was there, I did the chapter on emission spectroscopy in the *Treatise on Analytical Chemistry*.[13] Then at Technicon, Don [A.] Burns was the other guy always entered on a patent with me.[14] He and I wrote a chapter for that treatise, another volume of course, on automation.[15]

GRAYSON: Okay, yeah, automation, instrumentation for analysis system, Wiley & Sons, Treatise—yeah, okay. So…

---

[13] Marvin Margoshes and Bourdon F. Scribner, "Emission Spectroscopy," in *Treatise on Analytical Chemistry*, Part I, Vol. 6, ed. Izaak M. Kolthoff and Philip J. Elving (New York: Interscience, 1965), pp. 3347-461.
[14] D.A. Burns, M. Margoshes, and M.M. Cassaday, Sample Transport System, U.S. Patent #4,526,754; July 2, 1985
[15] Marvin Margoshes and Donald A. Burns, "Automation: Instrumentation for Analysis Systems," in *Treatise on Analytical Chemistry*, Part I, Vol. 4, 2nd ed., ed. Izaak M. Kolthoff and Philip J. Elving (New York: John Wiley and Sons, 1984), pp. 413-65.

MARGOSHES: Some of them that weren't on emission spectroscopy. A few years ago—[might be] ten years ago—before the newsgroups disappeared there was one on chemistry that I read regularly. One of the people there that I interacted with is a professor in a university in Pakistan, trying to teach instrumental analysis, but obviously there [were] some difficulties. He asked me to review a manuscript [on] homemade spectrometer using a CD as a grating…

GRAYSON: As a grating?

MARGOSHES: Yeah. You know, he's working under very difficult conditions. He recognized me [as the guy that] had written that article years ago. He wants a copy of it. I said, "Well, I don't have any copies. But look, it's way out of date." The field's changed so much since then, but still he wanted it. Well, I felt flattered enough so I actually scanned [every page] and turned it into a PDF file and sent it [to him]. I was going to tell him, "Look, you can probably find the back issue of the book to buy online." But he probably doesn't have enough money.

GRAYSON: Yeah, yeah. Tell me about "Demand-Pull and Science-Push in Multielement Analysis."[16]

MARGOSHES: Okay. I wrote that for the A pages in *Analytical Chemistry*. I was on their advisory committee for years. They knew me. It was really an educational piece on how technologies get developed. There's Hippel at…I just don't know if he's still active there in MIT. He wrote a book. It's here. It's called *Sources of Innovation*.[17]

He made a number of case studies, including laboratory instruments, of how innovations come about. They're usually done by people who are users, who have a need, okay. That's a demand-pull. Okay. He's got a need and he [looks] around for a way to meet this need. Other inventors start, "I have a technology. What can I use it for?" And come up with an idea on it. It's very rare that that turns out to be a really useful idea. One exception that I know of is the FTIR. Myron Block, even though the experts he asked about it said, "Nah, nobody wants that." Well, once it was out, everybody wanted it.

But you look at the <**T: 165 min**> Beckman pH meter, for example. Beckman was the inventor, but somebody else has [the] need and [came] to him, and he didn't have an instrument company. But he knew the technology. It was, sort of…but Beckman didn't say, "Well I have this technology. What can I do with it?" Somebody came to him with a need. So, this was demand-pull. And it could go very quickly.

---

[16] Marvin Margoshes, "Demand-Pull and Science-Push in Multielement Analysis," *Analytical Chemistry* 51 (1979) 1317A-22A.
[17] Eric von Hippel, *The Sources of Innovation* (Oxford: Oxford University Press, 1988).

GRAYSON: I wonder if you could say the science-push side is like maybe pushing a piece of spaghetti: it's hard to do, but there is a [very good] example of this science-push side…

MARGOSHES: Well, it's hard to sell it to people, if there isn't an underlying need.

GRAYSON: Well, but there is an interesting example, I can think of the science-push side. That is J. J. Thompson, who was a physicist who was using the positive ray analyzer and realized that it would be a great analytical tool for chemists, so he actually wrote a book, a monograph on the use of [positive] ray analysis, You know, positive rays for chemical analysis, in 1913.[18] Well, it took a long time before that actually came to pass, but he was right. but you, know, he couldn't get…

MARGOSHES: For other reasons, it took a long time.

GRAYSON: Yeah.

MARGOSHES: The GC [gas chromatograph] is an example. The technology was there, sort of, but now a user came along who wanted to do this, and he was told that because of the detector you have to have a lot more sample than you have. He decided, "I can either try to get a lot more of this material or I can try to get a better detector." And he invented a better detector. That is what determines what kind of chromatograph you can build, still. That's the problem. I can put a chromatograph on a chip, but what kind of detector would you use on this?

GRAYSON: Sure.

MARGOSHES: So, in almost every case you want to look at in detail…the studies they made at MIT were not only the instruments, but also the improvements that came [on] it, all by users. When the first personal computers were built, nobody had any idea what they [were going to] be used for, none at all. Companies bought them, like Technicon. As I said, they gave them to the secretaries not the bosses. They took away a two-hundred-dollar typewriter and gave them a two-thousand-dollar computer and never even told them how to run the computer. They just didn't know what to do with these, except it's something you should have.

---

[18] Joseph J. Thompson, *Rays of Positive Electricity and Their Application to Chemical Analysis* (London: Longmans, Green & Co., 1913).

Meanwhile, the engineers at Technicon were yelling because they couldn't get them. They knew what to do with them, but no, no, no. These are for people like this. I had to be devious. I had to say, "Look, if you let me have a computer, you don't have to give me a secretary." They weren't going to give me a secretary anyway.

GRAYSON: So, what's this Ad Hoc Task Force to Monitor *Analytical Chemistry*? What was that about?

MARGOSHES: What?

GRAYSON: It says here that, you were on the American Chemical Society Ad Hoc Task Force to Monitor *Analytical Chemistry*…

MARGOSHES: Oh, there were questions phrased by the way decisions were going to be made in that…

GRAYSON: What to publish?

MARGOSHES: Whether the editor was involved as much as he should be, or is all being done by the journal staff. Sometimes, very often…it came about because people had legitimate complaints about decisions that were made [that were basically wrong. It was because they weren't reviewed by the editor, so we were asked to look and find out what's going on. We found out what I've just described.

GRAYSON: Which I guess, I assume, resulted in a change in management or change of editor or…

MARGOSHES: Well, yeah, I think they told the editor, you've got to put more time in it.

GRAYSON: He wanted to be the editor, but he didn't want to work that hard.

MARGOSHES: When I was asked to replace Fassel as editor of *Spectrochimica Acta*, I wanted to know what was involved in it. The editor of the *Journal of the Optical Society of America*, was <**T: 170 min**> at the Bureau of Standards then, so I went over and had a chat with him. Said, "How do you handle a manuscript? What do you do?" He says, "Well, a manuscript comes in. I send it to reviewers, and I do whatever they say." I said, "What happens when the reviewers disagree?" He says, "I assign it to a third one."

Well, I knew I couldn't do that kind of review. I have a responsibility; I have to be sure that…at some point, I have to get my oar in and make sure that it's right.

I had fights with editors. When I was still at Iowa State, I had an article on infrared spectroscopy I wanted to publish. We decided that the J*ournal of Physical Chemistry* should include infrared spectroscopy. That's physical chemistry, right? They didn't see it that way. They never had a paper on infrared spectroscopy. So, they didn't quite reject it, but they said, "It's too long. You got to take out this data and that data and that data." I didn't really want to, but, okay, we did it and sent it back. This time it's, "Well, you know, you make certain statements there, and you don't have the data to prove it." "Well, yeah, we don't because you made us take them all out!"

GRAYSON: Yeah, right. Don't you love it?

MARGOSHES: Well, at that point we gave up, and sent it somewhere else.

GRAYSON: Yeah. Yeah. I love it when you get that type of a thing, where they say change it. Then you send it back. [Then they] say, "Well, why'd you do that?" "Well, you told me to."

MARGOSHES: Oh, another one, this one on the flame photometry, the sodium/potassium business. We send the paper in…or maybe it was the calcium/phosphate business, I don't remember at this point. Anyway, we didn't send the paper in until a few months after we had given the talk at Pittcon. So, it comes back, and it's like, "Everybody already knows this." We wrote back [to them]: "Show [me] somebody [who] knew this before Pittcon." That was the end of it.

GRAYSON: So, I see you were involved in the school board at Tarrytown…

MARGOSHES: Yeah.

GRAYSON: So, that was like a civil…

MARGOSHES: That's an elected office.

GRAYSON: Elected office, okay.

MARGOSHES: Yeah. In New York state and most states, the school boards are elected. The school budget has to be passed or turned down by the voters. The year I became a member was the last year I had any children in the schools so I had that reason.

GRAYSON: Okay, 1981.

MARGOSHES: Just I [was] disgusted with the way the board was handling things, and I thought I could do a better job, and I did. Well, there were other people came on at the same time as me. The old board were saving money on maintenance, and the buildings were falling apart. After I was on the board, took a tour of the schools; in one building the janitor said how worried he was with having one of these doors fall over on a child, the wood is so rotted away. They let this go on because they had to save money. We turned that around, and it took more than a year.

But the first thing we did is, we made a list of all of the problems and then broke them into categories: safety problems first; then things that have a payback, like putting in brighter lights; and then everything else. We had no trouble selling it to the voters. Not in one big package, but the amount of work you do over one summer. They understood you have to do this. The hardest job you have as a school board member is hiring a new superintendent, and the first thing I had to do as a new school board member, along with the others, was hire a new superintendent. We got a very good one. One of the things that really bothered me…the old board to save money hired a superintendent who was willing to work for less because he came from an upstate area, where living costs were less. Probably his mistake. But he also…he didn't understand the nature of the community. He let things happen that just got me angry. He let a religious group from outside the community come in there and put on a show. I forget their name, something for Christ, and <**T: 175 min**>they're handing out pledge cards to kids.

GRAYSON: Oh, no.

MARGOSHES: Yeah. This is a very diverse community, economically, ethnically, religiously, and everybody gets along fine, but they don't want their children to be coerced, so I went to the president of the school board, and she just denied any knowledge of this: "Go talk to the superintendent." Okay. She felt [about it] just as much [the way] I did. He said, "Oh, I didn't know they were a religious group." I just turned and walked away. They've got the name, "for Christ," and they're not religious group?

GRAYSON: Yeah.

MARGOSHES: What are they? The idiot! So, they saved money, but they had to pay off the rest of his contract. Yeah.

GRAYSON: So, when you say the community, you basically had to go to them, asking for tax increases or…

MARGOSHES: Well, […] there's elections every year […] for the board and the budget. It's the same election time, usually late spring, because the board's term ends on July first.

GRAYSON: Do they just run a year?

MARGOSHES: No, you get elected…it depends on particular ones. The one I worked on it was three years.

GRAYSON: Three years, okay.

MARGOSHES: But you had turnover on July first. Also, the school budget, new budget took effect on July first, so you had to get those things in. If the voters turn it down, the board has the option of […] making changes and putting it up for election again or just reverting to the last year's budget, except for sports. You have to cut out extracurricular activities.

Sports is the extracurricular activity. […] Some people care about it very much, […] so the board can use that as a threat. If you're not going to vote for it, okay. Then, to get it through this next time, we're going to have to do that, and your son won't be able to play basketball or whatever. Right.

GRAYSON: All that good stuff. Well, that's interesting. Basically, you had about, almost a ten-year-long tenure and ended up being president at the end…

MARGOSHES: Well, that was nine years. Three three-year terms.

GRAYSON: Nine, yeah. Okay…

MARGOSHES: [I was president] the last three years…

GRAYSON: Three three-year terms. Okay.

MARGOSHES: Usually you do that for a year, but the one who was interested in taking over [for] what became the second year of my term had two children in school [and] had just pulled one out, and took him to a private school. There may have been a very good reason for that, but I [felt] it would look very bad to the voters.

GRAYSON: Yeah, well, all…

MARGOSHES: I wasn't looking to have that extra work.

GRAYSON: Yeah, yeah. But, you know, it's good that you stepped in when you saw the need, and got some things done.

So, what would you consider your most significant publication?

MARGOSHES: Well, the stuff I did in infrared never had any use that I know of. I think certainly the plasma jet work, particularly because of the Fassel follow-up. Maybe, if I had graduate students for the next fifteen years working on the plasma jet, it would have come out better. But, I didn't, and Fassel essentially picked it up and ran with it. But, I started it off.

The idea of the echelle spectrometer was sort of around then. Block Engineering, we did a prior art search, and we found just a mention in an obscure journal, that I could take something like Bill Elliott's echelle spectrometer, and point the TV camera on it, and make a spectrometer. Well, that eliminated the basic idea. I think our getting it out in the open and…got more people thinking about it. The development of the solid-state ray detectors was the other piece of the puzzle. The guy at the University of Arizona [Bonner Denton] played a key part in that. He characterized all these different types [of ones]. Most of the manufacturers who were planning to build an instrument came to him for advice.

GRAYSON: So, that <**T: 180 min**> […] echelle?

MARGOSHES: […] It's a French military term.

GRAYSON: Which translates to…I'm not good at French. Or military. Echelle means…what does it mean?

MARGOSHES: I don't know. I just recognize it as a military term.

GRAYSON: Okay. So, what differentiates the echelle spectrometer from…is it the grating in it? Or…

MARGOSHES: Yeah. Well, the echelle is a type of grating, which you're using in very high orders, and because of that, there's a lot of overlap. To take care of that, you have to first display the spectrum before the echelle at right angles, dispersion at right angles from the echelle.

GRAYSON: Okay.

MARGOSHES: So, the orders are moved vertically, separated vertically, and within each order, the wavelength is. You actually have overlap…some lines can be seen in two or three places. They can be seen [at] the middle [of] one, and the beginning of the next one, the end of the [one] before that. And it fits out beautifully for emission spectrometers, because with an ordinary grating, the resolution is the same on all wavelengths. With a prism, it varies depending on the prism material, varies in wavelength.

GRAYSON: Yeah.

MARGOSHES: And with the echelle grating, the resolution is highest at the shortest wavelength, as you go out in the visible, it gets less. But if you look up a hand[book]…no, the MIT wavelength table, or the Bureau of Standards wavelength table, you see how the wavelengths are distributed? Much more sparse out in the red. They're very tight in here. So, it's a perfect match between the nature of the spectra and capacity, and you get the high resolution where you need it.

GRAYSON: Right, where you need it. Yeah.

MARGOSHES: In fact, it's so high that even some minor changes in the shape of the line can be changed by things that are going on in the discharge; electric fields and all that sort of thing.

GRAYSON: Wow.

MARGOSHES: In an ordinary spectrograph, all you basically see is an image of the entrance slit, and the lines are usually, completely contained within that. In this, the shorter wavelengths, they would spread over more than one detector. Well, that's okay. You know that's happening, you just read [them all]. Get them together.

GRAYSON: Interesting.

MARGOSHES: Yeah. So, it's the perfect match.

Things like Fourier transform don't work there, because in Fourier analysis the noise gets spread over the whole spectrum. Now, in infrared spectroscopy, it's pretty much already evenly spread, but that's not the case with emission. The strong lines carry a lot of noise, so that noise gets proportionally spread over small and large…not proportionally, the same amount. So, the less intense lines get very noisy. That's not so good.

GRAYSON: Not good.

MARGOSHES: No.

GRAYSON: So, we're, kind of, getting close to the end, are we…do you have any other topics that you wanted to mention, just to discuss that we haven't covered? I don't know. We've had a pretty good long discussion here.

MARGOSHES: Well, I just want to mention a few other things [that] I made notes of here.

GRAYSON: Okay.

MARGOSHES: Again, getting back to this idea of getting general knowledge. These are real life instances. In the early days of NASA [National Aeronautics and Space Administration], they came to us in NBS with a circuit board that they're preparing to send up in space. These are pretty small circuits <**T: 185 min**>. I guess they were little integrated circuits of their time, but very large by today's standards.

But any rate, to protect them, they had […] put a varnish over it, and there were some specks in there. Now what they were, they didn't know. But one thing, when you're putting something up in space, you want to be sure it's going to work. Some specks there, and we don't know that [they're] damaging, but we don't know that they aren't.

Now, I had a minor in analytical chemistry at Ames and looking for courses to take that might be useful, I took a course in chemical microscopy. I never used this until I came to the National Bureau of Standards. I had a technician working for me, Martha Darr, who was very good at this, working with very small things. She used the microscope a lot. People come to you because they have a problem. She found examining a sample through a microscope would often help. I can mention one example she did. I wasn't in it. […] There were some groups in the analytical chemistry division, who were trying to make and store very pure acids, […] storing them in Teflon containers. They kept developing iron that wasn't in there when they put it in, but after a while, [the acid] had iron [in it]. What's going on? Then, they noticed a speck in one of [the] bottles.

They brought it in. Can you analyze this? Well, first of all, getting it out of the Teflon® without losing it is a problem. But, we said we'll try. Martha put the bottle under a microscope, and found just lots of specks. Some of the specks [looked] like [bits] of metal, and some [looked] like maybe bits of glass. What's going on here? So, she reported that back. And the bottle manufacturer went back to the maker of his extruding gear, to try and clean that up, because the theory was, it was getting contaminated extrusion. Martha Darr called up DuPont [E.I. DuPont de Nemours] said, "About the specs in the Teflon bottles…" "Oh, we know about those. When we powder the Teflon, [it becomes] electrostatically charged [and] just picks everything up."

GRAYSON: Yeah, right.

MARGOSHES: Well, see, she solved the problem by looking at it. Okay.

So, this guy from NASA comes with some photos of these specks. And I looked at them. I said, "Those are air bubbles." Because one of the things I learned in chemical microscopy…one thing, a chemical microscopist works with liquids. That's why you always have to look [vertically] down on the microscope…

GRAYSON: Yeah, right.

MARGOSHES: Biologists set the microscope at an angle where it's comfortable. Okay. And no matter how careful you are, a little air bubble gets in there, you know what it looks like. I also knew from restoring furniture at home, that when you varnish something, you have to be very careful about air bubbles. They had air bubbles in the varnish. Can you imagine how difficult it would have been to analyze those?

GRAYSON: Oh, yeah.

MARGOSHES: Yeah. It's having this scattered knowledge. More scientific knowledge, okay. Before, I mentioned cobalt protein.

GRAYSON: Yeah.

MARGOSHES: Some guy at NIH came and […] they just isolated a protein, and they found cobalt in it, and were all excited. But they would like me to analyze it—or somebody at the Bureau of Standards to analyze it—[to see what other metals were] in there. I got it, because I'd never done this type of thing [at Bert] Vallee's lab [but] I knew the procedures, so I did it. [I was] full of all sorts of things, and from my experience in isolating [a protein] I knew where it came from. One of the standard steps in isolating proteins is salting out, you add salt to it, or you can do the same sort of thing with an organic solvent. But any rate, different proteins with different…less salt levels or different nonaqueous solvent levels, will precipitate out. So, it's a way of getting bulk <**T: 190 min**> separation. Now, for salting out, you usually use ammonium sulfate, because it's very soluble, and it's not terribly expensive, especially if you don't get the reagent grade.

GRAYSON: Oh, yeah.

MARGOSHES: They get more industrial grade, which is just full of all sorts of metals. Now once the proteins get hooked onto those metals, they don't let them up. When I was isolating this protein, what I was doing was recrystallizing ammonium sulfate. You couldn't…I got rashes all over my arms. I had to go see a doctor about that, getting ammonium sulfate on my arm, but I was getting a pure protein from all of that. But those NIH people don't know that.

Another time they came to me, they were cultivating some special cells in a tank with water. They were dying. Somebody suggested, well, maybe there's some metals in there are killing them, could I analyze it. Yeah. They bring us a sample. "Well, by the way, where'd you get this bottle?" "Well, the reagent bottle we rinsed out." "Go away."

GRAYSON: Yeah. Great.

MARGOSHES: Had another guy come to me. I forget what the metal was, but he was worried about impurities might be in there. It was a little tiny speck of material. […] I said, "How did you get it into that vial?" He says, "I put it on the tip of my finger." I said, "What level of contamination are you worried about?"

GRAYSON: Yeah, right.

MARGOSHES: "Well, one percent." I said, "Well, you could have that much very easily, a bit of sweat." See, if you work with very low trace amounts, you really have to think differently.

But it's knowing this thing. I [can] not only tell him [what's] there, I can tell him where it came from. The glass electrode, this was a guy who came to me with a piece of glass, and it had a coating inside, and [there] was a side piece. He wanted to know what the coating was. I said, "What are you doing here?" He said, "Well, I have a glow discharge I'm looking at. I can look at spectra that way and get pretty high resolution spectra." I said, "What are you looking at?" He told me what spectra he was looking at. I said, "What are your electrodes made of?" He said, "Copper." [I said], "What are doing with this discharge?" [He said], "Looking for spectrum." [I said], "Go back and look at your spectrum, and you'll see the copper lines." Came back the next day. I explained to him that these discharges [cause] sputtering. He didn't know that. He came back the next day, he said, "Tell me about sputtering."

So, I'm saying that if you're doing analytical chemistry, you're solving problems, and the more you know about lots of things, that [you'd] never think to look up.

GRAYSON: Yeah.

MARGOSHES: So, as that experience builds and also, it's like the *Times* crossword puzzle. I can solve some of it you can't because they keep throwing in Yiddish words. I don't speak Yiddish, but I know some of those words.

GRAYSON: Yeah, exactly.

MARGOSHES: You probably don't know any.

GRAYSON: I don't know any Yiddish words.

MARGOSHES: No. So I have a little more information than you do.

GRAYSON: Right, in that area, anyway.

MARGOSHES: So you've got to know…that's why I say, what I learned from Warren Wacker: there's no useless information.

GRAYSON: Yeah. I think we covered the time-sharing computer part, next page, and echelle…

MARGOSHES: […] I'd like to throw in one other thing.

GRAYSON: Okay.

MARGOSHES: Advice I give to young people: don't get too specialized. It's not going to last. At some point in your career, you're going to have to change anyway. You're really better off learning how to make the change. […] The last one I gave [this] advice to…I mentioned I have a grandson who has type 1 diabetes just starting engineering school as a freshman. They told him…now, it's only his second semester, but they've got to choose a major. Now, I didn't talk to him directly. I talked to my daughter about <**T: 195 min**> this.

I said, "You've got to tell him this. He's got examples. His parents were both scientists. They're working as scientists, but they're not doing it in the fields they [studied]. I'm a scientist. I [changed] fields. You're going to do the same thing." He finally settled on one area of engineering that I think was a good choice, because it's mechanical engineering, which enters into a lot of other things.

So, I think the real thing they have to learn in engineering school is the principles of how to engineer. Working with engineers, I do what scientists in training do. We do literature research. What's the difference between engineers and scientists? There have actually been studies. One significant difference is…which […] shows what happened. You give a problem to a scientist, and he heads for the library. You give a problem to an engineer, he goes and talks to other engineers. If they're really pushed, they'll talk to a scientist.

This happened late in my stay at Technicon. The engineers and scientists were at loggerheads a lot of the time, and they didn't think too much of what we did, and I didn't think too much of the way they did things. But somebody in marketing had an idea. You try to make your product different in some way. And in the labs they had adopted using bar codes extensively. And they're always printed in black. Let's make ours red. Yeah? But the machine reader won't read the red lines.

GRAYSON: Yeah.

MARGOSHES: You say, yeah. They couldn't figure it out. Now, because it said, "Why you stupid S.O.B., don't you realize…

GRAYSON: I mean, [don't they use an] infrared…

MARGOSHES: But, you know, I knew immediately what was wrong. Well, he just didn't…I don't know if he never took a course in optics to understand how colors develop or anything. If he's an artist.

Today, everybody has digital cameras and they want to make prints out of their own. And they can't make what they see in the screen look exactly like it is on the print, because you're getting colors in two optical states

GRAYSON: Well, yeah.

MARGOSHES: One by subtraction, and one's…just by subtracting all the opposite colors.

GRAYSON: Yeah. It's completely different process.

MARGOSHES: I say, one, you fill out your form, just one single color. The other you subtract all the colors and you just need one to keep. Two different processes, and one's on a glass or plastic screen, and one's on a piece of paper. It makes a difference what paper you put it on…

GRAYSON: Oh, sure.

MARGOSHES: Yeah. So, if you want to do a good job in photography, you have to know what you're working with. If you want to do it on a computer, you have to understand what the computer can do, and can't do.

GRAYSON: So, how are we doing? […] Have we covered pretty much everything that you have in your syllabus outline, and…

MARGOSHES: Oh, I didn't mention that one miniaturization project, the ion selective electrodes. This came about out of a grant program from the University of Utah. They were working on ion sensitive transistors and looking for funding. We saw it as a possible opportunity for very low cost testing devices for sodium, potassium, he just wants to throw away, because you could in principle make so many of these on single wafer to pass it up.

So, we worked out a grant agreement with them, but the patent part of it hadn't been settled. Their university's patent attorney was very hard to deal with, very hard. Our patent attorney thought he had over the phone agreed on something <T: **200 min**>, and this guy would write it up. It was something entirely different. Meanwhile, the researchers got funding from NIH, so they cut it off, which was fine. Couldn't stop them. I understood. He was very unhappy with [it], and I was, but we just couldn't get past this patent attorney. Not the only one I had trouble with. They just weren't […] used to working with industry.

So, what are the alternatives? Well, Jay [N.] Zemel here at the University of Pennsylvania in the electronic engineering department, published an article in *Analytical Chemistry* on diode sensors, not transistors, so I went to our patent people who had seen the patent application. I said, "Would this get us out from under that patent?" Yes.

So, we talked to Zemel about it, and he liked the idea, but he wasn't going to manufacture. He liked the idea of doing the research, not the manufacture, so he put a student on it and developed diodes. Now we're ready to take the next step, which is to find somebody who would make larger numbers for us. We found that a group at the University of Arizona was just getting in the field and willing to do this for us. In exchange, we sent one of our chemists there to help them do some things. It was a nice arrangement…

GRAYSON: Yeah.

MARGOSHES: Everybody's happy. We collectively got to thinking about how we're going to package these diodes. The problem was the same with transistors or diodes. These semiconductor devices are very sensitive to moisture, but you have to expose them to aqueous solutions to make them work. How to do that? Zemel came up with the idea of using a coated wire approach to keep the semiconductor part separated through a wire.

You can make it. Just take a wire, coat one end, […] connect the other end to a diode or a transistor and make it that way. He claimed they're really equivalent technically, not equivalent in the patent sense. Scientifically, engineering surfaces, they're equivalent. But that seemed to be making it a little too much complicated. We just basically gave up on the idea.

The conclusion…I know […] other companies were working on it at the same time. You can have some niches where you can make very small sensors, where you need the sensor to be very small. But we weren't looking for that. We were looking for places where the sensor could be very cheap, like the ones that are now used for testing glucose. Do you know what the Clark electrode is?

GRAYSON: No.

MARGOSHES: Okay. Clark who is still somewhat active at the University of Cincinnati Medical School, developed this glucose electrode. Take a standard platinum electrode. You put it behind a membrane that will keep glucose oxidase at the electrode and let sugar in from outside, but not…nothing, you know, not the whole cell, not all the mess passes a selective membrane. You need just sugars, because the enzyme's also selective, but normally if you put the platinum electrode into blood, it becomes contaminated by blood proteins and it's useless, so he had an electrode. Now, the first instruments used [that] Clark electrode [but] these disposable sensors used the same idea, but in a different way. They have powdered graphite in there, mixed in with the enzyme. I only know this from reading <**T: 205 min**> the patent, because I don't have the means to take it apart and see what this thing is, but essentially, they're not using platinum. That would be too expensive. They're using graphite. Even if that gets poisoned, it takes five seconds for the measurement. What you're measuring is […] oxygen and it's being used up depending on the amount of glucose is what rate it's being used up. So, even if the electrode gets poisoned, it doesn't matter providing you can get the reading before it's useless. You can't use the electrode again.

GRAYSON: Yeah.

MARGOSHES: But […] they're very cheap to make, I'm sure. They sell them for a lot of money, but that's where they make their profit. They give […] away the testers.

GRAYSON: Yeah. Well, that's something that I observed when we were in Rome with my diabetic granddaughter. She lost her meter the first day we were there and went to the drugstore and they gave her a meter, but she had to buy these things.

MARGOSHES: Yeah, right.

GRAYSON: And [they're so damned expensive. And you] go through three or four dollars' worth in a day, if you've got to do that kind of heavy monitoring that she had to do. It's kind of a rip-off, if you ask me.

MARGOSHES: They make their money. But, you know, there's a lot of competition there. There's a lot of companies [who] make them. As far, as I know, they all work pretty much the same way. The first ones used colorimetric methods on paper. Paper inherently introduces a certain amount of noise into the measurement because it's not a really uniform material. You know, from one piece to another, it'll behave a little differently. But, you know, the sort of business that you're talking about, just making their money on test strips is what they call a razor blade business.

That's exactly what it is. Clinical chemistry originally…Technicon brought out the AutoAnalyzer, they would give away the instructions for making reagents; you could make your own reagents, but then they started making reagents. Then [as it evolved], the profit was in the reagents. Some of the companies would essentially give away instruments or loan it to you free, because you had to come back for the reagent.

When I came to Technicon, they were just building their largest analyzer, called SMAC, S-M-A-C, Sequential Medical Analyzer, and the C stood for computer [Sequential Multiple Analyzer Computer]. Oh no, it wasn't that one. It was [for the one after] that, which used a more advanced flow technology which was not really very sturdy, but each analysis called for one microliter of serum, and seven microliters each of two reagents. Now, how do you make the money on the reagents, at seven microliters of each reagent per sample? Okay?

So, they thought they got smart. […] You know, at least [in] the HP [Hewlett-Packard] printers, there's a bar code on the cartridge. They read that when you put the cartridge in, and they say, well, you got a new cartridge. Okay. They know how many […] prints [you should] be able to make. They warn you that if you try to refill that cartridge, it doesn't work so well anymore.

Okay. So, they decided they'll use the same system. The bar code reader would recognize and after all you can't leave the reagent there too long, if you don't use it by a certain amount of time, [they can] tell you to take it away. But by the time you run the next number of samples, we know the reagent's all used up. You can't…it won't let you refill.

GRAYSON: Oh, hang on a second. […]

[END OF AUDIO, FILE 1.2]

GRAYSON: Yeah. Okay. Sorry about the interruption there.

MARGOSHES: So, the idea was that you couldn't refill these cartridges. You had to buy a whole new cartridge from Technicon, at Technicon's price.

GRAYSON: So, they had these things set up so they automatically dispensed the appropriate quantities of…

MARGOSHES: Well, that was all built into the computer [control], the way it was operated.

GRAYSON: Okay. So, it's like an ink cartridge kind of thing, same deal, that it, in the same…

MARGOSHES: Yeah. Because you were sending a sample in several segments, and each segment, for a different chemistry, so the computer had to be informed which test was supposed to be run on that sample. It had all that information and had to know […] where I check this reagent, where I check that. So, that was all.

GRAYSON: Okay.

MARGOSHES: So, the machine was in the market for only a few months, less than a year and I get a manuscript to review from the journal *Clinical Chemistry*. Some people in Sweden had looked into computer code and figured out how to get around this and refill. Now they wanted to tell everybody about it.

GRAYSON: Oh, boy.

MARGOSHES: I consulted with one other guy just to be sure, [who] I knew I could trust. I can't review this. I mean, it's an obvious…

GRAYSON: Conflict.

MARGOSHES: Anything I say…you know, even if I could set aside the company connection anything I say can be misread. I just can't. I sympathize with them, because it's hard [for them] to find somebody of stature who knows the instrument. I don't know what they ever did about that. It was a good idea [gone bad].

GRAYSON: Well, I mean, in those situations [I think] people are always game to try some other way to get around […] whatever the barrier is, and…

MARGOSHES: […] I've used [those] inkjet printers also, just to setup simple experiments in chromatography for the students at Sarah Lawrence. You can run any kind of paper through there, if it's stiff enough. If it's not stiff enough, you have to put a backing on it. Just print a row of [dots with] different colors and far enough [set off], so they can roll the whole thing up and put it into a container with some eluents in it, and watch how the colors, different colors dilute. It's a very simple system to make those for the class.

GRAYSON: This is a kind of chromatography, paper chromatography type of experiment…

MARGOSHES: Yeah, right. I'm trying to work them up to the more complex chromatography, but the way it started was just some paper chromatography…

GRAYSON: Yeah.

MARGOSHES: Another one […] that didn't work because I didn't try it out in advance. Let's analyze the colors on M&Ms. They'd been taught how to make tiny capillary columns. You take one of these throwaway droppers and you put a little glass wool or cotton in the bottom, then put in whatever, you know, silica gel that you want to fill the column with and you've got a nice little column to work with, cheap, throwaway. We then would go and take the effluent, try to capture a band and then it comes out, we'll take it over to the spectrophotometer, and measure color, and compare it standard food dye samples. I had no idea how little dye there is on an M&M.

GRAYSON: Oh, wow.

MARGOSHES: It was a good idea, but it's hard to…you have to go through a lot of M&Ms to scrape off surfaces. And they couldn't even eat the chocolate part, because you're in a lab, you can't…

GRAYSON: Yeah.

MARGOSHES: You know, once they're in the lab, they're not food [anymore]…

GRAYSON: Yeah, right, exactly. What an interesting idea, that I guess, you probably need to always try them out ahead of time just to make sure you don't have these little…

MARGOSHES: Yeah. Well, I didn't, so that was my mistake. It seemed so neat. But […] these students aren't chemistry majors.

GRAYSON: No. So, you've got a nursing agreement with pre-nursing or pre-med…

MARGOSHES: They have also, they're mostly a fine arts school.

GRAYSON: Oh, okay.

MARGOSHES: Fine arts college, but every so often…one of the big people at Dell is one of their graduates, and <**T: 05 min**> the faculty keep getting new Dell computers. They don't know how to use them very well, but they get the latest models.

GRAYSON: Oh, wow. That's too bad.

MARGOSHES: But they're not all perfect. I was over there doing something with them, with the chemistry prof [who] I work with, doing something with her computer. I put a CD in the drive, and the machine ate it. I couldn't get it out.

GRAYSON: Oh, my.

MARGOSHES: I had to call up their tech guy to come and fish it out for me. I've never had that happen.

GRAYSON: That's weird. Okay, any other things that you want to cover. We…

MARGOSHES: I can't think of any. What time is it getting to be?

GRAYSON: It's—it's getting to be time that we're going to be leaving after hours, that's not a problem.

MARGOSHES: Oh, okay. That's good, because what we can do is, do you want to walk down with me to the Penn's View Hotel…

GRAYSON: I don't think so. Let me get this guy…

[END OF AUDIO, FILE 1.3]

[END OF INTERVIEW]

LIST OF PUBLICATIONS AND PATENTS

1. M. Margoshes and V.A. Fassel, "The Infrared Spectra of Aromatic Compounds. I. Evidence Indicating Intramolecular Hydrogen Bonding Between Substituent Groups and Ring Hydrogens," *U.S.A.E.C.-I.S.C.* (l953): 259.

2. M. Margoshes, F. Fillwalk, V.A. Fassel, and R.E. Rundle, "Relation Between Bond Length and Stretching Frequency for the Carbonyl Group," *J. Chem. Phys.* 22 (1954): 381-2.

3. M. Margoshes and V.A. Fassel, "The Infrared Spectra of Aromatic Compounds. I. The Out-of-Plane C-H Bending Vibrations in the Region 625-900 cm-1," *Spectrochim. Acta* 7 (1955): 14-24.

4. M. Margoshes and V.A. Fassel, "Infrared Functional Group Analysis of Aryl Silanes," *Anal. Chem.* 27 (1955): 351-3.

5. K. Nakamoto, M. Margoshes, and R.E. Rundle, "Stretching Frequencies as a Function of Distance in Hydrogen Bonds," *J. Amer. Chem. Soc.* 77 (1955): 6480-6.

6. M. Margoshes and B.L. Vallee, "Direct-Reading Flame Spectrometry; Principles and Instrumentation," *U.S. Dept. of Commerce, Office of Technical Services* PB 111743 (l955).

7. R.D. Kross, V.A. Fassel, and M. Margoshes, "The Infrared Spectra of Aromatic Compounds. II. Evidence Concerning the Interactions of π-Electrons and σ-Bond Orbitals in C-H Out-of-Plane Bending Vibrations," *J. Amer. Chem. Soc.* 78 (1956): 1332-5.

8. M. Margoshes and B.L. Vallee, "Flame Photometry and Spectrometry. Principles and Applications," in *Methods of Biochemical Analysis*, D. Glick, ed. (Interscience: New York, 1956) Vol. 3, pp. 353-407.

9. B.L. Vallee and M. Margoshes, "Instrumentation and Principles of Flame Spectrometry. I. A Multichannel Flame Spectrometer," *Anal. Chem.* 28 (1956) 175-9.

10. M. Margoshes and B.L. Vallee, "Instrumentation and Principles of Flame Spectrometry. II. Effects of Extraneous Ions in the Simultaneous Determination of Five Elements," *Anal. Chem.* 28 (1956): 180-4.

11. M. Margoshes and B. L. Vallee, "Instrumentation and Principles of Flame Spectrometry. III. Automatic Background Correction for a Multichannel Flame Spectrometer," *Anal. Chem.* 28 (1956) 1066-9.

12. M. Margoshes and B.L. Vallee, "A Cadmium Protein from Equine Kidney Cortex," *J. Amer. Chem. Soc.* 79 (1957): 4813.

13. W.E.C. Wacker, M. Margoshes, A.F. Bartholomay, and B.L. Vallee, “Bananas as a Low-Sodium Dietary Staple,” *New England J. Med.* 259 (1958): 901-4.

14. M. Margoshes and B.F. Scribner, “The Plasma Jet as a Spectroscopic Source,” *National Bureau of Standards Report* 6160 (Sept. 2, 1958).

15. R.E. Thiers, M. Margoshes, and B.L. Vallee, “Simple Ultraviolet Photometer,” *Anal. Chem.* 31 (1959): 1258-61.

16. M. Margoshes and B.F. Scribner, “The Plasma Jet as a Spectroscopic Source,” *Spectrochim. Acta* 15 (1959): 138-45.

17. M. Margoshes, “Some Properties of New or Modified Excitation Sources,” in B.F. Scribner, ed., *Symposium on Spectroscopic Excitation* (Philadelphia: Amer. Soc. Testing Matls. Spec. Techn. Publ. 259, 1960), pp. 46-58.

18. B.F. Scribner and M. Margoshes, “Excitation of Solutions in a Gas-Stabilized Arc Source,” *National Bureau of Standards Report* 7342 (Sept. 20, 1961).

19. M. Margoshes, “An Introduction to Flame Photometry and a Review of Recent Studies,” in W.L. Nastuk, ed., *Physical Techniques in Biological Research* Vol. 4 (New York: Academic Press, 1962), pp. 215-60.

20. M. Margoshes, “Annual Review: Emission Flame Photometry,” *Anal. Chem.* 34 (1962) 221R-4R.

21. B.F. Scribner and M. Margoshes, “Excitation of Solutions in Gas-Stabilized Arc Sources,” in *Actes des IX Colloquium Spectroscopicum Internationale*, Vol. 2 (Paris: Groupement pour l'Avancement des Methodes Spectrographiques, 1962), pp. 309-24

22. E.R. Lippincott and M. Margoshes, eds., *Proceedings of the Xth Colloquium Spectroscopicum Internationale* (Washington: Spartan Books, 1963).

23. M. Margoshes and B.F. Scribner, “A Study of the Gas-Stabilized Arc as an Emission Source for the Measurement of Oscillator Strengths. Determination of Some Relative gf-Values for Fe I,” *J. Res. Natl. Bur. Stds.* 67A (l963): 561-8

24. B.F. Scribner and M. Margoshes, “Annual Review: Emission Spectrometry,” *Anal. Chem.* 36 (l964): 329R-43R.

25. M. Margoshes and B.F. Scribner, “Simple Arc Device for Spectral Excitation in Controlled Atmospheres,” *Appl. Spectry.* 18 (1964): 154-5.

26. M. Margoshes and B.F. Scribner, "Emission Spectroscopy," in I.M. Kolthoff and P.J. Elving, eds., *Treatise on Analytical Chemistry* Part I, Vol. 6 (New York: Interscience, 1965), Chap. 64, pp. 3347-3461.

27. M. Margoshes, "Recent Advances in Excitation of Atomic Spectra," in *Proceedings of the XII International Spectroscopy Colloquium* (London: Hilger & Watts, 1965), pp. 26-42.

28. S.D. Rasberry, B.F. Scribner, and M. Margoshes, "Characteristics of the Laser Probe for Spectrochemical Analysis," in *Proceedings of the XII International Spectroscopy Colloquium* (London: Hilger & Watts, 1965), pp. 336-9.

29. M. Margoshes and B.F. Scribner, "Annual Review: Emission Spectrometry," *Anal. Chem.* 38 (1966): 297R-310R.

30. M. Margoshes, "Excitation and Ionization in Arc and Spark Excitation Sources," *Appl. Spectry.* 21 (1967): 92-9.

31. S.D. Rasberry, B.F. Scribner, and M. Margoshes, "Laser Probe Excitation in Spectrochemical Analysis. I. Characteristics of the Source," *Appl. Optics* 6 (1967): 81-6.

32. S.D. Rasberry, B.F. Scribner, and M. Margoshes, "Laser Probe Excitation in Spectrochemical Analysis. II. Investigation of Quantitative Aspects," *Appl. Optics* 6 (1967):87-93.

33. M. Margoshes, "Selection of Wavelengths for Atomic Absorption Spectrometry," *Anal. Chem.* 39 (l967): 1093-6.

34. S.D. Rasberry, M. Margoshes, and B.F. Scribner, "Applications of a Time-Sharing Computer in a Spectrochemistry Laboratory: Optical Emission and X-Ray Fluorescence," *National Bureau of Standards Technical Note* 407 (February 1968).

35. M. Margoshes and B.F. Scribner, "Annual Review: Emission Spectroscopy," *Anal. Chem.* 40 (1968): 223R-46R.

36. C. Veillon and M. Margoshes, "An Evaluation of the Induction-Coupled, Radio-Frequency Plasma Torch for Atomic Emission and Atomic Absorption Spectrometry," *Spectrochim. Acta* 23B (1968): 503-12.

37. C. Veillon and M. Margoshes, "A Pneumatic Solution Nebulization System Producing Dry Aerosol for Atomic Spectroscopy," *Spectrochim. Acta* 23B (1968): 553-5.

38. Marvin Margoshes, "What's In That Microgram? You Can Be Sure…to 10 ppm," *Scientific Research* 3(5) (1968): 40-2.

39. M. Margoshes, “Remarks on Linearization of Characteristic Curves in Photographic Photometry,” *Appl. Optics* 8 (1969): 818.

40. M. Margoshes and S.D. Rasberry, “Fitting of Analytical Functions with Digital Computers in Spectrochemical Analysis,” *Anal. Chem.* 41 (1969): 1163-72.

41. M. Margoshes and S.D. Rasberry, “Application of Digital Computers in Spectrochemical Analysis; Computational Methods in Photographic Photometry,” *Spectrochim. Acta* 23B (1969): 497-513.

42. M. Margoshes and B.F. Scribner, “Annual Review: Emission Spectrometry,” *Anal. Chem.* 42 (1970): 398R-417R.

43. M. Margoshes, “Data Acquisition and Computation in Spectrochemical Analysis: A Forecast,” *Spectrochim. Acta* 25B (1970): 113-22.

44. M. Margoshes and J.S. Swinehart, “Instrumentation Without Humans,” *Industrial Research* 12(6) (1970): 52-5.

45. M. Margoshes, “Computerized Optical Instruments,” *Optical Spectra* 4(11) (1970): 26-8.

46. M. Margoshes, “When the Computer Becomes a Part of the Instrument,” *Anal. Chem.* 43(4) (1970): 101A-9A. Reprinted in A.J. Senzel, ed., *Instrumentation in Analytical Chemistry* (Washington: American Chemical Society, 1973), pp. 361-7.

47. M. Margoshes, “Application of the Laser Microprobe to the Analysis of Metals,” in C.A. Anderson, ed., *Microprobe Analysis* (New York: John Wiley & Sons, 1973), pp. 489-505.

48. M. Margoshes, “Computer Applications in Spectrochemical Analysis,” in J.S. Mattson, H.B. Mark, Jr., and H.C. MacDonald, Jr., eds., *Computers in Chemistry and Instrumentation. Vol. 5: Laboratory Systems and Spectroscopy* (New York: Marcel Dekker, Inc., 1977), pp. 89-139.

49. H. Adler, M. Margoshes, L.R. Snyder, and C. Spitzer, “Rapid Chromatographic Method to Determine Polyamines in Urine and Whole Blood,” *J. Chromatogr.* 143 (1977): 125-36.

50. M. Margoshes, “Pumping Pressure and Reagent Consumption in Continuous Flow Analysis with Unsegmented Reaction Streams,” *Anal. Chem.* 49 (1977): 17-19.

51. M. Margoshes, “Exchange of Comments: Pumping Pressure and Reagent Consumption in Continuous Flow Analysis with Unsegmented Reaction Streams. Reply,” *Anal. Chem.* 49 (1977): 1861-2.

52. M. Margoshes, “Demand-Pull and Science-Push in Multielement Analysis,” *Anal. Chem.* 51 (1979): 1317A-2A.

53. M. Margoshes and D. A. Burns, “Automation: Instrumentation for Analysis Systems,” in I.M. Kolthoff and P.J. Elving, eds., *Treatise on Analytical Chemistry*. Part I, Vol. 4, 2nd ed. (New York: John Wiley and Sons, 1984), pp. 413-65.

54. M. Margoshes, “A Modest Proposal on the Proliferation of Science and Scientists,” *Journal of Irreproducible Results* 30 (1984): 23.

55. M. Margoshes, “The Role of Microchemistry in Laboratory Medicine,” *Microchem. J.* 34 (1986): 25-34.

56. E. Stark, K. Luchter, and M. Margoshes, “Near Infrared Analysis (NIRA): A Technology for Quantitative and Qualitative Analysis,” *Appl. Spectrosc. Rev.* 22 (1986): 335-99.

57. D.A. Burns and M. Margoshes, “Historical Development,” in D.A. Burns and E.W. Ciurczak, eds., *Handbook of Near-Infrared Analysis* (New York: Marcel Dekker, 1992), pp. 1-5.

Patents by M. Margoshes

1. R.L. Vogenthaler and M. Margoshes, “Selectively Read Electro-Optical Imaging System,” U.S. Patent #3,728,576; April 17, 1973.

2. T. Hirschfeld and M. Margoshes, “Digitally Controlled Electro-Optical Imaging System,” U.S. Patent #4,335,336; October 19, 1982.

3. D.A. Burns, M. Margoshes, and M.M. Cassaday, “Sample Transport System,” U.S. Patent #4,526,754; July 2, 1985.

INDEX

W

Y

Z