CHEMICAL HERITAGE FOUNDATION

JAMES L. WATERS

Transcript of an Interview
Conducted by

Arnold Thackray and Arthur Daemmrich

at

Framingham, Massachusetts

on

21 August 2002

(With Subsequent Corrections and Additions)

THE CHEMICAL HERITAGE FOUNDATION
Oral History Program
RELEASE FORM

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(Signature) James L Waters
James Waters

(Date) 8/21/02

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

JAMES L. WATERS

1925 Born in Lincoln, Nebraska on 7 October

Education

1946 B.S., electrical engineering, Columbia University

Professional Experience

United States Naval Reserve
1943-1946 Apprentice Seaman
1946 Ensign

Baird Associates, Inc.
1947 Project Manager

James L. Waters, Inc.
1947-1958 Founder and President

Waters Associates, Inc.
1958-1972 Founder and President
1972-1980 Chairman of the Board

Waters Enterprises, Inc.
1978-present Founder and President

Waters Foundation
1955-present Founder and Trustee

Cetek Corporation
1998-present President and CEO

Selected Community Service

1955-1960 Framingham Town Meeting Member, Framingham, Massachusetts

Framingham School Committee, Framingham, Massachusetts
1960-1970 Member
1963-1964 Chairman

Honors

	Member, Tau Beta Pi
	Member, The Pittcon Hall of Fame
1993	D.Sc. (*honorary*), Northeastern University

ABSTRACT

James L. Waters begins his interview by discussing his family history and the emigration of his ancestors from England to Massachusetts in 1638. Waters was born in Lincoln, Nebraska in 1925, where his father, Leland L. Waters, worked at the family insurance business. Waters describes himself as an independent child, who preferred to do things on his own without the help of his parents, something he feels was critical in his success as a businessman. As a youth, Waters participated in little league football and maintained a paper route, a job that enabled him to gain a sense of independence. During Waters' junior year of high school, his father was offered a position as the treasurer of the B&W Bus Line, an opportunity that took the Waters family to Framingham, Massachusetts.

Waters graduated from Framingham High School in 1943 and enrolled at Massachusetts Institute of Technology, where he became a member of the Navy's V-12 program for engineering. Waters was sent to Columbia University to continue his studies as a physics major at the end of his second term. He was then discharged from the Navy and entered the University of Nebraska. In 1947, Waters accepted a position as project manager's assistant at Baird Associates Inc. and was soon promoted to project manager, working as an assembler and service man on various instrumentation. Waters, however, felt unfulfilled, and after a short while, decided the time was right to start his own instrumentation company.

At the age of twenty-two, Waters founded James L. Waters, Inc., working from his parents' basement. At the same time, Waters met Faith Pigors, whom he married in 1948. In spite of his lack of experience and naiveté in business, Waters' sheer determination to succeed enabled him to overcome the many obstacles that occurred while working on his first instrument, an infrared gas analyzer. Waters sold James L. Waters, Inc. to Mine Safety Appliances Company in 1955, but continued his work on instrumentation in a contract capacity with Mine Safety.

Waters founded Waters Associates, Inc. in 1958, and shortly afterwards began to delve into the field of gel permeation chromatography [GPC]. As Waters Associates' GPC instruments evolved, the company experienced phenomenal growth and in eight years managed to double its profits, many times over. The business began to decline due to R&D problems, so Waters Associates merged with Millipore Inc. in 1977. After conflicts with the Waters Associates board, Waters left the company to become the director of Millipore and, finally, a venture capitalist. Waters concludes the interview with a discussion of his wife and children and their careers.

INTERVIEWERS

Arnold Thackray is president of the Chemical Heritage Foundation. He majored in the physical sciences before turning to the history of science, receiving a Ph.D. from Cambridge University in 1966. He has held appointments at Oxford, Cambridge, Harvard, the Institute for Advanced Study, the Center for Advanced Study in the Behavioral Sciences, and the Hebrew University of Jerusalem. In 1983 he received the Dexter Award from the American Chemical Society for outstanding contributions to the history of chemistry. He served on the faculty of the University of Pennsylvania for more than a quarter of a century. There, he was the founding chairman of the Department of History and Sociology of Science, where he is the Joseph Priestley Professor Emeritus.

Arthur Daemmrich is the director of the Center for Contemporary History and Policy at the Chemical Heritage Foundation. He holds a Ph.D. in science and technology studies from Cornell University and has published on biotechnology policy and politics, the sociology of medicine, and pharmaceutical drug regulation. The projects he supervises at CHF bring long-range perspectives to bear on key issues in innovation, globalization, risk, health, and environmental policy. Daemmrich has held fellowships from the Social Science Research Council/Berlin Program for Advanced German and European Studies, the Kennedy School of Government at Harvard University, and the Chemical Heritage Foundation.

TABLE OF CONTENTS

INTERVIEWEE: **James L. Waters**

INTERVIEWERS: **Arnold Thackray and Arthur Daemmrich**

LOCATION: **Framingham, Massachusetts**

DATE: **21 August 2002**

THACKRAY: Let's begin by discussing your ancestors, their emigration to the United States and their settlement in Nebraska.

WATERS: My grandfather was interested in genealogy. He traced the Waters family history back to a blacksmith in London whose son, Richard Waters, emigrated with his mother and stepfather to Salem, Massachusetts in 1638. Most Waters in America are descended from two families: one is the Waters family from Salem, Massachusetts and the other is from Virginia.

In any case, Richard Waters was a gunsmith in Salem. I'm a descendant of one of the sons who moved to Topsfield, Massachusetts and became a farmer. His descendants lived in western Massachusetts at the time of the Revolutionary War; in Concordia, New York, during the Civil War—there are quite a few Waters in New York currently—and then in Indiana. My great-grandfather, Albertus Auretius Waters, took part in [William T.] Sherman's March to the Sea. He was about thirty-two years old at that time and served during three years of the Civil War. He must have been quite a tough guy, in terms of health, to have survived those three years of war.

From what I can determine, Albertus' oldest son, Henry, settled on the eastern edge of the Sand Hills in central Nebraska. Farming in that region was good for the first few years because the soil contained enough moisture but, after three or four years of farming, the soil dried out and it became difficult to grow hearty crops. As nearly as I can determine, Henry convinced his father (my great-grandfather) to homestead in Bartlett, Nebraska. He recommended that his father, in accordance with the Homestead Act, settle on the land for five years, sell it for a profit, and then retire with a nice pension.

My grandfather was the youngest son in that family. He decided to be a city boy. When he was in his thirties, he owned a grocery store in the city. He was a good salesman.

THACKRAY: Did he own the store in Lincoln, Nebraska?

WATERS: Yes. Then he bought a small insurance company from somebody. I don't think he paid very much for it. It grew quickly during the 1920s and my father joined the company but

they ran short of capital in the 1930s. They went bankrupt about 1934 and my father had the horrible job of cleaning up the company, which was very depressing for him.

On the other side of my family, my maternal grandfather's name was Jacob Yungblut. The Yungbluts came from Freiberg, Germany, originally, around 1840. I don't know that genealogy very well. There were four Yungblut brothers. Jacob Yungblut was a man's man. He died two weeks after I was born, so I never knew him but people described him as a charming man—somebody who was everybody's friend. He belonged to the Rotary [Club] for around thirty years and never missed a meeting. He was a salesman. The Yungblut brothers owned a grocery store in 1910.

THACKRAY: Was that grocery store also in Lincoln, Nebraska?

WATERS: Yes. The Yungbluts first settled in Marietta, Ohio, right across the Ohio River from West Virginia, in the 1840s. Three of the brothers lived in Lincoln, so at some point the brothers must have migrated to Lincoln from Marietta.

My grandmother's maiden name, on the Yungblut side of the family, was Logan. I don't know where the Logans came from but it's clearly a Scottish name. My great-grandmother on my mother's side was a Whiteman. They were in Rhode Island before the Revolutionary War. During the Revolution, they moved to Royalton, Vermont. The reason they moved to Royalton, Vermont was that they were Royalists and were pushed out of Rhode Island.

One of my cousins told me he remembered in 1908 sitting on my great-grandmother's knee. She told him the story about Ethan Allen and the Green Mountain Boys. At the end of the story, she declared, "They were just a bunch of rabble!" [laughter] So there was still a little bit of that Royalist attitude left in my great-grandmother, who was born around 1830 and died around 1910. It just shows how strong feelings last for many years. You know, people in Atlanta haven't forgiven Sherman yet either! [laughter]

As for my parents, my father, Leland L. Waters, was born in 1898, lived in Lincoln, and went to the University of Nebraska [UN] for two years. Then he joined the Air Corps during the First World War and learned to be a pilot in Texas. He'd seen so many pilots die in crashes during his training in Texas, that afterwards he frequently declared that he would never fly again. Of course, he flew after the rise of commercial aviation but he still refused to fly in biplanes or anything like that. He never got out of Texas during the War; he was still in training when the War ended.

Then my father went to the University of Michigan and got a degree as an actuary; clearly, by then my grandfather was in the insurance business. When my father came back, he became the treasurer and the actuary in the insurance company. My father was a very nice man, a gentle man, a very honorable man. For instance, he borrowed forty thousand dollars to invest in the insurance company in the 1920s and paid back all but four thousand before the Great

Depression. To understand how much money that was back then, take forty thousand and multiply it by ten!

The bank forgave him the interest on the loan and he finally paid the remaining principal off around 1950. He made small payments here and there for twenty years but he paid it all off eventually. As I said, he was honorable, and the pressure of the Depression during the 1930s affected his health somewhat. He had an upset stomach a lot of the time, which I'm sure was caused by stress.

My uncle, Paul [T.] Babson, married my mother's sister and was Roger [W.] Babson's cousin. Paul was very successful in the investment business. He founded United Business Service in Boston. Early in 1942, the treasurer of the B&W [Boston & Worcester] Bus Line died and my uncle thought my father, Leland L. Waters, would be interested in that position. I remember the night Paul called on the phone. I was a junior in high school in Lincoln, Nebraska. Father told us about the opportunity, which I thought was wonderful.

Many people have asked me if I was devastated to move away when I was about to begin my senior year in high school. Well it wasn't—to me it was great. It was the challenge of starting all over again, meeting new kids, and so forth.

I enjoy attending high school reunions. I've attended my Lincoln High School reunions and my Framingham High School reunions; both have been quite nice.

THACKRAY: B&W Bus Line was a significant entity in those parts, wasn't it?

WATERS: Yes. They had one hundred and twenty buses that ran on what we called the "turnpike," which is actually Route 9 now. It was always called the "turnpike" until the toll road was built and named the Massachusetts Turnpike. Anyway, the treasurer's job was a great opportunity for my father. He got to use his skills as treasurer and he later became company president. He seemed ten years younger to me after he got that job.

My mother [Marian L. Yungblut Waters] was a very charming woman. She could charm the birds out of the trees. She was quite determined and just the right wife for my father. She was the sunshine of his life and he was the stability that she needed. They had a very good marriage. I remember times when my mother was convinced something was the right thing to do and my father said, "No, we're not going to do it." She'd pout a bit but then let him make the decision. However, she made most of the day-to-day decisions, especially concerning our social activities.

THACKRAY: What was your mother's educational background?

WATERS: She spent two years at the University of Nebraska and then became a kindergarten teacher. My parents were married in 1922. My mother was born in 1899, so she was about twenty-three years old when they were married; whereas my father was about twenty-four years old. I was born three years later. In fact, my birthday is on 7 October and their wedding day was on 7 October. My father always used to joke that he thought it was about time that they got married!

My mother was very strong-willed, especially with respect to me. I was the oldest child. I have a younger sister, who is two years younger than I am. My mother wanted me to follow her plans for my life. She wanted me to impress the women who came over in the afternoon to play bridge. She wanted me to do the right thing so everyone would exclaim, "Jimmy is such a well-behaved boy!" Now, somewhere along the way I decided to be independent. I remember numerous times when she said, "Why do you do so much? You don't have to do all those things;" statements that I took as, "You're not necessarily doing the things that I think you ought to do." They were various things that weren't on her agenda, like running for school committee but she had the good sense to lose the battle, which I think added a lot to my character. I give my mother a lot of credit for that decision.

I was very independent, even when I was very young. I remember a story of when someone tried to help me when I was very young, I said, "I do it—my own!" So I was very independent and determined to remain independent. I never rebelled against my family, or, let's say my only rebellion was doing what I felt was right for me, because if I don't think well of myself, I don't care who else thinks well of me. It just doesn't matter. I need to do well so I can think well of myself.

My mother never went back to work after she married; she stayed home. We were moderately well off. We were not among the wealthy in Lincoln but we were clearly right in that second tier of well-off business people.

Lincoln is an unusual community because it has the State Capitol, it has the University [of Nebraska], and of course it was a business center for the large farming community around it. So there were lots of merchants, wholesalers, and department stores. There were also the politicians, a rather minor group, and the academic professors. There were different circles in the Lincoln society. You might be in the merchant class and know almost nothing of state politics. While, on the other hand, the merchants very often took a prominent role in city government. In other words, the mayor was probably a department store owner. There was a lot of integrity and a lot of responsibility in the business community.

Incidentally, if you ever get near Lincoln, go to the State Capitol Building. I think it's the most beautiful building in the world. It's an Art Deco building that was begun around 1922 and was finished around 1933. They built only what was appropriated for construction each year and they appropriated without going into debt. So if they appropriated three million dollars in a year, they did three million dollars worth of construction and then waited for the next year's appropriation. The new Capitol was built around the site of the old Capitol Building; the old Capitol was in the middle and offices were built around it. When enough of the building was

built around the old Capitol Building, they tore the old one down. The new Capitol Building is a representation of the Nebraskan plains. It consists of a flat building about three stories tall and a tower that's about fifteen stories tall. I just happen to like Art Deco.

THACKRAY: Did you belong to groups like the Boy Scouts [of America], or own a children's chemistry set? What were you up to when you were ten, eleven, and fourteen?

WATERS: I think my main motivation was to think well of myself. Of course, I had to achieve something to think well of myself. So let's go back. I was a terrible student during my first few years in school. To be honest, my third grade teacher, Miss Heiney, was a terrible teacher. I hated her! I hated school! I just barely passed. I did a little better in fourth grade and then a little better in fifth grade. I remember overhearing my parents' conversation after having received my report card. My father asked, "What is wrong with Jimmy? What are we going to do to help him?" My mother replied, "Well, Beelie," which was my father's nickname, "we might as well accept it. Jimmy isn't very bright. He isn't going to do very well." When I tell that story, most people ask if I was devastated by that comment. No! I was thrilled! She was off my back! [laughter] Actually, my grades shot up after that! [laughter]

I was doing reasonably well by the time I was in seventh grade. My father used to kid me that I didn't learn to read until I was in fifth grade. By fifth grade, I read *Big Little Books*. They were little books that were roughly in the shape of small cubes, with big type. They were about things like Tarzan and so on.

When I was in the sixth grade, I joined what was basically a little league football team, which was started by a wealthy man in Lincoln. Most of my team members were in seventh or eighth grade, so I was young but I was reasonably big. My size was helpful but I wasn't a very good football player; I didn't have the necessary desire to "kill" the other guy, which is something you need to play well. In any case, joining the football team is an example of something I did to prove to myself that I could do it.

Luckily, we belonged to the Lincoln Country Club and every Fourth of July they'd have swimming races. I was a good swimmer and won most of my races.

I remember my bike was stolen when I was in fifth grade. My father had insured it and I think he got about twenty dollars as compensation. I wanted the Cadillac of bicycles, an Iver Johnson, made in Fitchburg, Massachusetts. I remember this so well. It cost forty-two fifty and it was a great bicycle. I went out and shoveled walks. I made the twenty-two fifty. Then, I combined that with the twenty dollars my father got from insurance and bought my own bicycle. So here again, I was in fifth or sixth grade and I wanted to be independent.

Around 1935, when I was about ten years old and in fifth grade, I recognized my father was having a tough time. You see, life wasn't bad in Nebraska during the early years of the Depression, 1929 to 1932. The crops were good, so everything was fine for us economically;

the economic slump didn't hit us because we weren't manufacturers to any significant degree. But things were terrible when the drought came. When it was hot, the crops failed; when the crops failed, the farmers had no income; and when the farmers had no income, the merchants didn't either. Everyone suffered.

When I was in sixth grade, one of the neighbor boys had a paper route. I became his substitute and earned twenty cents for carrying the papers in either the morning or the afternoon. He had a route with about ninety evening customers and thirty morning customers, so the paper route was very valuable. What tended to happen was, when a paper route carrier got older he could take a higher paying job and he generally left his route to his substitute. Such was my case, so I inherited the paper route when I was in the eighth grade and kept it until I was in the eleventh grade. I used to make about seventeen dollars a month from the route.

THACKRAY: That was quite a lot of money back then.

WATERS: It was damn hard work, though. I woke up just before five in the morning, got on my bicycle, rode of a mile to pick up the papers, and then rode about a mile around my route delivering the papers. I got back home around six o'clock, went back to sleep for another hour and then got up and went to school. A friend of mine had the route next to mine and we did something very smart. We carried each other's routes. So for four weeks I would carry both of our routes and then the next four weeks he'd do the same thing for me. That made things much better. I also had an evening route to carry as well. The papers came out a little before 4:00 pm and I was expected to deliver them before 5:00 pm. If you didn't carry the route, you paid your substitute twenty cents for carrying.

THACKRAY: It probably wasn't too hot on those January mornings, was it?

WATERS: It was <u>damn</u> cold. Lincoln doesn't have a lot of snow, so I could always ride my bicycle. Occasionally, I rode down the street in the path a car made in the snow. When I think about it nowadays, that bicycle was everything! It gave me complete independence. For instance, the theaters used to show lots of double-feature cowboy films. So I'd go see the double-feature at one o'clock, get out of the double-feature a little bit before 4:00 pm, and go carry the papers.

We lived about 3 miles from downtown Lincoln. I would get on my bike, ride the 3 miles down, come back to the paper route, carry the paper route, and then go back home. You know, nobody would do such a sissy thing as wear a helmet! [laughter] We got very good at things like jumping curbs, for instance. You just come on with the front wheel up and over the curb you go. As your bicycle riding skill increases, you get to the place where you can put the papers in the paper bags on the handlebars, start out, pick a paper, fold it, and throw it. Usually you grabbed hold of the handle bar when you threw it. But you could fold the papers as you

went around the route. Of course, that was a time when the newspapers were thin enough to be able to fold in a rough eight-inch square. I got very good at sailing them! [laughter]

So, we're now up to about seventh grade. At that time, my main source of income was my paper route. I think I'd already decided that I wanted to be in business for myself but I didn't know what business to choose. Lincoln had a very good school system. We had an interesting activity in junior high school—it was done very well. The activity required that we study different businesses in the city; one term covered wholesaling; another term concerned retailing; another term was insurance and so on. Then we'd go visit some business.

[END OF TAPE, SIDE 1]

WATERS: In ninth grade, we picked an occupation. I was always pretty good at arguing so I decided to be a lawyer. I studied up on it and interviewed a lawyer. By the time I'd finished, I decided I didn't want to be a lawyer, mostly because it involved an awful lot of writing and English was probably my weakest subject. My father bought me a chemistry set and I did a few experiments but I was more interested in making something that went "poof!" I never did any of the chemistry experiments like the boy did in the marvelous book that I read a little while ago called *Uncle Tungsten* (1). That is such a marvelous chemical education for a youngster. Of course, Oliver Sacks didn't become a chemist; he became a doctor. [laughter] But it's a marvelous story. I didn't have a particular engineering or science background at all, but I always got excellent grades in science and math.

I always saved my money because I wanted to be independent. Consequently, I had about a thousand dollars by the time I graduated from high school. By the time I got married, I had saved about forty-five hundred dollars. So that was like a twenty-two year old today having saved forty-five thousand dollars! I was saving money because I wanted to be in business for myself someday. I didn't know what I wanted to do but I was looking for opportunities.

In eighth grade, Shirley Hines decided it was time for Jim Waters to begin dating. [laughter] So I dated Shirley Hines and we went to a roller skating rink. That was my first date. I dated frequently from then on. I never had any real close girlfriends, but I had girlfriends and went to dances. I think there was within me some great desire to do almost a little bit of everything. It was no particular concentration at all. I knew I wanted to get married. I probably was looking for a wife by the time I was in high school—not very seriously but you know, if the right girl came along it would've been wonderful for me.

For all my life, I've always been under the care of a woman. I suppose I've never really been on my own at all. I was under the care of my mother until I went into the [United States] Navy. Then for three years I was under the care of the Navy, which was just like a mother and maybe even more so. [laughter] After I got out of the Navy, I went back home and lived there until the day I got married, and I've lived with my wife ever since. I've always been under the care of a good woman. Interestingly, I gave a lecture recently and afterwards a very earnest

woman came up to me—I had the feeling she was a bit of a feminist. She asked, "You said you'd lived with these women all your life. What did you ever do for them?" [laughter] I thought for a moment and then answered, "I loved them!" [laughter]

DAEMMRICH: Did you experience much culture shock when you moved from Nebraska to Massachusetts?

WATERS: I felt some but it wasn't very bad because around my second day at high school I met Tony [Sidney F.] Greeley. Now, Tony had more friends than anybody in the world and he maintained those friendships. He decided I was a good friend of his and that made it very easy for me to get acquainted with other people. Then it turned out that Barbara Shoup, who was in my high school class in Framingham, had been left high and dry when her boyfriend went off to a military school. Barbara was a very sociable and a very determined young lady. So along comes Jim Waters. Wow! Like that! I never knew what hit me! [laughter] Everybody should have an experience with a Barbara Shoup. I mean it. The earlier in life you have it, the better off you'll be, because once you've been manipulated you'll know how to detect when it happens again. Years later, I recognized it—it's just like in *Vanity Fair* with Becky Sharp (2). Becky Sharp and Barbara Shoup are the same person! [laughter] So I dated Barbara Shoup throughout my senior year.

Framingham was fairly different. Lincoln was a very homogeneous community and Framingham was almost the exact opposite. My high school class consisted of about one-third Italian students, one-third Irish students, and one-third Yankee Protestant students. Everyone got along fine because there was no dominant group in the school. Then, when people got married later on, one of the Irish girls would marry an Italian boy, for instance. So it's a good community. It's probably one of the reasons why the Framingham Heart Study is in Framingham: they had Cushing Veterans Hospital here, they had a very active medical community, and it was far enough out of Boston to be independent—and then it had this highly differentiated community.

THACKRAY: Why were you living in Framingham?

WATERS: Because the B&W headquarters was in Framingham. It was right down in Framingham Center, on Route 9.

All right, we're still back in junior high school. Then I went to high school and again, I did the standard things. I took as much math as I could take. I took all the science and so on. I remember almost nothing of the physics I took in high school. It just wasn't very good. Chemistry wasn't very good either, although it was probably as good as it could be in those days. I remember the day I went to get my grades in Lincoln so that I could take them to Framingham. I got the transcript and the girl in the office said, "I guess you'll be going to MIT

[Massachusetts Institute of Technology] now." I asked, "What's MIT?" She replied, "It's a great technical school in Boston." That was during the War years. I graduated from Framingham High School in 1943.

I really only applied to one place. I applied to MIT but I didn't apply with any great conviction. It's just that I was good at science and I was good at math. I kind of liked those things and it seemed like MIT would be a great place to go. So I applied and was accepted; and I think that particular year almost any civilian would've been accepted because most young men were in the military.

It was around that time that the Navy started the V-12 program. They held an exam sometime in March or April and I said I wanted to join. They picked me. They sent us to MIT. As engineers, we got eight terms of college. You did a term, you had a week off, you did another term, and you had another week off. They gave you an extra week off at Christmas. In two-and-two-thirds years I graduated from college. That last term was deadly—I couldn't think straight anymore! But it was a marvelous education because we weren't fighting in the Battle of the Bulge and they were paying us fifty dollars a month in addition to providing all of our living expenses. Of course, as a result, they thought they could work us to death and they did. I mean, we had twenty credit hours every term; whereas, I suspect college kids nowadays feel overwhelmed if they have thirteen or fourteen credit hours a term. Indeed, the Navy worked us hard but it was a marvelous education.

The Navy V-12 program must have had about a hundred thousand men. Everyone in the V-12 program had the same curriculum during their first two terms at MIT, after which everyone picked a specialty. I had a physics professor I liked so I decided to major in physics. There were thirteen other physics majors and the only place they had physics majors was at Columbia University. So at the end of my first two terms at MIT, I was sent to Columbia. It was a marvelous course because we had math and physics every term. Then we had four terms of electronics, a term of metallurgy, two terms of physical chemistry, two terms of chemistry, a term of AC [alternating current] machinery, and a term of DC [direct current] machinery. You can see, it was an absolutely solid engineering education under a physics major. You know, for me, it couldn't have been better because I got exposed to all kinds of different things.

THACKRAY: You never thought to go back to college in Nebraska.

WATERS: Yes. When I graduated from Columbia, my parents gave me a trip back to Lincoln as a graduation gift. They took me to LaGuardia [Airport] for my evening flight. Those were the days when they could go right up to the plane and watch you walk up the steps into the DC-3. The DC-3 landed briefly in Cleveland to refuel, before it continued on to Chicago. I changed planes in Chicago and flew to Omaha. Of course, when you were flying at night in those days, they had the beacons and so you could look out the window and you'd see the line of beacons out ahead and out behind and see that the plane was following the beacons aloft.

I went out to Lincoln. I spent a week there with my grandparents and dated Jeanne Branch, who was my sister's age. Jeanne was very, very nice. I was still in the Navy but I'd graduated from Columbia. The Navy sent me to ship salvage school at Pier 92 in New York where the ocean liner Normandy burned and sank. You know, as a physics major, isn't that the most logical thing in the world—that the Navy would send me to ship salvage school? Then I was transported to Hawaii on the way to the Bikini [Atoll atomic] bomb test. On the way out, I took the train to Lincoln and then again spent a week in Lincoln after the ship salvage school experience. During that time, I dated Jeanne some more and decided that she was great. Finally, I went back to the University of Nebraska when I got out of the Navy.

I was planning to study at the University of Nebraska for about a year—to just take some general subjects and kind of goof off a little bit. I taught algebra at the University and then I left for California. I was put on a sea-going ship salvage tug, which is a big ship with a hundred-man crew, and we sailed out to Pearl Harbor. I was there a week when the Navy realized that my points would be up before the Bikini bomb test. When you earned enough points you could be discharged after the War. So they asked me if I wanted to go to the Bikini bomb test. I said, "No, I don't want to go to Bikini."

The Navy sent me back to California and discharged me there. Again, I was saving money. I got all my transportation money and back pay. I bought a money order—I had about one thousand dollars at that point from the Navy. I sent the money order to my father because I didn't want to carry that amount of money across the country. After that, I got out on the highway and bummed my way to Lincoln where, again, I met Jeanne. I didn't do anything that summer but goof-off. Then I went back to the University of Nebraska in the fall, started to date Jeanne and broke up with her within a week. [laughter] That didn't go anywhere, but then I was trapped in Lincoln with no date.

The high point of the term at UN was an English Literature course with a marvelous professor—I enjoyed it immensely. However, I was unhappy with the rest of my schedule because I taught algebra to a bunch of kids who didn't want to learn algebra. So I quit, came back to Framingham, and began looking for a job. My father thought it would be good if I took a sales job in a technical field. I remember that I interviewed at Minneapolis Honeywell [Regulator Company] but jobs were kind of scarce at that time.

THACKRAY: What year was all this happening?

WATERS: This was in February of 1947. There were aptitude tests for veterans—you could spend a whole day taking multiple-choice tests and at the end of the day you would be evaluated. I went to Harvard and did the test and at the end, the guy said, "Well," he said, "It's kind of strange. You've got this physics major education but," he continued, "the place where you correlate best is with two different groups. You correlate best with professors and with ministers. That's your aptitude." I can see it in me. You know, I am a bit of a preacher.

I got the advice but I disregarded it and went to work for Baird Associates [Inc.]. I went back to my professor at MIT and he said, "I know a man named Dr. O'Brien who works for Baird. I think they're looking for young people. Why don't you go over and interview?" So I interviewed with Dr. O'Brien. He liked me and at the end of the interview he said, "Would you like to come to work for Baird?" I said, "Yes. Looks good to me."

If I have a great failing—and I do have failings—it's that I do not look broadly enough. I'm impulsive. Sometimes I'm very analytical; I'll analyze all the alternatives. In many situations, I've said, "That feels right. I like it. I'll do it." So I went to work for Baird without looking anywhere else.

THACKRAY: What were you hired to do?

WATERS: I was hired as the project manager's assistant for Baird's double-beam infrared spectrophotometer. It was the first double-beam infrared spectrophotometer and was developed by Norman Wright at the Dow Chemical Company. Baird had the exclusive license for it. I arrived when the second unit was being made.

The prototype had been built. It may have been shipped to a customer. It was the first instrument of a production group of ten. I can remember aligning it was really a big job; it took about three days to align the unit, mostly because we didn't know how to do it very well. By the time I left Baird we were up to about instrument number thirteen. I was doing all the alignment at that point. I could align a unit in less than four hours.

THACKRAY: How big was Baird at this point?

WATERS: It had about ninety employees.

THACKRAY: You had encountered instrumentation in the Navy but how significant was instrumentation in your view of the world?

WATERS: Instrumentation in the Navy was nothing. At college, oh wow! We could get Lissajous patterns on the oscilloscope we had at college. We had an audio oscillator made by a company called Hewlett-Packard, Inc. and that was quite modern. But I had no background at all in instrumentation—Baird was just where I started my first job.

THACKRAY: It was better than algebra! [laughter]

WATERS: It was better than the alternatives! In the Navy V-12, I picked physics as number one; number two, I picked EE [electrical engineering] power; number three, aircraft engines. I've often said to myself, "God, think of what would have happened to me if I'd got EE power." Of course, it might have been exactly the same thing. I would have gone back to the professor, he would have said, "Here's Baird," and it wouldn't have made any difference whether I was a physics major or an EE power major, I'd have got the same job. There are just so many different opportunities for things.

THACKRAY: Why didn't you sink into Baird for the next five years?

WATERS: About three months after I got there, the project manager got a promotion and he took over a different project. So I became the project manager. Now, in Walter Baird's mind, that infrared spectrometer was a finished product. All we needed to do was make them; he had no plans to improve them. We tried to convince Baird that the instrument was too big; I mean, you couldn't get it through an ordinary door. We said, "We've got to come up with something smaller." "No," he said. "I put my money into it. That's it. We're going to make it." It was the only double-beam spectrophotometer for about two-and-a-half years until Perkin Elmer [Corporation] came out with theirs and eventually put Baird nearly out of business because Baird never improved their instrument. I was installing instruments, I didn't assemble them but I calibrated them. I aligned the instruments and so forth, but I didn't take part in much of the engineering. In other words, I was a glorified service man and assembler.

DAEMMRICH: Were they making them in assembly-line fashion or one at a time?

WATERS: There were a bunch of Baird double-beam infrared spectrophotometers sitting out in various stages of manufacture and then they'd put the component parts on the units. They wouldn't put all of spectrophotometers on at the same time, probably because we were delivering only about one or two a month. I think they had some backlog. They sold the spectrophotometers to Esso in Linden, New Jersey, the Mellon Institute [of Industrial Research], and Sadler [Research Labs] in Philadelphia, which had a small chemical operation.

Installing at Sadler was something. The truck came and delivered the instrument at four o'clock in the afternoon outside of Sadler. Sadler was right in downtown Philadelphia, up on the third floor of a building with an elevator. If you can imagine, here was this big instrument sitting in a crate on a little narrow sidewalk at four o'clock in the afternoon. We got it out of the crate and we took half of it apart because it wouldn't fit through the elevator door. We took it apart while everybody was walking back and forth in the street. We finally got it up into his lab.

I don't know where it was in Philadelphia. You could probably go and find where the place was.[1] It was on a little narrow street right in downtown Philadelphia.

THACKRAY: What did they cost?

WATERS: I think they were selling for around twenty thousand dollars, which is like one hundred thousand dollars today. It was an expensive instrument but again, it was a tool that nobody had. Sadler planned to develop and sell a library of infrared spectra. He was going to run infrared spectra on a lot of different chemical compounds.

After the War, the United States government sent teams into Germany to uncover the technologies that had been developed. At Baird, I read a report about a man named [Karl] Luft, who developed an infrared gas analyzer. Baird was also making an infrared gas analyzer. The instrument used two bolometers, which made it a nonselective detector. It was made selective by, in effect, desensitizing one of the beams to whatever you were looking for, so that, in effect, gas was passed through both of the beams. Then, one of the beams had all of the carbon monoxide wavelengths removed, so that one beam was affected greatly and the other beam remained mostly unaffected by the gas, thereby making the instrument selective to carbon monoxide only. It was not truly selective and I thought Luft's invention was much better.

At this point I thought, "This is my opportunity—all I have to do is reduce the Luft technology to American practice and I'm in business." Of course, it wasn't nearly as easy as I thought it would be! [laughter]

That Christmas (1946), Tony Greeley organized an ice skating party. I met a marvelous girl, Faith [C.] Pigors, there. I was ga-ga about her from the day I met her. She was very smart and very sweet. In some ways, she makes you think she can't fight her way out of a paper bag but she's tough as nails, too, in many ways.

[END OF TAPE, SIDE 2]

WATERS: So I met her at the ice skating party. I found out she was attending Mills College in Oakland, California but she lived in Framingham. I was determined to date her when she came back from college in the summer. I was successful. By the end of the summer we had agreed to get married. When I met her, she was in the middle of her freshman year. In the middle of her sophomore year, at Christmas time, we were engaged; she left college at the end of her sophomore year, and then we got married that September. Actually, 11 September 1948 is a whole other story! [laughter]

[1] Sadler Research Labs was located on 3314 Spring Garden Street, in downtown Philadelphia.

THACKRAY: So you were at Baird in February 1947, is that right?

WATERS: The sequence of events was:
Naval discharge, May 1946.
Attended the University of Nebraska, September 1946 to February 1947.
Worked at Baird Associates, March 1947 to December 1947.
Started J. L. Waters, Inc., December 1947.

THACKRAY: So you were only nine months at Baird when all was said and done.

WATERS: Yes. Now, in terms of meeting Faith, she and I met in December 1946. We agreed to marry in September 1947. We were engaged in December 1947. Then we were married on 11 September 1948.

THACKRAY: There was a lot happening on two parallel tracks! [laughter]

WATERS: You bet! In late November 1947, I wrote Faith and said, "You know, I'm working at Baird, but I've got a great business idea and we're going to get married—I can't do all three." Then I said, "I'm going to quit my job at Baird." I quit my job at Baird and that's what happened.

THACKRAY: When did you first read about the Luft infrared spectrophotometer?

WATERS: About September 1947.

THACKRAY: How did you come across Luft's work in the first place?

WATERS: I learned about it because Baird had been collecting US government reports about instrumentation in Germany during the War.

DAEMMRICH: Are you speaking of Project Paperclip?

WATERS: It might have been Project Paperclip.

THACKRAY: Was it your job to read those reports?

WATERS: No, but they were around. Baird collected the reports and passed them around, asserting that they might be interesting. Baird decided not to use Karl Luft's approach in the Baird gas analyzer because they had another approach in mind. I wasn't competing with Baird when I left and started my own business, but I ended up competing with Baird in the future.

THACKRAY: From what you've said earlier, it sounds like you were a young man looking for trouble.

WATERS: I was looking for an opportunity to start my own business. I think that came partly because both of my grandfathers had been in business for themselves, as had my father and my uncle, Paul Babson; and I had a very independent nature. People have asked me why I didn't go back and get my Ph.D. My response is that I didn't think I'd pay myself any more money if I had a Ph.D.! I think it was my combination of fighting for independence from my mother and seeing successful entrepreneurs that helped me decide what I wanted to do. I wanted to do it for myself.

Now, I was as green as grass when I started my own business. My father said to me, "Don't do it now. Get more experience. You've only worked for nine months and you need a lot more experience before you can start your own business." I was all by myself. Indeed, for one-and-half years I was my only employee. It was god-awful lonely. I had an amplifier and a unit with a condenser microphone and the condenser microphone needed a very high-impedance resistor to get a big signal out of it. I put a one-stage amplifier on it and got a bigger signal but it wasn't anywhere near what I needed. Then, I added a second stage amplifier and everything worked fine.

I added a third stage and "Vroom! Vroom! Vroom! Vroom!" I couldn't figure out what was happening, so I read my [Frederick E.] Terman textbook. It's motor boating. In an audio amplifier, it would go "putt-putt-putt-putt." The noise is feedback from the high signal stage through the power supply and into the first stage of a multi-stage vacuum tube amplifier. I added more RC filtering in the power supply and fixed the problem. Still, my development of the gas analyzer was just one problem after another problem.

You know, I had no right to be successful but I was willing to beat the problems to death.

THACKRAY: Were you talking with other people?

WATERS: No, I don't consult others as much as I should. I would have been much better off if I'd asked for more advice.

DAEMMRICH: Did you meet with customers when you were at Baird?

WATERS: I wasn't in sales at all, just in service but I had met some customers. I had a very interesting experience about twenty-five years after I installed the Baird instrument at Esso. While we were installing one of our first Waters' gel permeation chromatography instruments at Esso, I noticed there were a couple of Baird spectrophotometers in the lab—it was a big open lab. I noticed someone was working at one of them, so I went over and asked how he was doing. He replied, "I'm trying to get this instrument aligned." I said, "Let me help you," and it all came back. I aligned it quickly. [laughter] Afterwards he said, "I know you. Your father installed the first double-beam spectrophotometer here!" [laughter] To which I thought, "Boy, I was either a very mature twenty-two year old or an awfully young fifty year old!" [laughter]

THACKRAY: Did the people at Baird try to stop you from leaving?

WATERS: No. I didn't tell them my plan. I just said, "I've got some ideas and I'm going to do them on my own. I think they would have liked me to stay but I was confident about starting my own business. I just said, "No, I'm going to leave." I gave them a couple weeks' notice.

THACKRAY: Where did you start your business?

WATERS: I started my company in the basement of my parents' house. I was living with my parents at the time.

THACKRAY: So you were commuting from upstairs to downstairs! [laughter]

WATERS: Right.

THACKRAY: For how long?

WATERS: When it came time to hire an employee, my mother declared, "Not in my basement!" I had to move out. By that time, I was married and living with Faith.

THACKRAY: Were you and Faith living in an apartment somewhere?

WATERS: Yes. We rented the gardener's cottage on a big estate that didn't have a gardener anymore! [laughter] We were as poor as church mice. I made fifty-dollars-a-week at Baird and so that's what I paid myself—fifty-dollars-a-week. I had, at this point, almost five thousand dollars of savings. My parents put in two thousand, Faith's parents put in two thousand, and Paul Babson put in ten thousand. I limped along. I never made any money in J. L. Waters, Inc. In the end, I sold it to the Mine Safety Appliances Company in 1955, which made me think I was very wealthy at the time. Of course, I don't think so anymore. [laughter] I've done better since.

THACKRAY: Did you incorporate?

WATERS: Yes.

THACKRAY: Did those other people have shares?

WATERS: Yes.

THACKRAY: What percentage of the stock did you own?

WATERS: I had something like 60 or 70 percent.

THACKRAY: At that time, you were wrestling full time with how to make your Luft-type infrared analyzer work, correct?

WATERS: Right and it took me considerably longer to get it to work than I had thought.

THACKRAY: But you didn't lose faith that this was a viable project?

WATERS: I was pretty discouraged some days.

THACKRAY: Were you struggling to make the analyzer work on a daily basis?

WATERS: Yes. I worked on it everyday, all day long. I wouldn't recommend it to anybody. I mean it was just very discouraging. There were things I didn't know. For instance, I had a machine shop machining parts for me. I didn't know there was another way to get the stainless piece that they machined besides going to the warehouse in Boston and watching them saw it off the bar. But I could've sent a purchase order in! My naiveté was just gigantic! But I learned.

My father said, "You ought to get more experience before you start a business." I said, "No. This is a great opportunity. I'm going to do it." He replied, "Well, you'll get knowledge awfully fast that way!" He was right.

DAEMMRICH: Tell us more about Paul Babson.

WATERS: He is my mother's sister's husband. He was originally from Seward, Nebraska. The Babsons were originally from Gloucester. They had many sons in several generations. Babsons are everywhere in New England. Roger Babson, a very eccentric person, got the Babsons into the financial business. At one point, the fishing industry was down, Roger Babson decided to market what he hoped would be a great delicacy—chocolate flavored fish. I don't think it ever went anywhere but he had the money for such ventures. He founded the highly unusual Babson College. Originally, in the 1920s, it was a college for the sons of businessmen who wanted their sons to take over their businesses. So the son went to college, which was set up like a business, every student had a secretary and an office. I suppose the tuition was sky-high but that's the way Babson College got started. Paul's father lived in Seward, Nebraska, which is about 50 miles west of Lincoln. My father told me Paul had a popcorn stand in downtown Lincoln when he was in college, from which he made quite a lot of money. I remember one time when I said to my father, "You know, Paul was a poor boy from Seward but he made a bunch of money from his popcorn stand while he was in college." My father laughed and replied, "Paul's father was a very successful hardware merchant in Seward and Paul was one of the few kids who had a Stutz Bearcat!" [laughter] Although he had a Stutz Bearcat, he had the popcorn stand, too! He was very entrepreneurial.

THACKRAY: At that time, were you aware of people like Arnold O. Beckman? Obviously, there was Baird. Looking back, it was a fantastic time to enter the instrument business.

WATERS: No, I wasn't conscious of the environment at that time; I just recognized this opportunity. While I was in the Navy, people were tearing up streetcar tracks and buses were taking over. I conceptualized a device for tearing up streetcar tracks. The operator would put it

under the rail, pull it forward, gradually lift the rail up and cut the rail and let it fall onto a truck and repeat it with the next section. I was just looking for an opportunity. I was lucky that I got into the instrument business. It was a good place to be.

THACKRAY: To summarize this period, you were working away in the basement, getting encouraged and discouraged.

WATERS: Right. Then finally I succeeded.

THACKRAY: As you started to realize that your instrument would work, what was your sales plan?

WATERS: I just thought that if I developed it well, it would sell itself. Now, what happened actually was that Mine Safety Appliances wanted to get into the gas analyzer business and they were having a terrible time in their R&D [research and development] department.

Mine Safety Appliances is a Pittsburgh company; the biggest company involved in safety products for industry. They're on the New York Stock Exchange. They had a mining instruments division for things like explosion detectors, filters for cleaning up toxic gases, respirators, and so on. They were organized in such a way that if their R&D department developed something that didn't work quite right when it got to manufacturing engineering, it was kicked back to R&D. As a consequence, they couldn't get things into production because projects were constantly being sent back and forth. They heard about my work and asked if I would combine forces with them and work for them in Pittsburgh.

THACKRAY: How did they hear about your work?

WATERS: I think they went to a Gordon [Research] Conference and somebody at the Gordon Conference knew what I was doing.

THACKRAY: When was that?

WATERS: About July 1948. Dan [Daniel D.] Freel at [E. I.] DuPont [de Nemours and Co., Inc.] bought the first infrared analyzer I made. The second unit I made went to the Naval Research Lab for use on submarines.

THACKRAY: How did you have those contacts?

WATERS: I think word of mouth. Mine Safety wanted to buy me out and have me come to Pittsburgh. I declined the offer because I wanted to be independent. Then they asked if they could be my sales agent. I said, "Yes. That'd be great." So they sold the units I made. I did the R&D and the manufacturing and it worked out very well.

THACKRAY: When did Mine Safety and you make that alliance?

WATERS: In 1949, one-and-a-half years after I started developing the infrared gas analyzer.

THACKRAY: When did your first instrument go to Dupont? Was it then that Mine Safety was beating a path to your door?

WATERS: Right. The relationship worked out very well for both of us because we both brought things to the table. In many ways I was in way over my head. I had no right to succeed except that I was willing to beat a difficult problem to death. Of course, what tended to happen was that I had some specialized knowledge that Mine Safety wanted, so they beat a path to my door.

[PAUSE IN RECORDING]

THACKRAY: How far have we got?

WATERS: We've just barely got past Barbara Shoup! [laughter] Life is simple compared to history. I can live life faster than I can describe it.

THACKRAY: Back to life in the basement. Was the fact that people were finding their way to you pretty exciting?

WATERS: Yes, but I was immersed in making the infrared analyzer work; it was such a problem. I had to make it work! Around that time, I'd just been married and then it wasn't long, in April 1950, when we had a son [Richard C. Waters, "Dick"]. All of those things were a real struggle. My wife's father, Paul Pigors, was a professor at MIT—business administration

was his specialty. He wasn't scientific at all. But her mother was a Cabot and quite wealthy. So my wife lived well as a child.

Living with me, however, my wife shopped for the cheapest kind of meat she could find, you know? In fact, we almost never ate meat. We weren't terribly poor but we lived in a small four-room house with plywood walls and radiant-heated, asbestos board ceilings. Our son was six years old and our daughter [Barbara Waters Roop] was three and they were still sleeping in cribs until we moved into a bigger house.

Anyway, I was visiting Mine Safety in 1955 and we were out to dinner. They said, "Why don't we see if we can arrange to buy J. L. Waters, Inc.?" My first reaction was, "No"—I didn't want to do it. But then when I considered that my wife had cabin fever and was busy with two small, young children in a four-room house—selling out sounded pretty attractive. So we worked out a deal.

I think I sold the company for two hundred thousand dollars and fifteen years of royalties at 3 percent, which was very nice. Those royalties gave me quite a boost for starting my next company. Of course, all of those dollar figures would be six times bigger in 2003. I was well enough off so I could build a house and take care of my family. Also, I was pretty exhausted. So for three years, I moved the technology I developed to Mine Safety in Pittsburgh and then I closed up the operation in Framingham.

THACKRAY: These days, running your own start-up is all the rage, but did you know other young people like yourself who were doing similar things?

WATERS: That's correct in one sense. There were a number of companies. For instance, Sigma Instruments made relays and then there was Waters Manufacturing [Company]. I never met Robert Waters. He made potentiometers. All of these things were spin-offs of the technology developed during the War and they all were very attractive. I remember thinking to myself, "I wish I could make potentiometers rather than try to make infrared gas analyzers." Now, of course, they've all become very small since then but Sigma, at that time, was quite successful.

[END OF TAPE, SIDE 3]

DAEMMRICH: When Mine Safety bought you, what were they buying? They weren't buying you, because you didn't become a full-time employee.

WATERS: Well, yes, I did. They became the stockholder owner of J. L. Waters, Inc. and I got capital gains on the shares. My parents made some money, my in-laws made some money, and Paul Babson made some money.

Paul was a wonderfully grand person. Once in a while you meet somebody as nice as he was; he's one of my models for behavior. He put ten thousand dollars into my company. When I sold the company, his share was worth around thirty thousand. He said, "Look, Jim, why don't you do this? I'll take 6 percent interest on the ten thousand. I'll just make gifts to you and Faith to make up the difference between the thirty thousand and the amount for me. That's all." He is a very generous man.

THACKRAY: Your first employee was hired in early 1950. By 1955, how many employees did you have?

WATERS: About twenty-five.

THACKRAY: Were you the only person in the R&D department?

WATERS: No. I had another engineer with me, Arthur Sinkinsen, who was helping me improve the instruments design. Arthur was an excellent design engineer.

THACKRAY: The presentation to the Instrument Society of America [ISA] was on 10 September 1951, and at that point, you can pontificate about your instruments.

WATERS: Yes. This is the diagram of an early instrument. It was drawn probably before the instrument was ever photographed. What happened was Nelson Hartz, a sales manager from Mine Safety, said, "We need something written up like this that we can use as sales literature." So that's how that got written.

THACKRAY: Had you been to an ISA meeting before?

WATERS: We would exhibit at a chemical show around Christmas time in New York. I think it was Chemical Instrumentation. Then there was the instrument show. I don't remember much about that. It wasn't Pittcon [The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy].

THACKRAY: Pittcon started in 1949 but it wasn't very big on anybody's radar screen.

WATERS: That's right. Early on, we never showed at Pittcon. I first went to a Pittcon meeting around 1955 and it was still in a hotel in Pittsburgh.

THACKRAY: Did you have an instrument to show by 1951?

WATERS: Yes.

THACKRAY: How many did you sell over time? What was the market like by the time you attended the Pittcon in 1955?

WATERS: By that time, 1955, I imagine we'd sold about two hundred instruments.

THACKRAY: How much did the instruments cost?

WATERS: I think they were four thousand to four thousand five hundred each. We sold a number of them to go in the Fortier [Louisiana] plant of American Cyanamid [Company]. We had a number of them placed in the hills around Los Angeles for carbon monoxide.

THACKRAY: What was the main detection use? Who were the main consumers?

WATERS: They were put in chemical plants mostly, so most of the detectors were explosion-proof.

THACKRAY: Were they for process control?

WATERS: Yes. One of the problems with the process control business is that people would say, "We've got eight reactors, so we'll need eight of your units, if they work." Then they'd buy one but they'd learn so much about the process that they'd change the process and then they wouldn't need the instrument anymore. They would want us to take it back! [laughter] So that was an awful business! [laughter] Of course, everything was customized along the way, so it was just horrible.

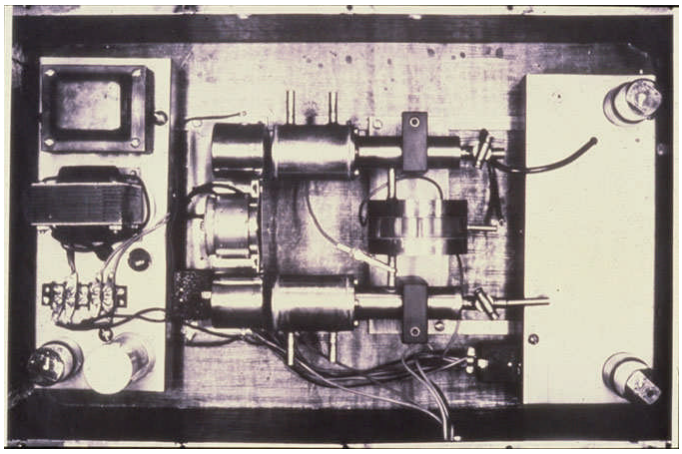
THACKRAY: Even so, the market was large enough, correct?

WATERS: Right.

THACKRAY: If you could do it all over again, would you work in process control instrumentation?

WATERS: No!

Here is the first prototype unit I made (figure 1). Power supply here, amplifier here. This is one of the detector gases. This is the other one that connected together to two stainless things here, with a Plexiglas plate in between where the condenser microphone is and the output of the condenser microphone coming out here. This is one cell; this is another cell. There's an infrared source, another infrared source, and a little chopper motor in between here with a chopper disk.



(figure 1) **LIRA Infrared Gas Analyzer Prototype, 1948.**

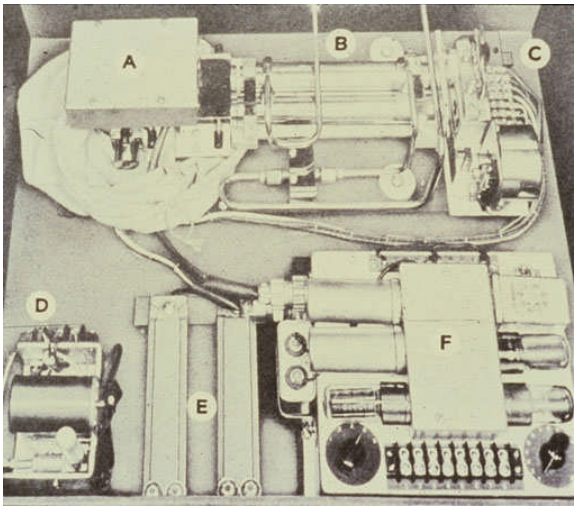
THACKRAY: What are the approximate dimensions of this instrument?

WATERS: The box was about 18 inches by 36 inches.

DAEMMRICH: Do any of those instruments still exist?

WATERS: Not that I know of.

By 1949, I had a commercial unit (figure 2). As you can see, we vastly improved the instrument.



(figure 2) **LIRA Model 100, 1949.**

THACKRAY: Is this instrument contained entirely in a black box?

WATERS: Yes.

THACKRAY: Was the Model 100 the first instrument you sold?

WATERS: Yes, in 1949, a year-and-a-half after I started.

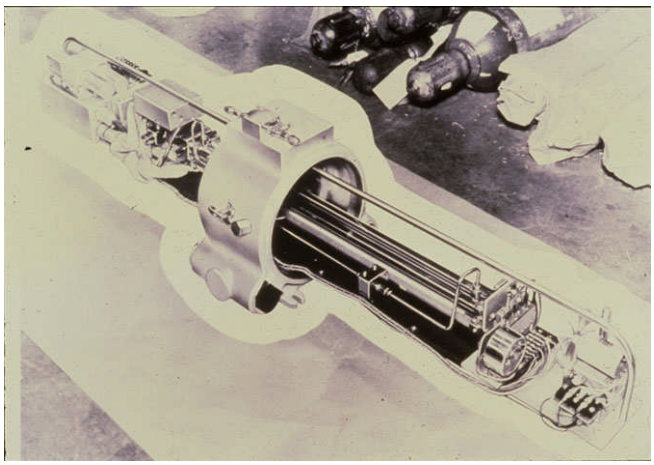
THACKRAY: Are any of these still in existence to your knowledge?

WATERS: I don't know. Mine Safety had a booth at a Pittcon I attended six or seven years ago. I went in and got to talking with a guy who said, "You know, I have one of your units.

We've had it for more than twenty years. It's still running out in the plant." I said, "Well I'll be darned." He replied, "It has a slider that goes back and forth as it chops the beams. It just keeps chunking along!"

When we were developing the instrument, we wanted to use a low frequency to get as much movement from the condenser microphone as possible. So we were chopping at two cycles a second and we needed to get an amplifier at two cycles a second, which was difficult. You know, that was before the day of stable DC amplifiers that you now get with integrated circuits. This thing would've been a piece of cake with integrated circuits.

Here's an explosion-proof version with a long cell for high sensitivity (figure 3). Here's the detector at the extreme right, the pre-amp up on top of it, the cell in the middle, and the chopper motor at the left then going back and forth there.



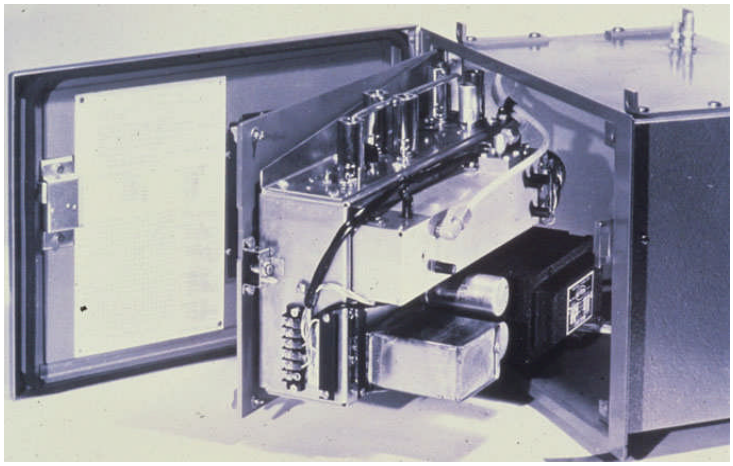
(figure 3) **LIRA Model 100, 1950.**

DAEMMRICH: Where's the output? What are they reading?

WATERS: The amplifier's back here at the extreme right. These two covers screw together and the electrical connections come out here. It's a standard explosion-proof box.

Now here we are by 1952. We're getting better all the time. I suddenly discovered that instead of having these long stainless tubes (figure 3), I could take an aluminum block, drill two holes in it, and put a stainless steel liner inside (figure 4). These were stainless steel liners that were polished on the inside and gold-plated so they'd reflect the infrared light well. Here is the detector at the left end of the block, the little chopper motor is here (right end of the block), and

this is all kind of made out of a big block of aluminum. That bolts on the side here. Here's the amplifier right up here (on the top). The power supply is down under this (in back of the block). Here's the voltage regulator, a big condenser for filtering, all on a door that swings out (figure 4).



(figure 4) **LIRA Model 200, 1952.**

THACKRAY: You were leading this long process of improvement, essentially and this was taking most of your time and energy.

WATERS: Yes. The instrument was improved greatly but I was managing production at the same time. I was well out of the basement at that time and some of these pictures will show it.

THACKRAY: So you were in your twenties by that time.

WATERS: Right. I started my business when I was twenty-two and I was thirty in 1955.

THACKRAY: You must've been very happy by the time you were thirty, no?

WATERS: I never learned to make money. I believed it was immoral to charge more than double your direct costs—and of course, you can't make money that way because there are too many other costs that appear along the way. I kept wondering what would happen if I raised my

price. I thought I wouldn't sell as many instruments and then I'd be in all kinds of trouble. I never thought what my product's value was to my customers. I knew it was important to deliver a valuable product but I hadn't yet realized that it was reasonable to sell a product for twelve thousand dollars if the customer saw that product as being that valuable.

Later on, I started Waters Associates [Inc.] with the concept that I was a good instrument developer. I decided to develop instruments for other people, because in effect that's what I did for Mine Safety. I developed an instrument for Mine Safety and in the end sold them the company. Then I developed a balloon hydrometer—not a great development—for the Air Force Cambridge Research Center. I developed a flame photometer for Consolidated Edison [Inc.] to detect sodium in boiler-feed water at their Indian Point Nuclear Power Plant. Along the way I developed a refractometer, which I licensed to Mine Safety. Later, I bought it back from Mine Safety, hired Mine Safety's salesman, Larry Maley, and we went into the process control instrument business with the refractometer.

Larry Maley and I did a whole lot of things together. For instance, we developed a conoblender, which continuously blended Coca-Cola syrup with water. More specifically, the instrument's purpose was to blend the high-sugar content, highly viscous Coca-Cola syrup, measure the refractive index of the mixture, and keep the mix constant. The instrument never worked well. I mean, the whole process control thing was not a great success but it got us started as a business. Actually, it was the reason we got into gel permeation chromatography. We had the most sensitive refractometer which was excellent for use as a detector for gel permeation chromatography of polymers.

THACKRAY: In accordance with your deal with Mine Safety, they bought J. L. Waters, Inc. and you became a development person for Mine Safety, correct?

WATERS: Right. In the contract I agreed to work for them for three years. I think I ended up only working for them for two-and-a-half years but it was the right thing for me because it let me decompress. About that time I was also a member of the town meeting in Framingham. Framingham is a town, not a city and it had an open town meeting up until about 1952 when it then became an elected group of two hundred town meeting members. So I became a town meeting member.

I started my political career in about 1955. I was on a school construction committee. Then for nine years, starting in 1960, I was elected to the Framingham School Committee. I was chairman of the school committee for two of those nine years. That's the extent of my political career. Maybe I was going back to my old pattern of doing everything. To explain this, maybe I need to talk about my school experiences.

In Lincoln, the high school was a three-year high school. Lincoln High was the Nebraska State Champion rather consistently, so it had a good football team and I went out to play football. First year, I was junior varsity; second year, I was on the team but I was third

string. That senior year I would have been the only lineman coming back in the senior year and I probably would have been lucky if I'd made first team! [laughter] I was big enough but I just didn't have the killer instinct.

At the same time, I was on the swimming team and in my junior year I was Nebraska State Champion in the 200 yard breaststroke. This is an odd combination—swimming and football at the same time, but I think it was my desire to excel at a rather broad range of things. I just found it very interesting. I've not been good at or wanted to stay with one thing for all of my life. I've gone through many different phases.

I went through the J. L. Waters, Inc. phase. I went through the Waters Associates phase. And I haven't been active in Waters Associates since about 1979. Then I went into a venture capital phase of investing in companies. Then I got into a phase with a technique called "system dynamics," where we've introduced in school systems "what comes around goes around" to help children learn more about complex problems and the trade-off between short-and long-term benefits. For instance, almost everything that has a good long-term effect has a bad short-term effect and *vice-versa*. If children can realize this at an early age, then they can take charge of their own lives. They can say, "Look, I'm in third grade. I know that I'm an investor now. I'm investing in my future. I'm not just going to school or being made to go to school. If I want to have a happy mid-life and old age, I'd better make my investment today. If I don't, I'll be in trouble."

THACKRAY: That's where you are today.

WATERS: Right.

DAEMMRICH: Please discuss your transition from Mine Safety to Waters Associates. Mine Safety was a bigger company than J. L. Waters, Inc. and you don't like big companies. Is that why you started your own company again?

WATERS: No. Mine Safety Appliances wanted to move the technology to Pittsburgh, which was very appropriate, so I trained their employees. We moved different sections of the manufacturing division to Pittsburgh. At first, Mine Safety did all the machine work. We decreased our efforts because Mine Safety was doing most of the work. I actually laid off a few employees. When my job was finished, I took five employees and founded Waters Associates. We closed up the James L. Waters, Inc. company in Framingham and the next day they came to work for Waters Associates. At that point, about ten people got laid off and a couple of people moved to Pittsburgh.

THACKRAY: Did the five people who came with you to Waters Associates share a common attribute?

WATERS: Yes. They were good people.

THACKRAY: But were they development people?

WATERS: One person was a machinist; another was an assembler. They were mostly technical people without college degrees but they were my support.

At the time, there was a lot of government money floating around in the form of grants for inventions. So although I didn't have an instrument to sell to the marketplace, I developed one very quickly.

THACKRAY: What you conceptualized at that moment sounds very similar to what Bob [Robert W.] Allington did for his start-up operation; that is, developing instruments for somebody who needs one.

WATERS: I don't know Allington, but that's the way it was.

Now, I was very lucky. About a year after we started, Hardy Shepard called upon me. Hardy was a venture capitalist with Payson & Trask. Payson & Trask was one of the sponsors of Minute Maid, way back when high vacuum technology came out of World War II. Mrs. [Joan] Payson was a Whitney. She had a lot of money and she owned the Mets baseball team at one point. Hardy was just wonderful. He invested early on in Waters Associates. He stuck with us from 1957 until 1985, for twenty-eight years. When he finally sold his interest, he had earned one hundred times what he put in. He was a wonderful venture capitalist.

Larry Maley and I were selling GPCs [gel permeation chromatographs] when Hardy took us out to dinner one night and said, "You've got to raise your prices. You've got to make some money." Hardy had been on that kick for years. We kept saying, "People won't buy if we raise the price. We charge them as much as we can." That night Hardy finally said, "Why don't you just do it? Raise the price 10 percent and see what happens." We raised the price. Nothing bad happened. Business went on just as before, except we began to make a little money. I was just incredibly stupid. Today I give people the lecture that "price has nothing to do with cost." Price is related to what the customer believes is a reasonable value for a product. The relationship between price and cost is whether you want to be in the business or not. If somebody could have gotten that through my thick head when I was twenty-two years old, I'd be wealthy today! [laughter] Sometimes idealism gets in the way.

DAEMMRICH: Early on at Waters Associates, you were selling GPCs to Dow Chemical, right?

WATERS: We had a very good refractometer. John C. Moore at Freeport Dow Chemical Company developed gel permeation chromatography. He took cross-linked polystyrene beads and packed them in a column and ended up with a column packed with different pore size particles.

[END OF TAPE, SIDE 4]

WATERS: If you injected a polymer onto the column, the big molecules couldn't get in any of the pores, so they'd go fast. The small molecules would get in more and the very small ones even more. So you got a size distribution coming out of the column. Before GPC, it took three weeks to get a molecular weight distribution for a single polymer; using John's GPC, we got the same result in about an hour-and-a-half. I remember a man from Hercules [Chemical Company, Inc.] looked at the GPC result and said, "That would have taken me three weeks to do and it wouldn't have been as good as what you've done." GPC technology was truly a revolution.

Now, John needed a refractometer to build his GPC unit and he bought one of ours but he wouldn't tell us what he was planning to use it for. Our refractometer was for process control with a moderately large cell to support lots of flow. John said, "Look, I want a cell ten times smaller than what you've got." I replied, "You don't need that for process control. You've got all kinds of flow here. You shouldn't do it that way." He said, "I want that. How much more will it cost me to get it?"

I wanted a smaller cell for some other applications anyway, so I said, "We'll build you a smaller cell for a couple of thousand dollars." We built it. He thought it was fine. About six months later he wanted another unit. John wanted a refractometer to operate at 130 degrees centigrade. I asked, "What are you going to use it for?" And he answered, "Orthodichlorobenzene." Orthodichlorobenzene is a liquid at room temperature, so high temperature isn't necessary. He needed the high temperature to dissolve polyethylene in orthodichlorobenzene but he wasn't telling us! [laughter] Again, he was willing to pay for the unit. If he were willing to pay for it, we would do it.

Then Dow needed an instrument manufacturer to commercialize a GPC unit for them. They went to Beckman [Instruments, Inc.], but Beckman declined to do it. They probably had all their R&D people engaged, so we finally got the exclusive rights for GPC. We had to write Dow a ten thousand dollar down payment check. Oh, boy! That was a lot of money at that time. But that was the start of a major growth period for Waters Associates.

THACKRAY: When was that check written?

WATERS: In 1963.

THACKRAY: Let's go back to the 1958 to 1963 period, when you were setting up Waters Associates with the five guys you brought with you. Your goal was to develop instruments for other people. Had you already gotten some orders on day one of Waters Associates?

WATERS: Yes. First, Mine Safety wanted a Model 300 infrared gas analyzer, so I had a contract with them for its development. We also built a balloon hydrometer for Cambridge Air Force Research. In the meantime, I developed a process control refractometer, which I licensed to Mine Safety. That brought in a little extra cash. Later we bought back the rights for the refractometer from Mine Safety. However, Waters Associates was just limping along in the beginning; I don't think we made any money in those years.

THACKRAY: So you were mainly building instruments at that time.

WATERS: Maybe two or three at a time.

THACKRAY: But they were unique.

WATERS: Then we built the flame photometer for Indian Point Power Plant.

THACKRAY: But they're not turning into production lines.

WATERS: No. Nothing was turning into production lines. Around 1960, Larry Maley joined Waters Associates. He was the salesman from Mine Safety who was good in the process control area. He was a very good salesman and was great at finding opportunities. Later on he got some venture capital backing and bought the process control division from us. He kept bringing ideas for other instruments back from the field and just overpowered his new organization with them.

THACKRAY: Yes. In 1962, four years after you started Waters Associates, you went from being very successful to just floundering around.

WATERS: Yes. That's right. Trying to find a business.

THACKRAY: In addition, your family was a still a major responsibility. How did you cope with that stress?

WATERS: Remember, I had a royalty stream coming in from Mine Safety. I built a nice house for my family. My family was just fine; then a whole new phase of my life began. My son was born in 1950. When he was about ten or eleven years old, in fifth grade, he came home one day and said, "I just hate school. I just want to fly out the window." He had a second story classroom at the time, and Faith and I thought he wanted to commit suicide. So we started psychotherapy as a family.

Dick really needed help. I mean, we were decent parents but we were not meeting his needs well. Faith began psychotherapy at the same time and then I was asking, "What did you learn today in therapy? What did the therapist say?" So I became involved. It was a wonderful thing for me because I learned a lot about myself. I learned how to be a better husband. It wasn't that Faith and I had any significant problems, but we probably hold the world's record for therapy. We were in therapy for thirty-five years.

THACKRAY: That's what makes you such a nice guy! [laughter]

WATERS: That may be! When I was courting Faith, my future mother-in-law told Faith that "Jim is a rough diamond," and Faith replied, "No, he's a rough diamond." They were probably both right. But maybe some of the roughness wore off over time. In any case, therapy was beneficial because it made me a more productive instrument designer. I never had any great problem admitting I was wrong, but today I'm very mellow. It's no big deal if I make a mistake. People often ask how I became successful and I say, "My main success has been that I've made mistakes faster than other people!" [laughter] Similarly, my wife and I sit back and say, "You know we're blessed in that we don't have big egos." If you've got a big ego, you've got to defend the damned thing all the time. In the end, it isn't worth all the effort.

THACKRAY: Did you have confidence in the process control business?

WATERS: It is a very hard business. Now, there are some positive aspects. For instance, Tracer Labs Inc. made an instrument that used nuclear radiation to measure paper thickness. You couldn't get around it. The pulp was slightly different over time and the gauge was absolutely necessary because you always wanted the paper to have the same thickness. Now it was much harder to find a volume application for the chemical analysis instruments. Once they

got the data from the carbon monoxide detectors around Los Angeles, they learned what their problem was and didn't need the instruments anymore.

THACKRAY: You were known in the instrument world by then, correct?

WATERS: Right.

THACKRAY: Were you attending instrument shows?

WATERS: No. If you think about it, the process control field is very different than the chromatography field. When we got into gel permeation chromatography, GPC's sold themselves.

Larry Maley had a brilliant idea. We had sold about fifty GPCs and we were having trouble because half of our customers thought our instrument was wonderful and the other half said, "I can't make it work! I encounter all kinds of problems and then I plug a column." At Waters, we didn't know enough about polymer chemistry to help our customers. We had a concentration of GPC customers in the Cleveland area with the rubber and polymer industry. It was the middle of winter and Larry conceived of the first International Gel Permeation Chromatography Conference. We owned the conference because we had started it. We had a professor as the keynote speaker and called for papers. We gave a few papers ourselves but most the papers were by customers.

The successful users wanted to give papers. We organized the conference so that each paper was twenty minutes, with twenty minutes of discussion for every paper. For instance, a guy would brag about what he'd done right and then those that were less successful asked, "How do you avoid plugging columns?" "I filter the sample every time." "But I plug the columns." The conversation continued: "What pressure do you use when you push it through the filter?" "I use 200 psi." "We found that didn't work. You should never go above 50 psi. Otherwise, you'll push the gel right through the filter." Meanwhile, we were busy making notes. [laughter] Larry's idea for a conference was brilliant and everyone learned a lot.

The next year we held the conference at the Fontainebleau in Florida and to this day, Waters owns that conference and can invite whomever they want. They hold it about every two or three years now. All Waters has to do is just not be outrageous in what they're doing for themselves and it is a great thing. We learned a tremendous amount about our customer's needs.

THACKRAY: So that whole gel permeation sequence favors the prepared mind in the sense that you were there bidding for the contract when Beckman didn't want it.

WATERS: We had a problem once we got the contract. The contract was with Dow in Freeport, and Dow in Midland said, "What in the hell are you guys doing, giving the contract to that little dinky organization? Waters Associates is just going to mess it up." We went on a campaign to show Midland what we could do and gave them great service. Within a year, the guy from Midland was a strong supporter of ours. After a few years, Dow saw we needed more money to exploit GPC and they loaned us four hundred thousand dollars. We were paying them 10 percent royalty on gel permeation chromatography. We later agreed to convert both the loan and the royalty to stock ownership. Still later, Dow sold a good part of their stock in Waters and the sale was one cent on Dow's earnings per-share for the quarter. We knew we'd made a contribution.

THACKRAY: How was Waters Associates set up?

WATERS: It was a corporation. I was the sole shareholder for a while. Then Hardy Shepard's venture capital company made an investment.

THACKRAY: When did they do that?

WATERS: About 1961.

THACKRAY: Why did you accept that capital?

WATERS: Because I hadn't learned how to make any money yet and I was growing. I needed more money. The other side of it was that I had really struck up a friendship with Hardy. He was a lot like Paul Babson. I mean, he was just one of the greatest gentlemen of all time. His advice was very good, his contacts were good, and he was very helpful to us.

THACKRAY: Was he located in Massachusetts?

WATERS: No, he was in New York.

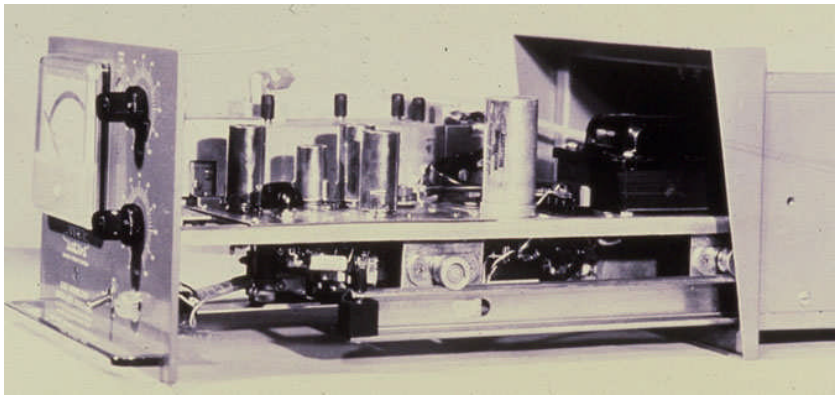
THACKRAY: How did you meet him?

WATERS: He came to an instrument show and saw what we were showing—this was back before GPC. This was back when we had the refractometer and he just was out there to find a good investment. He and I hit it off. I think he invested more in me than in the product. He just figured that I would struggle hard enough and something good would come out of it.

THACKRAY: You were in process control and laboratory instruments at the same time.

WATERS: Fundamentally, I decided that we just couldn't be in two businesses at the same time. The process control business and laboratory instruments business are very different and we were getting the bad habits of both. The process control was only about 10 percent of our total business. Larry Maley was in love with the process control business. So he finally went out, raised some venture money and bought it from Waters. It was a shame Larry left us because he was a great sales manager. We had a terrible time finding the right sales manager afterwards.

Figures 1 to 4 are the early years of the infrared analyzer. Gradually we get better with the Model 100 (figure 2), the Model 200 (figure 4), and then the Model 300 (figure 5).



(figure 5) **LIRA Model 300, 1959.**

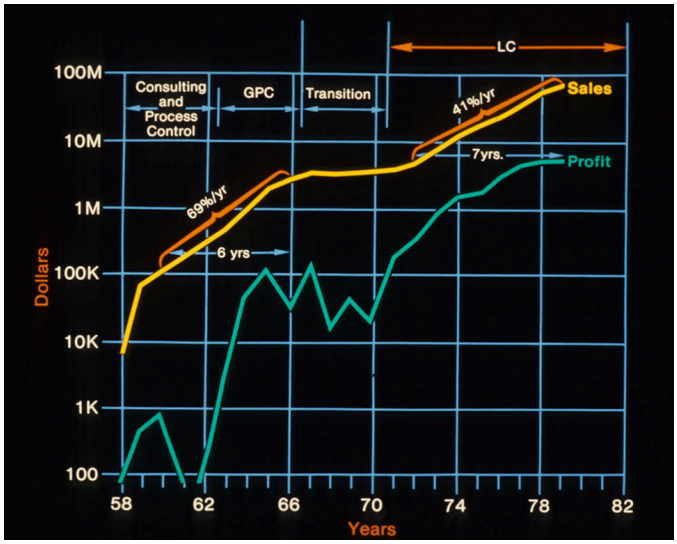
Here's my parent's house (figure 6)—I was down here in the basement from 1947 to 1949. Then when I wanted an employee, my mother said, "Not in my basement." I then had this little place here—120 square feet in the Monnick Hardware building (figure 7). It was divided into two different parts until I finally took over half of the building, which amounted to about 1,000 square feet. Afterwards, I moved into the top floor of an old shoe factory; I don't have pictures of that building, which we occupied from 1951 to 1958. At first, we occupied 7,000 square feet of the shoe factory and later 14,000. It was a four-story wooden building built to make shoes for soldiers during the Civil War.

(figure 6) **James L. Waters, Inc.'s first plant, 1947-1949.**

(figure 7) **James L. Waters, Inc.'s second plant, 1949-1951.**

I still remember the time I sent everyone home before a hurricane. The building had fluorescent lights that hung from the ceiling and as I was about to turn the lights off, I looked up and I saw the fixtures swinging back and forth. There was no breeze inside the building. I couldn't figure out why the lights were swinging. Then my physics major training gave me the answer: the lights were standing still, it had been the building that was swinging back and forth! [laughter]

Now here's the Waters Associates' growth pattern—it shows revenue and profits (figure 8). Here's 1958, maybe nine thousand dollars in sales, up to ninety thousand the next year, and then here's the GPC growth, 1963 to 1966, when we saturated the initial market in GPC (1966 to 1971). We got up here to about three million dollars per year. Then we went into a transition here, until we got into liquid chromatography [LC] in 1971, and then here we grew 41 percent a year for the next seven years.



(figure 8) **Waters Associates' growth pattern chart from 1958 to 1982.**

Now, you look at the profit here, there's almost nothing. Here, we're making profits of one hundred thousand dollars on two million dollars of business. That was just not adequate. Now, here we come up to a respectable profit. It's about this time that I learned how to price things right.

What we decided, right in here (1970), was that we had too many R&D projects. We'd better concentrate on the right thing. For example, what did we need for liquid chromatography? We came to the conclusion that we needed an excellent pump—with easy solvent change, relatively pulse-less flow, and easy to control flow. So we built the M6000 [liquid chromatographic] pump, which boosted our growth greatly. When it came to pricing the M6000 pump, we were very ingenious. We called in all the salesmen, introduced the new product—we had Burley Hutchins who designed the M6000 describe all its great features—then we gave them a short economics lecture about how pricing affected profits. If we didn't have enough profits, we couldn't afford to do certain things that we needed to do. The question was how good the pump was and what was it worth to the consumer. We suggested we needed a price of at least three thousand dollars. Then we left the room and allowed the salesmen to recommend a price. In the end, they recommended four thousand. We asked if they were sure they could sell the M6000 at that price and they replied, "Definitely. The M6000 has all these great features." Then we made money like all get-out! [laughter]

THACKRAY: This graph is very interesting, Jim. By looking at it, one may assume that the forty-five year old Jim Waters went into business in 1970.

WATERS: Yes. [laughter] "Finally, he learned how!" That interpretation is just about right. It took me a long time to learn how.

THACKRAY: Yes, that's very striking because in eight years your profits go from one hundred thousand dollars to seven or eight million dollars.

WATERS: Right. Of course, you could see just how hard that was. We had a big lay-off in 1970. We went from one hundred and seventy-five people to one hundred and fifty and finally to one hundred and twenty-five employees. Actually, the one hundred and twenty-five people turned out all the work that the one hundred and seventy-five had done before.

THACKRAY: Please discuss some of the management problems you had growing from a one hundred thousand dollar business to a ten million dollar business. They're quite different.

WATERS: That's a whole other story. I manage a company as a project. I can manage that one hundred and seventy-five people quite well but my style doesn't work very well beyond that amount. In other words, a good manager will find a square peg to put in a square hole—I'm not like that. I will help the guy do the right job and that's just not good management.

I had a good production manager here, Frank Zenie, who became president in 1972. I worked on special projects within the company during that period. I hired a strong CFO [chief financial officer], a strong sales manager, and so forth. Frank managed them very well up to about 1976. Then he began adding people and he just had terrible judgment about adding people. He tended to promote his cronies regardless of their abilities or accomplishments. We began to lose market share in 1976 and by 1977 we leveled off. We merged with Millipore [Inc.] in 1980 and by then I had moved out of Waters.

In 1979, I had a disagreement with the Waters' board of directors. The board felt I was "just like many crazy entrepreneurs: you can't keep your hands off the business when you turn it over to somebody else." I was saying, "You guys are right, I am having trouble but Frank is not performing well." They finally realized we had a management crisis and I said, "We've got to merge with somebody. We've got to have an owner around here who will take good care of the company." Millipore made an investment in Waters in about 1975. Dee [Dimitri V.] D'Arbeloff, Millipore's chairman, who was on our board, realized there should be a lot of synergy between filter technology and liquid chromatography because they're both separation devices. They merged with Waters but that's a whole other story about two similar business cultures.

The cultures of Millipore and Waters were so similar that they never had problems with things like pension plans or how they treated employees. Millipore selected a manager for Waters Associates and instructed him to do things the way Millipore headquarters wanted them done. Waters had an extremely strong culture. Within about six months, Waters would convert the Millipore manager to its own style and to goals that were somewhat different from Millipore

headquarters' goals. That was very frustrating for Millipore so we just went from one manager to another manager. The merger was good for Waters because Waters did reasonably well in the end. Eventually, Millipore decided that everyone would be better off if Waters Associates became independent again. It was a good move.

THACKRAY: Go back into the merger with Millipore. Just before the merger were you the CEO [chief executive officer] or chairman of the board of Waters? What was your title?

WATERS: I was just chairman.

THACKRAY: And after the merger?

WATERS: After the merger, I had nothing to do with the Waters division of Millipore. I became a director of Millipore.

THACKRAY: You were out.

WATERS: Correct. We began losing market share around 1978 because Frank promoted the wrong people into key jobs. Frank's mistakes were obvious to me, but my board didn't realize it until later. Initially, the board told me I was interfering with the company too much and I had to move out. Around 1979, I began showing up one day a week, something like that, trying to make sure people were doing the right thing. It was about that time when the board of directors realized Frank was doing the wrong thing. Consequently, they moved Frank's focus to long-term strategy and put John Buckner, who had been the chief financial officer, in charge of the company. The problem was that John wouldn't stand up to Frank.

[END OF TAPE, SIDE 5]

WATERS: If John had a plan to do something, he'd say, "This is my plan, Frank. Is it okay?" It just got to the place where we spent a year-and-a-half trying to solve our problems. We weren't succeeding and I became very frustrated with my board. They became frustrated with me and frustrated with Frank also. Finally, I went to the board and told them we had to find a buyer. I owned 30 percent of the company's shares at that point.

THACKRAY: When did you go public?

WATERS: We went public in 1973 and had another stock offering around 1976. In late 1979, the board thought selling the company was a good idea. I had a buyer in mind, which was IBM Instruments [Inc.]. I thought they would be a great buyer and we'd add something great to IBM. It turned out that Millipore made us a very good offer so we never began soliciting other companies. D'Arbeloff of Millipore made us an offer at around 50 percent above the market price of our shares. It was a good price. So we merged with Millipore.

THACKRAY: Though the name remained, you sold your shares and your interest ceased in Waters Associates.

WATERS: I owned Millipore stock.

DAEMMRICH: What was happening in the LC [liquid chromatography] field at Waters Associates in the decade before the company was sold to Millipore?

WATERS: We realized the field was growing like all get-out. We had about a 35 percent market share back in 1972. I was determined to keep that share because it was worth an awful lot. LC was growing at about 41 percent a year. We couldn't self-finance that much growth. Even though our profits had increased, we could only self-finance about 25 percent a year. So we had two public offerings along the way in 1973 and 1976 to get enough money to expand our company without losing our market share. We didn't lose any market share up until about 1978.

THACKRAY: Who were your competitors?

WATERS: Our competitors were Hewlett-Packard, Beckman, Perkin Elmer, and a number of others. We viewed our situation as being analogous to "Snow White and the Seven Dwarfs" (seven competitors).[2] Waters Associates was Snow White and we were entitled to our rightful 35 percent share. It was extremely important that the dwarfs shared what was left over equally! [laughter] We did all we could to make sure they shared it equally! We went after whoever popped his head up above the rest! [laughter]

[2] Phrase used to describe the group of competitors to IBM (Burroughs Corporation, UNIVAC, National Cash Register, Control Data Corporation, Honeywell Corporation, General Electric Company, and Radio Corporation of America) that manufactured mainframe computers in the 1960s. IBM was known as "Snow White" and the seven other computer manufacturers became known as "the Seven Dwarfs."

DAEMMRICH: Do you think the loss of market share that you're describing was driven partly by external events?

WATERS: No. We started to make mistakes. We executed our R&D poorly and we served our customers poorly. I have always said that we have to deliver benefits to our customers. That's our business. I always thought I was in a manufacturing business. I was making instruments. It wasn't until years later that I discovered what was really going on. It was a lot my own personality that I didn't even realize.

I would go out in the field if somebody was having a problem. I would see the problems. I remember one of them. We had a little ledge in the injector. If you put the syringe in and hit that ledge, you bent the syringe. Then the syringe wouldn't work and you had all kinds of troubles. I would come back and I'd go to my people. I hated to be criticized but I didn't blame the person that was criticizing me if it was my fault. So I went back to my people and said, "You've got to get that damned ledge out of this thing. Right now!" Also, I always follow up. So I'd come back three days later, "How are you making out with the ledge?" If he hadn't done anything, I'd come back three days later. "How are you making out with the ledge?"

It finally got to the point where people realized it was easier to solve the problem than to have Jim Waters on their backs. I've never thought about this before but maybe it's just how my mother raised me! [laughter] She always followed up. But anyway, the end result was that the company was oriented towards customer satisfaction. I never intended for that to happen but it was the right thing for the business because liquid chromatography was very hard for chemists. They had questions, such as, "How do I pick the right column? How do I do these things?" All that education and handholding was the reason Waters had the 35 percent market share.

In 1972 we had another problem. Waters sales were about five million dollars a year, and we were competing against companies like Perkin Elmer, Varian [Instruments, Inc.], Beckman, and so forth. Their catalogs showcased a collection of instruments, whereas we only had liquid chromatography instruments. Each of them had many more salesmen than we had. We realized we had to be different if we were going to compete with those companies. D'Arbeloff was very helpful at this point. He said we should advertise our literature, not our products. Our ads contained literature about amino acid and drug analysis. We provided just enough information to whet our customers' appetites and provided a box number on the bottom of the page so they had to come back to us. D'Arbeloff also advised us to keep track of the customers who contacted us after seeing our ad, because they were our best prospects for future sales.

I carried our advertising techniques one step further by setting up telephone sales. I hired women who had no instrumentation experience to call the chemists and ask, "Did you get the literature that we sent? Is there anything else I could do for you? Would you like to talk with an expert?" If the woman determined that the chemist was just generally interested, she

asked if he would like to stay on the mailing list and receive our direct mail. On the other hand, if the chemist showed a stronger interest, the woman asked if the chemist was considering the purchase of a liquid chromatograph in the next year. If so, we would have our in-house technical salesman contact him over the telephone. Further, we provided salesmen in the field with a list of their best prospects to call on. So we were much better targeted. We didn't want to let our competitors have any freebies. The way we looked at it, they had to compete with us for every liquid chromatograph sale.

THACKRAY: Was telephone selling your own empirical discovery?

WATERS: Yes. It was.

THACKRAY: You're a good man to have around! [laughter]

WATERS: Thank you. [laughter]

DAEMMRICH: You said you didn't have a killer instinct in football but you had it in the business world.

WATERS: Definitely! [laughter] We had another expression at Waters Associates: "Being number two is like kissing your sister." [laughter]

(figure 9) **Waters Associates' first plant.**

When I founded Waters Associates, we rented the basement underneath the police department headquarters (figure 9); the town didn't own the building—they rented it. Actually, the policemen's bathroom was right above my office, so every time they flushed their toilets, the water ran through pipes in the ceiling of my office (figure 10). I remember telling Hardy Shepard that anyone who invested in a company where the president's office was like mine deserved every penny he could make!

(figure 10) **James L. Waters' office in Waters Associates' first plant.**

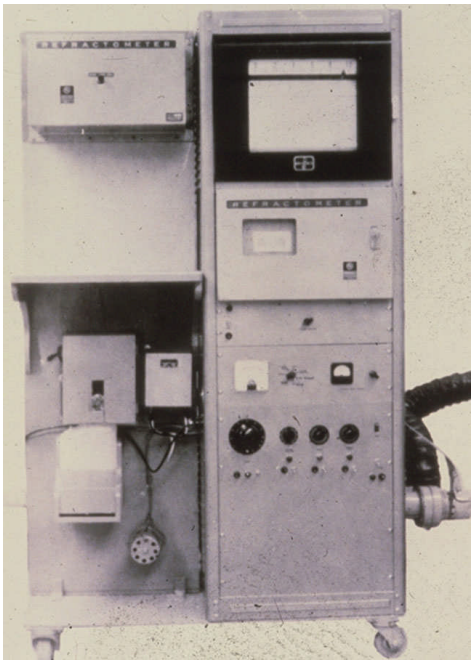
(figure 11) **Waters Associates' Milford plant, 1974-1976.**

Then we moved to the top floor here (figure 9) and eventually occupied both floors in the Framingham plant entirely. Now, when we moved to Milford (figure 11), this is the plant we built here a couple of years later, we doubled it. A couple of years after that, we doubled it again. We had the whole thing there. In 2005, the Waters Milford plant was a mile from end to end.

Here's the Model 300 (figure 5). The big aluminum cell and detector blocks are down this side; the amplifier is on this side. The M300 is the first instrument I developed at Waters Associates. This is the boiler-feed water, a flame photometer, for Indian Point Power Plant.

THACKRAY: How many did you produce?

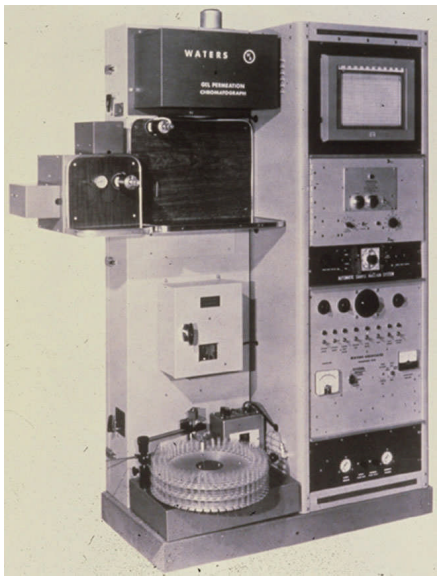
WATERS: I produced three of them. We sold one to a nuclear power plant in Baltimore and two to Consolidated Edison.



(figure 12) **Gel permeation chromatograph [GPC] prototype in 1962.**

Here's the first prototype GPC we built for Dow in 1962 (figure 12). We must have gotten the license from Dow in about 1961. There's a later version of it (figure 13) [GPC Model 200].

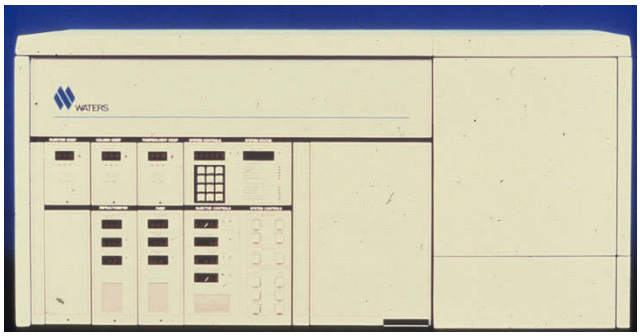
The first GPC conference was in Cleveland. [Fred W.] Billmeyer, a professor at Rensselaer Polytechnic Institute, was our keynote speaker. About seventy people including John Moore, who developed the GPC technology, and Larry Maley, our sales manager, attended the conference.



(figure 13) **GPC Model 200, 1966.**

THACKRAY: Was that in 1965?

WATERS: I think it was 1965. Here's a picture from 1966 of the Model 200, getting better (figure 13). It featured an automatic injector and a fraction collector to collect fractions. Then we redesigned the gel permeation chromatography in 1979 (figure 14). That was done by Bob Limpert. He was a salesman who did a great job managing this R&D project.



(figure 14) **GPC Model 150C, 1979.**

We made an Anaprep and our plan was to isolate narrow molecular weight samples of polymers, but it never went anywhere. Then we made a Chromatoprep. Again, we kept trying

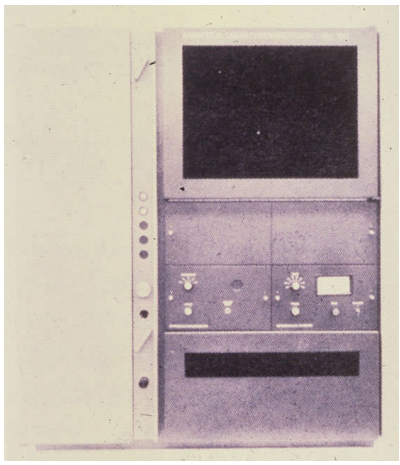
to find the right business—bigger prep columns. That never went anywhere for us but preparative chromatography went somewhere later on. We were just too early.

THACKRAY: Who was doing the R&D around that time? Were you hiring significant numbers of chemists and physicists?

WATERS: Yes. We started making a transition in 1970. I was heading R&D from 1958 until about 1966. I hired Karl Bombaugh around 1966 to handle R&D, but he had a very big ego and a very gruff attitude. It soon became impossible to deal with him, so I fired him in 1970. Then a very ingenious designer named Burliegh Hutchins became VP [vice president] of R&D.

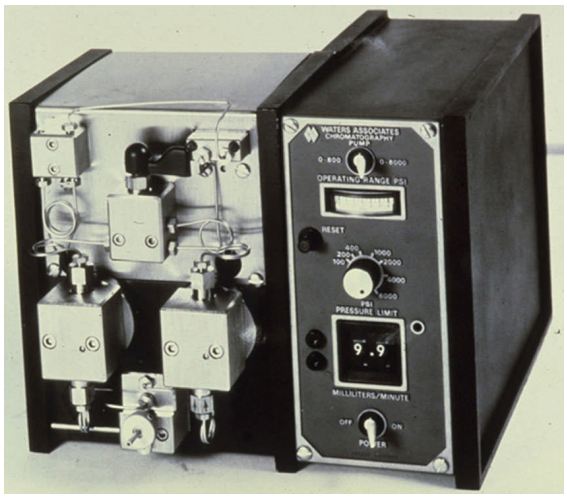
Though I eventually fired him, Karl Bombaugh did get us started in liquid chromatography. For instance, he went to conferences and when he returned, he encouraged us to be more deeply involved in liquid chromatography. We had a very early liquid chromatograph back in 1968. It was only a first attempt but it was horrible. The last instrument I designed was the R400 refractometer in 1970.

In 1967, I designed an early liquid-liquid chromatograph. It had three different pumps with big pistons that pushed liquid through the column. It was an awful instrument. I think we sold two of them and took two of them back! The license came from Shell [Oil Company] in Modesto, California.



(figure 15) **The ALC 100 high-pressure analytical liquid chromatograph introduced in 1968.**

Now this is the ALC 100 (figure 15). The ALC 100 was a real liquid chromatograph. We sold a lot of them later. The Model 201 was developed by Karl Bombaugh and we sold a lot of them as well.

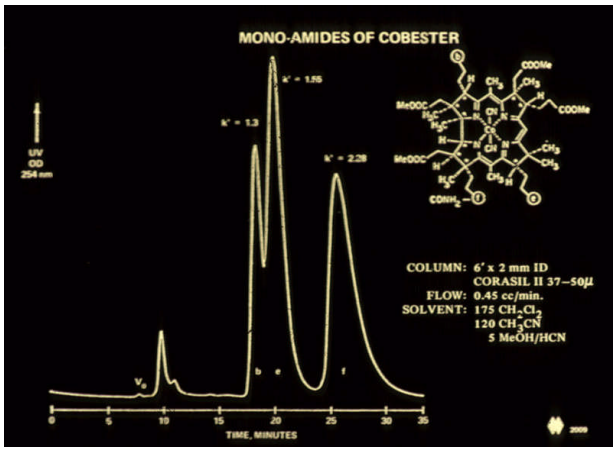


(figure 16) **Model 6000 liquid chromatograph pump, 1971.**

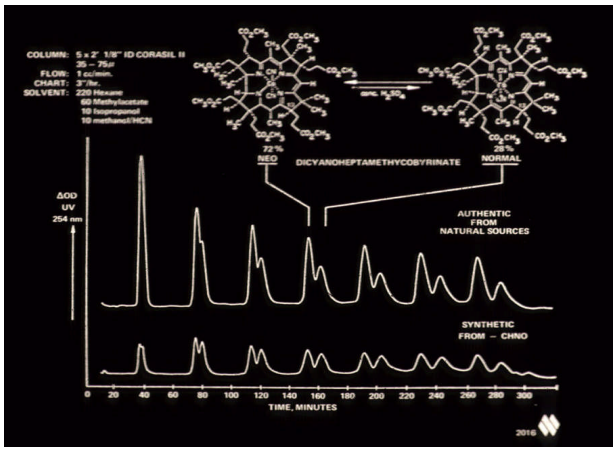
By the time we get to 1971 we're really in the swing of things. This is the Model 6000 pump (figure 16).

(figure 17) **At Harvard University, in 1972.**
l. to r.: Hamberger, Huber, Waters, and Woodward

This is Helmut Hamberger, Joe [Joseph F. K.] Huber, and [Robert Burns] Woodward (figure 17). I can remember it was on a Friday. Helmut was Woodward's chief post-doc. Here's the molecule (figure 18) Woodward was synthesizing. It was rearranging between these two (figure 19). It was about 1,000 molecular weight. It's a big compound. Woodward was adding a functional group at one point in the molecule and during the reaction, the molecule rearranged. He couldn't get the reaction to produce the desired compound.



(figure 18) **R. B. Woodward synthesized mono-amides of cobester.**



(figure 19) **Cobester synthesized and rearranged.**

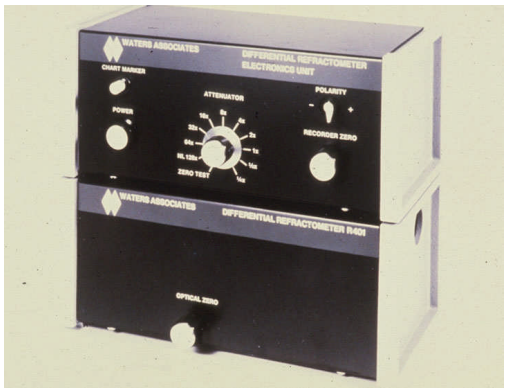
Professor [Albert] Eschenmoser, working with J. F. K. Huber, developed the separation technique at the Technical University [Eidgenossische Technische Hochschule] in Zurich, but they could only isolate micrograms of pure compound because the column wouldn't support a bigger injection. It was at that point when Helmut asked for our help. Jim [James N.] Little (Waters VP of sales) and I discussed the problem after Helmut left the office and we agreed that the problem was awful. We decided to simply sell him an instrument and let him work out the solution. Back then, I didn't know who Bob Woodward was, but Jim knew he was a Nobel Laureate. To me, Woodward was just another chemist at Harvard [University]. Regardless, I knew our LC instrument could be a valuable tool for organic synthesis chemists. I tried to convince the Waters' sales force and application people that organic synthesis was an important field five years before. They were all analytical chemists; they said, "There's no business there."

By Monday, I recognized our chance to get involved in organic synthesis. Jim Little came back exclaiming, "Wouldn't it be great if we could do something for Woodward? Wow! That would be great!" A year before, Dee D'Arbeloff gave me some very interesting advice. He'd said, "If you have a new technology for a field that you know almost nothing about, the best way to learn about that field is to make someone already in that field a success with your technology. When you've done that, you'll know a lot about that field and how to use your equipment. After that, find someone else in that field with a somewhat different problem and make him successful. Then you will be the world's expert in liquid chromatography for organic synthesis." D'Arbeloff was absolutely right.

I wasn't intimidated by the reputation of Woodward's lab or the fact that I knew very little about chemistry; I think there's just something in my personality. To me, Woodward was just a very smart guy. I went in and I cracked one problem for them, which took about three days. I remember Helmut, who is a very serious Austrian, said, "If Woodward is interested in this work he'll come down sometime in the next five days to see what is going on." Well, Woodward came down the first day and asked me about my work. I remember Helmut exclaimed, "Wow, is he interested!" He really was. Albert Eschenmoser later said to me, "You know, we isolated it first but Woodward has tons of material!" [laughter]

I solved three other problems for Woodward while I was in his lab. At the end of the fifth day, I asked Helmut, "Helmut, how many of these problems do you think I have to solve before Woodward gives me my Ph.D.?" Helmut thought I was serious! [laughter] He didn't know how the hell to tell me that Woodward wouldn't give me a Ph.D.! [laughter] I let him suffer for about twenty seconds and then with a big smile I said, "Helmut, perhaps the number approaches infinity!" [laughter]

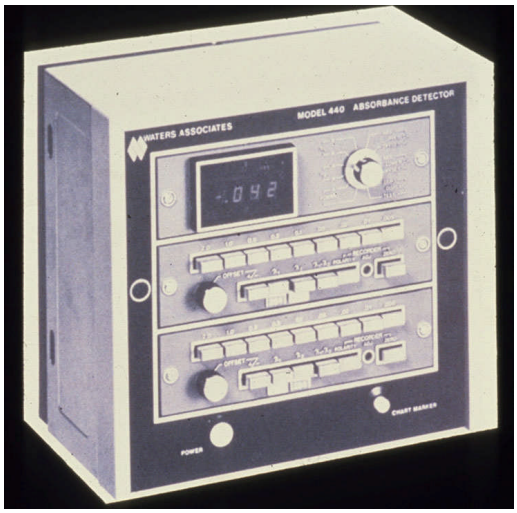
In the end we did recycle (figure 19) on Woodward's compound mix. This is the first pass through the column, the second pass through the column, the third pass, and you can see, by the time I got it out here (the seventh pass), I've got the two compounds nicely purified. We did that on a big scale.



(figure 20) **R400 refractometer, 1970.**

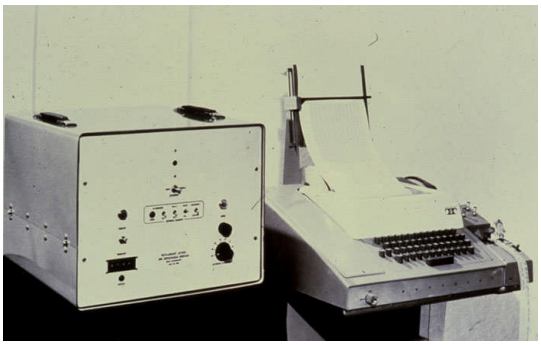
This is the R400, which is the last instrument I designed (figure 20). It was very interesting in the sense that by the time I did this design, we'd made about a thousand refractometers. I learned when I did this project; we'd made a thousand refractometers wrong. A refractometer is very sensitive to temperature change because when the density changes, the index of refraction changes. Ours were extremely sensitive. I've got a flowing stream coming in and I've got to bring the stream to the same temperature as a stationery cell. Then I'm okay, because I'm measuring differential refractometry. I always assumed my problem was getting the flowing stream to be the same temperature as the block.

We had this big aluminum block about 4 by 4 by 12 inches. The cell was at one end and the liquid entered at the other end. I put an ice cube in the tube, just before the aluminum block. I got a big signal due to the change of the refraction index. I said, "All right, now I know what my problem is. So what I'll do is, I'll bring this down here. I'll double the length of the tube in the block by entering at the cell end and then going to the far end and returning. I'm going to be much better off because I'm going to have twice the contact between the tube and the block." So I put the ice cube on the double length tube and got a signal ten times bigger. Then I realized what the trouble was. The cold liquid was coming in, cooling off the gigantic block. It then went to the far end of the block. As the liquid returned, it was cooled by the cool block, giving me a bigger signal. Years before when I designed the first refractometer, I assumed the theory and didn't do the experiment. As a result, I made one thousand RI [refraction index] detectors wrong. "Do the experiment," Professor Istavon Halash used to say. "Don't theorize. Experiment!"



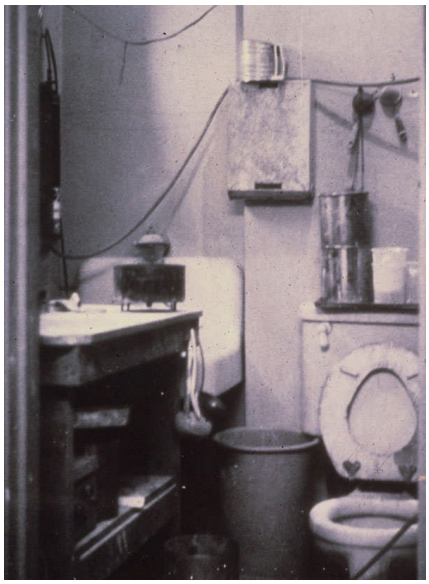
(figure 21) **Model 440 UV Detector, 1975.**

Our M6000 was where our real success came. We really made out well with that pump. This was Burleigh Hutchins' invention (figure 16). Very ingenious. We had the world's worst UV [ultraviolet] up until 1975 and then we had the world's best (figure 21). Then we got into prep chromatography.



(figure 22) **Digital Curve Translator, 1968.**

In GPC, the users get data from the curve shape; they want to calculate the number average and the weight average molecular weight of a polymer. We took the analog output, digitized it, and punched a paper tape on a Teletype. Then we took the paper tape and fed it into a Teletype that was connected by telephone to a computer. The computer made the calculations and the Teletype printed the report. You could call that one of the first computerizations of chromatography data (figure 22). I developed that system in 1968.



(figure 23) **The first Styragel manufacturing facility of Waters Associates in 1963, established in the female detention area of the former Framingham Police Station.**

We made the first Styragel for GPC in 1964, while we were in the former police station, after the police had moved out. This (figure 23) was the women's cellblock, upstairs; we pulled all the cells out and made Styragel there. We have a much more modern facility at Waters today. [laughter] Porapak was a packing material for gas chromatography. We got a license for that from Dow. Incidentally, along the way, Dow offered us the license to ion chromatography developed by Hamish Small. We turned it down, which was both a dumb thing to do and a very smart thing to do, because if we had tried to do ion chromatography and HPLC [high performance liquid chromatography], we probably would have fallen on our face and we would have lost market share to the other HPLC companies.

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THACKRAY: Did Millipore decide to spin the company out again?

WATERS: Yes.

THACKRAY: You were just a bystander from that moment on, correct?

WATERS: Actually, I'd been a bystander since 1980. When we merged with Millipore, I was available to help but Zenie was very mad at me for merging with D'Arbeloff. D'Arbeloff was trying to make peace and the best way to make peace was, "Jim, out!" [laughter] So I became a venture capitalist at that point.

I am completely disconnected from Waters now. The only thing I ask of them is, "Please don't embarrass me and I'll try not to embarrass you." I am proud of them. They make me look good, which is very nice.

THACKRAY: Is that because it turned out to be a good move to split Waters off?

WATERS: Yes. I think both moves were good. I think the merger was good and I think splitting it out from Millipore was excellent, too. Interestingly, the current Waters manager was a former CFO of Millipore. He's become a very good manager and is doing a first class job of moving the company forward.

THACKRAY: In looking back at your fifty years in the instrument business, would you describe where the business is today, as you understand it and how it has changed over time?

WATERS: It's a very dynamic business. It's what I call a scavenger business. It can't develop any fundamental technology of its own because the market isn't big enough. For instance, no one would ever have developed the integrated circuit for the instrument business. It was developed for some other purpose and then the instrument business decided to use it. It was riding on the back of all these pieces of technology that were developed for other uses. That's one aspect of it. The other nice aspect of it is there's lots of room for entrepreneurs. For instance, those who have a better idea for a column can start their own little column business. So it gets to be highly competitive, which is very good for any industry.

I think businessmen generally underrate the value of competition. They don't want any competition in their business, but they do want it between their vendors and between their customers. Of course, in the end, competition is the only thing that makes the world go round. That's why you see some foreign countries don't do well when they decide to put up barriers and develop their industry internally. They had a marvelous program on television the other night about India and the Hindustani car. What are they going to sell, about eighteen thousand a year? That company was founded the same year as Toyota! [laughter]

In any case, the analytical instruments business is a very good business from what I've seen. The industry has matured greatly since its inception and those involved can do much more than they once could. Consider the DC amplifier problem in the early days: vacuum tubes didn't make good DC amplifiers. To fix that problem, we fed the DC signal in, chopped it with a chopper to make it AC, amplified the AC signal, and then demodulated it with the same chopper in sync to create the amplified DC signal. In contrast, today you can buy a tiny microchip the size of your fingertip that is more stable than the box in 1960 with three vacuum tubes and a chopper in it. Progress makes an incredible difference!

THACKRAY: Given that entrepreneurial reality, isn't the big company at a disadvantage? Does success doom you, in a certain way?

WATERS: Yes. In a sense, a big company gets into trouble when they become bureaucratic and it's very difficult to avoid a bureaucracy as you become larger. Alternatively, a big company has the advantage of a sales force that can cover more territory. What tends to happen is the big companies buy out the smaller ones.

Waters is almost unique that way. It's the one company that started from scratch and has stayed true to itself. In truth, I suppose Beckman Instruments is the same way, as is Hewlett-Packard. When you consider liquid chromatography, Beckman, Hewlett-Packard, and Varian Associates each bought a smaller company that was involved in liquid chromatography—they didn't develop that technology themselves. Again, that's just a part of history.

Hardy Shepard used to tell the story about one of his investments that took place back in the 1950s, when a million dollars was worth almost six times what it's worth today. One guy that Shepard invested in said, "I want to be worth a million dollars. When I can sell my company for a million dollars, I'll sell the next day." Hardy didn't believe him. After all, the guy was a hard-driving, hard-working engineer. But sure enough, that's exactly what he did.

So the fate of a business depends greatly on the ambitions of the owner. People set goals in their lives and then try to accomplish them. Arnold Beckman's goal was probably much bigger than the owners of some of the companies that he bought, where the owner thought something like, "I want to travel up and down the United States in my yacht," and then sold out once he could afford to buy the yacht.

THACKRAY: What was your ambition, Jim?

WATERS: My wife and I have a saying: "It appears that success is not a cure for ambition!" [laughter] That's our trouble. We talk about it every once in a while! Why am I doing so much? She's seventy-four and I'm seventy-six. Why are we still doing so much? I think it's because we like what we are doing.

When I retired from Waters, I got a new religion and my religion has just one commandment. It says, "Thou shalt work eleven weeks and take two weeks off." I do that. It's been very, very important, because I like to work hard, but, by gosh, if I don't get away enough, I'll burn out early.

What is my ambition? I'd like my health to hold up. I'm willing to live another twenty-five years but I'd only like to do it if my health is reasonably good. I would like to see system dynamics in K-12 schools go somewhere. I had an early goal, which was to give my children their inheritance by the time they were twenty-one because I didn't want them waiting around for me to die. I succeeded in doing that. I gave them Waters stock back when Waters wasn't worth much of anything and now they are independently wealthy. They're not super-wealthy but they're wealthy enough so I don't have to worry and they're not waiting around for Faith and me to die. We're going to give all our money away.

I've discovered over the last fifteen years that I'm really a libertarian in the way I think; libertarian meaning everybody ought to have a right to do whatever they want to do as long as they don't interfere with anyone else's liberty.

THACKRAY: Talk about the Cato Institute.

WATERS: Yes, I'm a sponsor of Cato, the Reason Foundation, and the Institute for Justice. I support anyone helping other people realize that too much government is a very bad thing.

What I find truly frustrating is people's ignorance about healthcare. I mean, if we ever let the government control medicine, it's going to be disaster. One of the things I've just realized recently about my mother was her great collection of wonderful sayings. One was, "He who pays the piper calls the tune,"—that is exactly what will happen to healthcare. If the government pays for your healthcare, then the government will ration your healthcare.

THACKRAY: See the Veterans Administration for further details! [laughter]

WATERS: Yes, right. My mother had other great sayings, too. For instance, when I was a teenager feeling sorry for myself, she'd say, "Why don't you go out in the garden and eat worms!" I just didn't get much sympathy. I got real sympathy for times when I really hurt but not if I was just feeling sorry for myself. I remember in high school when I broke up with my girlfriend I was feeling very sorry for myself. My mother said to me, "Girls are like streetcars. There'll be another one along in a minute." [laughter] She was so right. There was another one along in a minute! [laughter]

I'd like to continue to make a contribution. But mostly my marriage has been a very successful one. Let me tell you a story.

THACKRAY: You haven't said much about Faith, so please continue.

WATERS: Faith is the third daughter in her family—I married the pick of the litter. She was not neglected physically but she was neglected emotionally. Her mother, for instance, told her she didn't think that Faith was smart enough to go to college and yet if she had stayed at Mills, she would have been Phi Beta Kappa in her junior year. I think she decided at an early age that if she were going to amount to anything, she would have to do it herself. She became quite independent in her thinking that way.

Anyway, I remember an argument she and I had once. We have a furnace that heats our hot water and we have an attic fan. So on a hot day, I discovered I could turn the attic fan on and bring the air conditioning that was primarily on the first floor up into the second floor, making the bedrooms much cooler. Well, my wife believed she had told me somewhere along the way that the attic fan blows out the pilot light on the furnace and makes it so there isn't any hot water.

Now here's where the story gets silly. My wife likes to take a hot bath each night and the night after I'd turned the attic fan on she went to take her hot bath and there was no hot water. She didn't say a word to me that night but she was very mad at me. Now she gets up before I do. So the next morning, she brought in a teapot of hot water so I could shave, saying that there's no hot water! She was very mad at me because she figured that I had blown the

pilot light out on the furnace. Of course, I didn't think I could blow the pilot light out because there wasn't one—we have oil heat—but I'd learned to be very calm during those situations.

Later, I went down and found the oil tank was empty; and so I told her. Ever since, we've been playing that back and forth and you know, it's a nice thing when I can say, "I know how important a hot bath is and instead of staying angry at me, it was very sweet of you to bring me a kettle of hot water so I could shave." And she says, "Yes, and I suppose that you knew how angry I was at you and I did say a few things about the stupidity of turning that fan on. And it's awfully nice that you didn't say, 'I told you so!'" [laughter] I suppose it's the little things like that that make for a much stronger relationship, as you gradually mature.

THACKRAY: Grow up! [laughter]

WATERS: You're absolutely right! As you gradually grow up! [laughter] Yes.

THACKRAY: Faith has been a housewife all these years?

WATERS: Not always. When the children became teenagers she decided to go back to college. This is a marvelous story that she tells. Some people at Radcliffe [College] wrote a book about older women going back to college, so she applied to Radcliffe. They said, "Your academic record is fine. We'd be glad to admit you, but you have to live on Harvard's campus." She said, "Come on! I've got a husband at home. I've got to take care of him. I can't do that." The dean who was interviewing her said, "It is a pity that you are ready for Radcliffe because Radcliffe is not ready for you!" [laughter]

So Faith attended Simmons [College] instead. She went part-time and graduated in four years. Then she went to Northeastern University and earned a master's degree in remedial reading. She became a reading specialist. Incidentally, in our family, I have a bachelor's degree, my wife has a master's degree, my son has a Ph.D., and my daughter has two Ph.D.'s. [laughter] So we've got them going.

THACKRAY: What are your son and daughter doing?

WATERS: My daughter is a lawyer. She has a small, independent practice where she lobbies the Massachusetts legislature occasionally and writes legislation for people who request her services. My son is the president and research manager for Mitsubishi [Electric Company] Research in the USA. He has a group of about one hundred people, mostly doing state-of-the-art computer science research at a facility in Cambridge. They're both fine. My daughter doesn't have any children but my son has four children—three of them are boys, so the Waters

name in my branch will go on for a while. My father was an only son, I'm an only son, and my son is an only son. Now I have three grandsons, so I feel better. [laughter] Looking back at my family history, my great-grandfather was one of seven boys and as they told the story, "There are seven of us boys and we each have a sister." Eight in the family. [laughter]

THACKRAY: Let's talk about your initial work as a venture capitalist.

WATERS: Around 1979, I started another business to computerize the marketing system that I developed at Waters. The system had been computerized at Waters but I computerized it even more to work with System/34, which IBM had introduced recently. System/34 was a fairly powerful, freestanding system that cost a couple of hundred thousand dollars. This was years before the PC [personal computer] was able to do this job. I thought if I could get the direct mail system with telephone screening, I could keep track of sales leads and service calls all in one system, which could help sales people greatly.

In truth, that project was one of my failures. The mistake I made was in thinking that a salesman would want to be organized! They don't want to be organized and they're not going to take the time to put the data into the system. I could have been successful if I reduced my idea to something very simple and then introduced it at the time the PC was coming out as a simple system to keep track of things. I started that business around 1979 and I closed it up about 1983.

THACKRAY: Did you have any employees in that business?

WATERS: Yes. I had about ten employees.

THACKRAY: So, in theory, your venture capital business was like a new Waters Associates.

WATERS: Exactly. In theory, it was. I figured I'd done it twice before, so it ought to be a piece of cake to do it the third time. I learned it's not a piece of cake if you pick the wrong business.

Then, about that time, one of my former salesmen went into business with Fred [Frederick D.] Sancilio, who founded AAIPharma [Inc.] in Wilmington, North Carolina. Sancilio was a sales representative for a thin-layer chromatography company. He had a small analytical lab, in which he did pharmaceutical lab work, and he sold some dissolution instruments. I invested in his company in 1981. Today, AAIPharma has sales of about three hundred million dollars. They've had ups and downs along the way. He is a very good entrepreneur. He's made quite a few mistakes, but he's done some rather brilliant things.

THACKRAY: It sounds like you got into that almost casually, as it were.

WATERS: Yes. For the most part, my business ventures have resulted from interactions with people who came to me or through someone I heard about or knew. So my business relationship with AAIPharma is one example. I've been with Sancilio a long time. Actually, I'm on the board of directors of AAIPharma.

Another business that I got into was credit card depositing for direct mail companies. The whole credit card system is built for the retailer. You're there, they can see your card, they can make verification, and so on. With direct mail, you're just giving your number over a phone. If the depository doesn't have an authorization on a deposit, the price is much higher from the credit card company. There were times when we deposited a billion dollars a day in the Christmas period. We were doing it for about a hundred different direct mail companies. We were running Stratus non-stop computers, so there was no way we would miss anything. That business became quite successful and was eventually sold to First USA Bank [N.A.].

Along the way, I thought the original entrepreneur of the business was making mistakes. I had control of the company, so I fired him. I didn't want to fire him but I wanted him to work outside of the company. He got mad at me, sued me, and started a competing business that actually did better than we did. We both sold out to First USA Bank because we realized we'd be better off if we combined the two companies and sold them together. In the end, we were at such loggerheads that we were unable to combine our companies. Then he sued on a ridiculous thing and lost.

I probably shouldn't have invested in the business. There were signs right in the beginning that he wouldn't be a good partner, but he could sell almost anything. He went to Bank of America [Corporation] and sold them on the fact that they were going to guarantee these deposits.

What happens in the credit card industry is that you buy something and let's say it's defective; you do a chargeback through your bank. The money comes back. We're the intermediate. If our direct mail company goes bankrupt on us, we're caught. We only had a couple hundred thousand dollars of capital and we were depositing millions of dollars a day. He sold the bank on letting us deposit with the bank. If one of our clients couldn't pay and we couldn't meet the chargeback, the bank would have to meet it. I would never have the gall to do it but he did it and he deserves a lot of credit. He was very ingenious, but just a little corrupt. That was another investment.

Another business I got into was with a man who designed a dissolution instrument for the pharmaceutical industry. They had six baths of dissolution that simulated the environment in the stomach. You dropped a tablet into the bath, sampled the time it took for the tablet to dissolve, and so forth. He designed a much better way to run the experiment, where the tablet

was dropped into the same chamber automatically and then the stuff was drained out. It was a much better design, but the pharmaceutical business is so conservative that he couldn't get them to change. That business didn't go anywhere.

Currently, I'm involved in the Cetek [Corporation], which uses capillary electrophoresis to discover drugs that associate with proteins. I think it's going to be successful. It's looking good but we still have to prove it and we're not quite there yet.

THACKRAY: It sounds as if you tend to be significantly involved with one thing at a time. Is that true, or not?

WATERS: Yes. For instance, I did a lot of computer programming for AAIPharma. I developed systems to help them keep track of their projects.

[END OF TAPE, SIDE 7]

WATERS: The software development was ongoing for about five years.

When I was with the credit card depositing business, I was never closely involved. But for a period of about a year, I spent one day a week working with them and making sure they were doing the right thing. I was very much involved in planning the software for the sales management system. I wrote much of that software. I was never very involved in the dissolution company. I also have an investment in a company in Pittsburgh, Thar [Technologies, Inc.], which is involved in supercritical extraction and supercritical chromatography. I'm practically uninvolved in that company.

THACKRAY: What about Cetek?

WATERS: I work full time at Cetek. I'm very much involved and working my heart out there.

THACKRAY: What is your workweek like?

WATERS: On average, I probably work about eight hours a day, five days a week. On a weekend, I can easily work for seven or eight hours.

THACKRAY: What kind of work are you doing at Cetek?

WATERS: With Cetek, I'm fundamentally identifying problems and getting people focused on the problems. We're trying to change the process of natural product drug discovery into a factory orientation. I'm trying to make sure that my people are solving the most important problems. I'm also working in the fractionation area, trying to determine the best way to fractionate a natural product and isolate the particular hit. Fungi make more than a thousand isolatable compounds and your hit may be several of those, so you've got to isolate each hit compound.

THACKRAY: So your Cetek project is close to home.

WATERS: It's very close to home. But there are days when I go home and wonder, "Why in the world am I doing this? I don't have to do this at all. I could be sitting twiddling my thumbs. I could be sitting doing system dynamics and helping those folks. I could be attending conferences like Cato."

THACKRAY: Do you ever attend conferences?

WATERS: Yes, quite a lot. I go to Cato symposia to get my injection of libertarianism.

THACKRAY: How did you get into system dynamics?

WATERS: That came about in 1980 when I decided, "I'm fairly wealthy. I'd better think about how to invest my money." I was aware of cycles in business—boom-bust cycles and so on. I wondered if one could predict when the boom and bust would come. I became acquainted with Professor Jay [W.] Forrester, who developed system dynamics and invented the ferrite-core memory for computers. Actually, I think the ferrite-core memory patent made more money for MIT than any other MIT invention (3). In the end, Forrester became a professor in the business school.

When I learned about system dynamics, I realized that that was the way I'd always thought about life. I always knew things accumulated and that there was feedback between different stages of a process. Actually, I had used system dynamics by making a spreadsheet that predicted profit and loss and the balance sheet quantities by quarter. I became interested in how we could use system dynamics to make the world better. My first thought was that we needed to teach people in Washington, D.C. about system dynamics. But after further consideration, I realized that the politicians in Washington would not give a damn about system

dynamics because they have a political agenda. Eventually, I realized system dynamics might provide something very useful for schoolchildren.

For instance, people are stocks and births are flows that add to the system. Now, the births are controlled by the birth rate, which may be controlled by numerous variables, as well as the number of people. So if I have ten times as many people, I'm going to have ten times as many births, everything being equal. The death flow is also tied to the number of people. But if we're dealing with animals, the death rate might be more influenced by the food supply or the strength of a predator. Let's say we're discussing mice and the wolves that eat mice. The death rate of the wolves may tie in with the number of mice. If there are fewer mice, then there will be fewer wolves.

Dynamics are everywhere. An English teacher uses system dynamics to study Hamlet and his desire to kill the king (4). Hamlet's desire to kill the king attenuated quickly. He couldn't stay mad. He would calm down and then a new event would happen that enraged him further—that's the drama of the entire play. So the English teacher decided to teach using behavior-over-time graphs. For instance, in any novel you can pick some event and over time show how it changes the dynamics of the story.

That teaching method has been a marvelous tool for children because it clearly explains the cause and effect of events in a story as they relate to the dynamics of an entire situation. What we've found is that children who learn with system dynamics become more mature. You see, adults tell children how to behave but they don't tell children how the world works. My theory is that children know how the world works when they are one or two years old. It's very simple, "manipulate mother and father," that's how their world works. However, when they turn three or four they realize that the outside world doesn't work that way but nobody tells them how it does work. Well, system dynamics is how it works and there are some simple rules they can learn.

Once children realize that they're in the business of accumulating skills and knowledge and it's their responsibility to do so, not somebody else's, the dynamic changes entirely. We've found it changes teachers too. The teachers, as they begin to think about system dynamics, begin to change the way they think about the world. You know, Faith and I have a minor ambition: all we want to do is change the world! [laughter]

THACKRAY: Was there someone doing this that you have found and have helped, or is this something that you yourself have developed and articulated?

WATERS: I'll give you a little bit of the history. Once I asked Forrester, "How can I help system dynamics?" His suggestion was, "Teach it in kindergarten through twelfth grade. That's the best way." Then I asked, "But wouldn't it be better in college?" He replied, "No, the curriculum is etched too deep. You can't get professors to change. It will happen only when

the students finally come in and say, 'Here's a model of what you're talking about, Professor.' And the professor says, 'My God! I never thought of it that way!' Then they'll change."

Gordon [S.] Brown was a professor at MIT who retired and moved to Tucson. Brown took some of the system dynamics technology into the Orange Grove Middle School and then we gave the school system a grant to help them introduce system dynamics in the middle school. Mary Scheetz was the principal of that school and she's now the head of the Waters Foundation as it relates to system dynamics. She currently lives in Portland, Oregon. In addition to herself, she has two specialists in Tucson and a specialist in Harvard, Massachusetts. They all are top-level mentors.

We provide grants to about eleven different school systems each year, so they can release a teacher to become a mentor for other teachers. I was fortunate when we started the program that I didn't feel strongly that it had to be run a certain way. My original goal was to teach kids to build models. You can build system dynamics models in the computer and then run them to see what happens over time. When you sign on to the Waters Foundation [http://www.watersfoundation.org] website you can download some models and see a lot more about it.

That isn't what happened. What happened was people began developing system dynamics games, like the Game of Friendship. For instance, how do you make more friends? By finding somebody who has a lot of friends and becoming their friend—then you'll have lots of friends. So the Game of Friendship taught simple dynamics, especially at the kindergarten and first grade level.

Moreover, the behavior-over-time graphs have been very popular. There is a system dynamics conference for teachers every two years attended by about four hundred teachers. There are many different school systems using system dynamics in many different ways. As a result, we've decided to be very experimental. What works, works. Mary Scheetz has a great expression: "We only jump on moving trains!" We're not going to try to get you moving if you're not moving already. Show us you can get moving and we'll help you. At some point, I would like to retire from Cetek and spend more time with system dynamics because I think I can help the program greatly.

The program has matured and it's going nicely. We're learning more and more how to teach the material at different grade levels. The biggest success we're having is at the elementary level, because the examples are small. The kids don't have a very sophisticated understanding of how the world works and systems dynamics seems to have a very big impact. One teenager was asked, "What has system dynamics meant to you?" He replied, "When I get in an argument with my mother, I ask, 'What are the dynamics going on here?'" It's a little harder to cope with children like that! [laughter] But you can be very proud of them, too.

THACKRAY: Thank you. Let's move on to Pittcon now. You said you first went to Pittcon sometime in the mid-1950s.

WATERS: Oh, yes. The first Pittcon I ever went to was in the mid-1950s. Then, of course, as soon as Waters got into the laboratory instrument business, we always showed at Pittcon.

THACKRAY: Did that mean that you yourself tended to be there?

WATERS: Yes, I tended to be there. Although I tended to be more an inside man than an outside man. In other words, I've always said, "I can do anything except selling and marketing." Then, as it turned out with Woodward, I opened up the organic synthesis market, got into the telephone selling, and managed the program. So I discovered that I probably could do those two things, but they're not for me.

THACKRAY: Describe the Waters Symposium.

WATERS: I got the idea for the Waters Symposium while attending a Pittcon in Atlantic City. At that conference, there was a conference hall where I could get up to the seats on the second floor and look down on the entire show. I went up to the second floor and as I looked down on the show I began to fantasize—this was during the 1980s—that I was a Russian sent by my government to Pittcon to determine how to develop the Russian instrument industry so that it would be the equivalent to the dynamic industry in America. From my vantage point, I could see all the little booths and the bigger booths and I realized there was no way that the controlled Russian economy could have all of the entrepreneurial activity that was happening in the United States. Further, you can't stimulate progress like we have in America without all of the entrepreneurial activity and competition. You can throw money at the instrument industry but the Russian system won't be as successful as the American system.

I thought it would be nice to have some kind of award to recognize entrepreneurs and secondly, that young entrepreneurs would come and listen to how we started our businesses. I suggested that idea to a couple of people at Pittcon and there wasn't much enthusiasm at first. As a matter of fact, it fell flat. Then Professor Jan Coetzee at the University of Pittsburgh became interested and got the program up and running.

The seminar hasn't turned out exactly the way I intended. I had hoped people would talk more about starting businesses, the problems they had with starting a business, and how they overcame those problems. What usually happens is that the entrepreneurs talk more about their later successes and then some of the time it's right back to the university professor talking about his latest research discoveries in mass spectrometry or HPLC. That's all right. Life doesn't always turn out the way you plan and I'm not unhappy with it. It's a nice thing but isn't quite what I'd hoped.

DAEMMRICH: What role do you play in picking the topics each year?

WATERS: None.

THACKRAY: It's wonderful that you thought of it, Jim, because we rarely consider what we've learned from past experiences.

WATERS: Yes. I think that's true. [laughter] You were asking about my wife at one point.

THACKRAY: Yes. Please continue.

WATERS: After Faith got her degree from Northeastern, she had a very interesting experience. She got a job at an alternative public school in Watertown, which is a lower middle-class community. She worked in the basement of the Armenian Cultural Center, teaching the leather-jacketed boys—those who say, "I haven't written anything since I was in sixth grade and I'm not going to write anything now." She was marvelous with them. They had been labeled as being dumb, but she didn't believe they were. She brought their intelligence out so they could see it. They were great talkers. They were good at speaking and thinking. She did that for six years. It was very taxing. She had a half-time job but she treated it as a one-and-a-half time job. Some of the stories about how the kids reacted to her classes are just marvelous.

For instance, Faith had a small Mercedes coupe when she applied for the teaching job. So when she first pulled into the parking lot, one of the leather-jacketed boys said, "That teacher, that car's hers!" Another replied, "It couldn't be hers." They came over and asked her. Of course, they all knew everything about cars. One of the ways she got them to write was to say, "Write me a procedure for changing the spark plugs in my car." Of course, none of them would deny knowing how to do it. Faith told them to write a simple, step-by-step procedure. Ultimately, the first step they wrote was, "pull the spark plug." She imitated that step, saying, "I can't get to the spark plug. I keep hitting something." The students replied, "Open the hood!" Faith responded, "You didn't tell me to open the hood." She gave back their procedures. Next, she opened the hood and pulled on the spark plug but she couldn't get it. The students exclaimed, "Use a wrench!" Again, Faith responded, "Where does it say use a wrench? Understand? Now, write it so I can do it." It showed them how difficult it was to write a good procedure. They didn't have to write a lot but at least they wrote something.

Another interesting method of Faith's was her lying curriculum. She had a whole curriculum about lying. Her students asked, "Us? Why would we need that?" Faith exclaimed, "You do lie." They replied, "Not us!" My wife had a great relationship with her students. Her

students knew they lied but they didn't think other people lied to them. They were very naïve. To teach them about lying, she asked each student to tell her two stories: one that's a lie and one that's the truth. Then the students tried to figure out which was which. For instance, one student said, "My uncle plays in the Boston Symphony Orchestra. I am one in a family of ten." Immediately, the students thought that the Boston Symphony Orchestra was the lie. So they began asking questions and this one shy boy suddenly asked, "What are the names of your brothers and sisters?" The student replied, "Helen, Ruth, John, David, and so on." Then about two minutes later, the shy student again asked, "Tell me again the names of your brothers and sisters!" He absolutely nailed him. Faith was saying that lying is easy. "The down payment is very low. It's the rent that's terrible. If you're going to be a liar, you'd better have a good memory!" [laughter] But the main point of the curriculum was to get them to listen and to read critically—she taught them about "spin," misrepresentation, and so forth.

THACKRAY: Do you have such a thing as leisure time outside of our venture capital activity?

WATERS: Yes. I take my eight weeks vacation a year.

THACKRAY: But in the ordinary course, you're not on the school committee anymore?

WATERS: No. I'm not on the school committee anymore, that ended in the 1960s. I haven't been involved in politics since then. My wife and I like to travel and we like cruises. We've been almost all over the world on cruises except to the tropics. We decided to stay away from the tropics. We've taken a number of vacations in northern Italy that we like very much. It's a nice place.

I think we've been pretty much all over the block. You probably know Jim Waters better than I do.

THACKRAY: Well, he's an interesting guy. [laughter]

WATERS: It has been very nice. I think I've been blessed in many ways. I think I've been lucky.

My son was very depressed in fifth grade, so we got counseling for him and then we all got into it. Psychotherapy has been a wonderful thing for us. You study the way in which you react to things and learn more about who you are and what drives you. In other words, you can be both blunt and tactful at the same time. When blunt is right, be blunt. When tactful is right, be tactful. Be less driven by your emotions. So that was a very important part of my life.

But I guess if I look back on it, I had very good parents. I had a marvelous education. The Navy V-12 program gave me an outstanding education. I was lucky in getting into the instrument business. I met the right girl the first time and the marriage has matured very well. The kids have had some troubles along the way but they've both turned out great; our son is now fifty-two years old, our daughter is forty-nine. By this time, you know how they turned out. They both turned out very well. They both have good marriages. I don't have very much to complain about in this world. The nice thing about it, at my age, it's still very interesting. AAIPharma is a very interesting company. Cetek is very interesting. Waters is not doing anything to embarrass me. You can't ask for much more. Then I have interesting people coming and letting me tell the whole story! [laughter]

THACKRAY: It's a very good story and I thank you for telling it.

WATERS: Thank you.

[END OF TAPE, SIDE 8]

[END OF INTERVIEW]

NOTES

1. Oliver Sacks, *Uncle Tungsten: Memories of a Chemical Boyhood* (New York: Vintage Books, 2002).

2. William Makepeace Thackeray, *Vanity Fair*: *A Novel without a Hero* (London: Bradbury and Evans, 1848).

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4. William Shakespeare, *The Tragedy of Hamlet Prince of Denmark,* The Harvard Classics Vol. XLVI, Part 2 (New York: P. F. Collier & Son, 1909-1914).

INDEX

F

G

H