CHEMICAL HERITAGE FOUNDATION

IRVIN I. RUBIN

PLASTICS PIONEERS ASSOCIATION

ORAL HISTORY PROJECT

Transcript of an Interview
Conducted by

James G. Traynham

at

Brooklyn, New York

on

26 February 2002

(With Subsequent Corrections and Additions)

ACKNOWLEDGMENT

This oral history is one in a series initiated by the Chemical Heritage Foundation on behalf of The Plastics Pioneers Association. The series documents the personal perspectives of the individuals related to the advances in plastics, polymer science, engineering, and technology, and records the human dimensions of the growth of the plastic manufacturing process industries during the twentieth century.

This project is made possible through the generosity of The Plastics Pioneers Association.

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

IRVIN I. RUBIN

1919	Born in Brooklyn, New York in February

Education

1938	B.S., chemistry, City College of New York
1939-1940	Graduate School, Brooklyn College

Professional Experience

	Robinson Plastics Corporation
1940-1942	Technical Director
	Montrose Chemical Company
1942-1945	Chief Shift Chemist
	Columbia Plastic Products Manufacturing Corporation
1945-1946	Acrylics Plant Manager
	Robinson Plastics Corporation
1946-1967	Plant Manager
1967-present	Owner and President
	RLR Industries, Inc.
1958-1968	Founder and Vice President
	Irvin I. Rubin Plastics Corporation
1962-present	Owner and President

Honors

1989	Fellow, Society of Plastics Engineers
1993	Member, Plastics Hall of Fame

ABSTRACT

Irvin I. Rubin begins the interview by describing his family history and how he came to work in the plastics industry. Throughout the interview Rubin describes in great detail the intricacies of working with plastic, starting with the injection molding process. Rubin began working at Robinson Plastics Corporation not long after its inception. There he developed his intuitive knowledge of plastic molding, and began to work as a consultant. A brief interruption to his career at Robinson occurred in 1942 when Rubin was drafted and subsequently released from duty. During the next four years, Rubin worked as the Chief Shift Scientist at Montrose Chemical Company and then as Acrylics Plant Manager at Columbia Plastic Products Manufacturing Corporation, before returning to Robinson Plastics in 1946 as Plant Manager. Rubin eventually become owner of the company and, additionally, founded RLR Industries, Inc. in 1958. Throughout his career, Rubin has been dedicated to the dissemination of plastics education, and now in retirement, finds himself working toward the preservation of the rich history of the revolutionary plastics industry. In an effort to share his knowledge of the industry's rapid progress, Rubin has run seminars, contributed to or written numerous publications, and is a member of the Plastics Pioneers Association. Irvin Rubin concludes the interview by reflecting on the profound impact the plastics industry has had on our everyday lives.

INTERVIEWER

James G. Traynham is a Professor of Chemistry at Louisiana State University, Baton Rouge. He holds a Ph.D. in organic chemistry from Northwestern University. He joined Louisiana State University in 1963 and served as chemistry department chairperson from 1968 to 1973. He was chairman of the American Chemical Society's Division of the History of Chemistry in 1988 and is currently councilor of the Baton Rouge section of the American Chemical Society. He was a member of the American Chemical Society's Joint-Board Council on Chemistry and Public Affairs, as well as a member of the Society's Committees on Science, Chemical Education, and Organic Chemistry Nomenclature. He has written over ninety publications, including a book on organic nomenclature and a book on the history of organic chemistry.

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INTERVIEWER: James G. Traynham

LOCATION: Brooklyn, New York

DATE: 26 February 2002

TRAYNHAM: This is a recorded interview with Irvin I. Rubin in his home in Brooklyn, New York, on 26 February 2002. The interviewer is James G. Traynham. Mr. Rubin, for the record would you please state the date and place of your birth?

RUBIN: I was born in Brooklyn, New York, in February 1919. I am eighty-three years old.

TRAYNHAM: What was your father's occupation?

RUBIN: My father worked in wholesale dry goods. He was an immigrant. My father came to the United States when he was probably about seventeen years old to avoid the seven-year draft into the Czar's army. Unfortunately, I don't know too much about his early life, but my father ended up in the wholesale dry goods business. Because times were different, the immigrant peddlers would go from door to door selling all kinds of merchandise. They had regular routes. Then they would come back weekly to collect money. In addition to selling dry goods, my father sold sheets, pillowcases, towels, bedding, and so on. My father would work very late because his customers, the peddlers, worked in the daytime seeing customers, and then came to him in the evening to buy whatever they needed to deliver the next day.

Two of my father's brothers came to the United States about the same time he did. One was a partner with him in business—both of my uncles have since passed on. One of his sisters married a Jewish doctor from Sweden. A matchmaker suggested that he go visit my father's family in Russia. He went, they got married, and moved to Sweden. They're the only members of the family left alive. The Germans killed the remainder of my family. I know very little about them and I sincerely regret that.

TRAYNHAM: What was your mother's background?

RUBIN: My mother came from a long tradition of highly distinguished scholars. For example, my grandmother's first cousin, Dr. Bernard Revel, obviously my cousin, was put on a dollar American stamp. Now you don't get put on an American stamp unless you have done something exceptional. He was the founder of Yeshiva University. He would visit my grandmother and my mother very often with his two sons, one of whom could always beat me in chess; the other I could always beat in chess. He was a Rabbi and one day, when I was about six years old, he asked me if I would like to become a Rabbi. I said, "No." He asked, "Why?" I replied, "You don't make enough money!" [laughter] On my grandmother's other side, there are distinguished scholars that go all the way back. Another of her first cousins, Dr. Louis Ginzberg was one of the luminaries of the Jewish Theological Seminary.

My father always made a living, but sometimes it was just by the skin of his teeth. My father was able to provide the usual amenities of a lower middle-class family and still afford to send me to summer camp. I learned the value of saving. I remember my parents vividly. They'd walk, each carrying two huge paper bags five extra blocks because they could save a few cents on groceries. My father, by the way, was a great wrestling fan, but he didn't ride on the Sabbath, so he'd buy his ticket before hand and walk about 2 miles to watch wrestling in the local arena.

I had a very good childhood. Every Saturday morning my father would go to the synagogue and when I was about five he took me with him. After lunch he would read to me from *The Swiss Family Robinson* (1), *Treasure Island* (2), and the like, but after ten minutes he'd fall asleep. So I complained to my mother, and she said, "Then learn how to read." So at five I was reading *The Swiss Family Robinson* and books like that. To me, it was very easy. Well, my mother, who taught in public school, was a great teacher. If I came home with a 99 percent average, she said, "That's terrible! You didn't get 100 percent!" She was right. There was always the push for excellence. Do the best you can.

My grandmother was a brilliant woman. She moved to an apartment on the same floor as ours. She could read, write, and speak seven different languages fluently, and she would talk to me. I couldn't talk to my mother. One day my grandmother and I were talking about America, and she said, "What makes America great are two things: freedom and the ability to make and keep money." I've never heard a better or more concise description of our country. My grandmother and I would spend time talking about all kinds of things. I once complained to her that I had trouble kissing girls. I must have been about seventeen at the time. She said, "How do you go about it?" I told her. She said, "That's the wrong way. You don't go for the body. You go for the head. You make the girl like you. Tell her the nice things you think about her. The rest will be easy." She was <u>so</u> right.

TRAYNHAM: You experimented and found out! [laughter]

RUBIN: Well, yes, but it took a long time. My grandmother also had a great library. She had beautiful books of [William] Shakespeare. She had read them all. She was a great lady. My mother lived to be about a hundred and one, just a month short of that age. She lived alone until she was about ninety-six, and then she got forgetful. We put her into a senior living home, and then, ultimately, her memory went, and she didn't want to live anymore because she couldn't remember the beginning of a program on television by the time the end came. She decided she didn't want to live, so she just died. She had her own hair, teeth, and eyesight and didn't need a hearing aid.

TRAYNHAM: Please tell me something about your childhood, your early schooling, what your interests were.

RUBIN: I have a younger brother [Ephraim Rubin], ten years younger than me, so in effect, I was an only child for ten years. I received an awful lot of attention from my parents, particularly from my mother who was born in Chicago, was a schoolteacher here, and got one of the first female driver's licenses in New York. There is a funny story there. My father, in those days, had a car, and we lived on President Street and Albany Avenue. At the bottom of Albany Avenue, a long slope, was farmland. She and her friend, Veronica, who was my babysitter, got into the car and drove down Albany Avenue, but they didn't know how to stop the car, so they ended up in a muddy ditch on the farmland. A policeman, with a rope on a horse, had to pull them out. He pulled them back up to our apartment house. I think that was the last time she ever drove a car, but she maintained her license until she was about ninety.

TRAYNHAM: Tell me about your wife [Laura V. Rubin] and children.

RUBIN: I was teaching the graduating class of Sunday School at my congregation, Brooklyn Jewish Center. My class was all boys about thirteen years old. After their Bar Mitzvah, the boys usually stopped their Jewish education. After consultation with the Rabbis, we decided to run a "fellowship" with the curricula based on Jewish Ethics. For example, "Is being stubborn sinful?" It was extremely successful. Once a month the Sisterhood made them a breakfast of orange juice, dry cereal, bagels, lox, and milk. One of my students, Arthur Viders, told his family about it. He reported to me that his sister had said that such a fancy breakfast should have a menu. He had a picture of his sister with him and she looked beautiful. To make a long story short, I took her out several days before her eighteenth birthday. She was even more beautiful than her picture.

On that first date I fell in love with her and knew I wanted to marry her. That happened in 1948. We have very similar backgrounds and interests. She loves to travel and happily, after a while, I had both the time and money to travel. Except for sub-Sahara Africa, we have been almost everywhere, including the Antarctic and have taken the Trans-Siberia railroad across Asia ending up in Moscow. We have been married for fifty-four years. She was an English major and has a master's degree in library science, has a New York high school library teaching license and works as a substitute librarian because she does not want to work full time. A while back she had started a business called Have a Happy Day—we live in an area with lots of rich widows without cars—my wife would rent a bus, take the neighborhood widows to a shopping mall, and then to a luncheon theater. On the way home she served sherry and crackers. She did this for ten years. Even though she never filed a claim, her insurance was raised to such prohibitive rates that she closed the business down.

We have two children. Our oldest, Jesse has an MEE [master of electrical engineering] from Cornell [University], an MBA [master of business administration] from the University of Connecticut, and a law degree. He is practicing law, as is his wife, Audrey [Rubin]. They have two children, the oldest, Janet, goes to the University of Pennsylvania and the youngest, Kenneth [Rubin], is entering Columbia University. Both had early enrollment. Our daughter, Julie [Reiter], is a full time mother and is married to Mark Reiter who is in the New York City Department of Corrections. They have a smart, beautiful and lively eight-year-old daughter, Ariel [Reiter], who is the apple of our eye. Since the age of four, Ariel has been working on my computer. We bought her a computer for her sixth birthday. I bought her a new program about three months ago, and I couldn't get out of it, so she said, "Why don't you hit exit," I did, and sure enough, that closed it.

TRAYNHAM: What about your brother?

RUBIN: My brother has a Ph.D. in theoretical physical chemistry, and he was a teacher in the graduate school at the Polytechnical Institute of New York at New York University. He decided that what he wanted to do was to solve difficult problems. His company is Optimal Analysis [Company, Inc.]. He looks for difficult problems, then he gets the best people he can like Kenneth Arrow, the Nobel laureate, to work on the project. He reviewed the oil program of the United States at the request of Congress. I'll tell you about some of the things that he does.

When we [the U.S.] evacuated Vietnam using our largest airplane, the C-5A, the door fell off while flying over the ocean, killing people. The Navy wanted to know whether it was a failure of the door or whether it was a failure of design. Therefore, they sent a Navy ship to try to dredge the door up. They had a vague idea where it was. The captain wired back asking for a specific location. You know, the Pacific Ocean is a big place.

They called my brother in and asked him if he could locate the door. He said, "No way are you going to find it." They replied, "Try. We've got to try a spot." They gave him as much information as they had, such as the winds, the tide, the air speed, the whole bit. My brother and his team put it into a game program and came out with a location. The ship dropped its grapple hook right onto the door the first time—a billion to one chance! Instead of getting all kinds of kudos from the government, the agency that gave him the contract said, "We knew you could do it all the time. Why did you give us such a hard time?"

He now has a line item in the federal budget to develop aids for science teachers who have no background in science. If you don't teach physics to grade school children, they'll be at a great disadvantage. You can't understand the world today without understanding physics. So they've developed a wonderful program for teaching physics by using readily available materials, and with all kinds of teacher back-ups. First they teach the teacher, literally. The teachers attend courses. It's been very successful. They're now looking to see how to best market it.

TRAYNHAM: What were your schooling experiences? Did you attend public schools in Brooklyn?

RUBIN: Yes, I went to Public School 161. It was very good in one sense, because in those days, teaching was excellent. I was considered a very smart student and skipped grades three or four times. I really wasn't mature enough to get the most out of the schooling, though. I would have been better off if there had been an enriched studies program. When I was in the graduating class, they gave a test for Townsend Harris [High School], which was the preparatory school for City College of New York [CCNY]. Townsend Harris did four years high school in three. The test was given on a Friday morning, and if you took the test, you didn't have to come back to school Friday afternoon. Because I could get a half a day off, I decided to take the test even though I liked school.

I was admitted, and, without sounding boastful, only the top hundredth or even thousandth percentile of the boys in the city of New York were allowed admittance. Three Nobel laureates have graduated from Townsend Harris. That's quite a record. I graduated in three years, in 1934, and then went to City College for four years, and graduated in 1938 with a B.S. in chemistry. It was a remarkable education, because at that time City College had more Nobel Prize winners per thousand students than any other college in the world. It had an incredibly good faculty. Their idea was that they're not going to teach you much in your vocation. You would learn that when you got out. They taught you how to be a cultured human being who would know how to solve problems.

For example, every science student had to take art courses. Every art student had to take science courses. We all had courses in public speaking and so on and so forth. When you graduated you had to read, write, and speak a foreign language. They always screwed you up, unless you were really good in your language, so you had to take the test up to three times. By the time we were done, we had a good command of the language. My language was French. I don't know if this belongs in here, but there's a very funny story. The first time I went to Europe on business I went on Air France, and the stewardess (in those days they were registered nurses), a very nice young lady, saw me reading a French newspaper. She asked me questions in French and I answered in English. She asked me why, and I said I was too embarrassed. Well, she said, "If you speak French to me, I'll give you a big hug and a kiss when you get off." So I spoke French.

TRAYNHAM: Did she give you a kiss? [laughter]

RUBIN: Yes, she did! Then I asked her what she was doing for dinner that night. She said that her boyfriend was going to pick her up when she got off the plane.

There's another funny story attached to that trip. I went to my hotel, the Georges Cinq [Hotel], and I saw that the flusher wasn't working right. I took out my English to French dictionary, got the correct words, practiced it, and picked up the phone to talk to the operator. When I was done, she said, "Yes, sir. I'll send up a plumber right away!" I said, "Where are you from?" She said, "Brooklyn!" [laughter] She was studying at the Sorbonne [Université de Paris-Sorbonne] and worked as a telephone operator to help pay her way through college. That's how naïve I was in the very beginning.

But, I learned a lot. A very good friend, Stanley Bindman, also an injection molder, told me about mold-making in Portugal. The Portuguese have a great history of exploration and science. They were building injection molds. When I went to Portugal, I found that they were much more efficient and their molds were much better than those made in the United States, and cost about a third less. I began building all my molds there—I'd visit about once a month. I learned a lot about mold making, which American mold makers didn't know at the time. American mold makers would give one person the responsibility for the whole job and you were at that person's mercy.

The name of the Portuguese company was Emidio Maria de Silva, in Marinha Grande, which is about 60 miles north of Lisbon. They did all the mold design in their design facility. When that was approved, out came a series of drawings for the lathe hand, the milling hand, the grinder, et cetera. They could have a lot of people working on the mold, and not be at the mercy of one man as was the case in America. When all the parts were done, the master mold maker would have them put together, under his supervision. They had molding machines to test it. The designer would be present at the test so he could see how it worked. They did remarkable work. We made medical devices for Deknatel [Inc.], which was later bought out by Pfizer [Inc.], and then was bought out by the people who were running it for Pfizer because they didn't make the same profit margin as drugs, and it was bringing down Pfizer's bottom line. One of the first molds I built in Portugal for them ran about a million-and-a-half shots with just ordinary maintenance.

Every mold I made there was a real gem. This is how it worked. I would send Emidio or his son, Rogario, who was an engineer, a part to quote, and then we would add our cost and profit and quote our customer. If we got the job, in about a week and a half I'd get a whole set of preliminary drawings. He would give it to one of TAP's [Air Portugal] stewardesses. I would meet the plane at the airport and she would give them to me. Then if there were any changes, I'd call them. We had a big piece of plastic, which was lined and numbered, A, B, C, D, 1, 2, 3, 4, et cetera. So if I wanted to locate a dimension or part I'd say, "Look at A5" and so on. Then I would okay the mold drawing and assume the responsibility for the design. If I was wrong, I would pay for the changes. This lowered my mold costs. To minimize mistakes, my people and I made a checklist of all the things we wanted to look for in a mold (Addenda I). When the mold was finished he would run it. If he had any suggestions to improve it, he would say so. Then either I or one of my friends who was also using him would check the mold while it was running. If the mold was all right, they'd ship it here airfreight. We were a good customer to PanAm [Pan American World Airways, Inc.], who was our carrier at that time, and to TAP when PanAm went out of business. And again, there's a rather funny story.

I had molds built in Spain, in Barcelona as well, and I was coming back via Lisbon on the Labor Day weekend, which is the busiest Trans-Atlantic flight time. I called the airport to confirm the flight and departure time that was usually 10:50 am. I thought I heard 10:50 am, but it was 10:15 am. When I got there the last bus to the plane had just left. I only had carry-on luggage with me and I recognized the plane out there. I asked the guard at the door if that was the plane going to Lisbon. He said, "Yes," so I started to run. He yelled, "You can't go." I said, "I'm gone!" He took his gun out, shot into the air, and I started to zigzag, not knowing he was shooting into the air. They hadn't pulled away the stairway to the plane yet. The whole plane tilted to the side because everybody was looking out the window to see what was happening. I got there and was exhausted. I knew most of the crewmembers by name because I flew in the winter when traffic was light. They were hysterical. They gave me a seat in first class; they fanned me! [laughter] I didn't really relax until we landed in Lisbon.

TRAYNHAM: Well, that's a very interesting story. Let's go back a bit to your college days. Was it at the City College of New York that you got interested in science?

RUBIN: I have always been interested in science.

TRAYNHAM: You started in high school?

RUBIN: No, I started before that in public school with a chemical set. I was interested in anything using my hands. My favorite toy that I got when I was about six years old was an Erector set. It consisted of metal bars, platforms, axles, wheels, gears, and the like, all put together with small nuts and screws. You could make almost anything with it. It was great because it let you do so many things. I was interested in photography and philately. I was very good as a carpenter. My father was an excellent carpenter. He would make boats for the bathtub when I was a little. I'd come out of the tub with my hands wrinkled because I'd stay in so long.

But I'll tell you how I got involved in plastic. I expected to be a chemist. I realized that I needed more information than a college degree could supply, so I went for my master's degree partly in the daytime, partly at night.

TRAYNHAM: Were you employed during that time?

RUBIN: No. I couldn't get a job. A kind thirty year old man at an employment agency said that as a Jew I would never be hired as a chemist, because in those days they just didn't hire Jews. He said, "Take any job."

My uncle Sol [M. Robinson], my mother's brother, was the largest importer of lampshades and lamp parts in the United States, and in Vienna when the Nazis marched in for the *ausschluss*. He knew there was going to be a world war. He went to Watson-Stillman [Company], who was the second largest injection molding machinery manufacturer in the United States at the time. Reed Prentice [Corp.] was largest. They gave him a turnkey operation where they would provide him with the mold, the material, Bakelite [Corporation] polystyrene, and the molding machine. All he had to do was press a button and parts would start to come out. He made lamp prisms, which hung on lamps and chandeliers, made out of Czechoslovakian glass (figure 1).

He had handmade samples made in Lucite. They looked as good as the glass. The War [World War II] started, and nobody could import glass prisms. The turnkey operation wasn't ready and he had orders for millions of parts. It's just incredible how many parts were used. The molds had twenty cavities, which meant there were twenty prisms made at one time. They were ⅝ of an inch thick, and were being molded in polystyrene. Each prism had a bubble in it no matter what they did. They had twenty bubbles per shot.

I was told what happened after I started working for Mr. Robinson. He was getting desperate by this time. After a lot of negotiations, Bakelite sent down their chief expert. He would write on a piece of paper, "We did this: twenty bubbles. We did that: twenty bubbles." He never made one good prism. Then he came to the conclusion that if you had bubbles there was air, so if you could get a vacuum in the mold, you wouldn't have any air, hence no bubbles. They built a rubber boot, so when the mold closed, it would be airtight. They ran a 25-horsepower power line to the fourth floor, got a vacuum pump and an undersized second hand tank, and they were ready to try the mold. The operator asked, "How the heck am I going to get the parts out?" The engineer said, very properly, "First we solve one problem, and <u>then</u> we solve the next problem."

When the mold was built, there was no need to make the mold airtight, air entered through the knockout pins, so they couldn't hold the vacuum. They spent a week making new knockout pins. They put the mold in again, and found a leak between the nozzle and the sprue bushing. They took it out and corrected the problem. Then they decided to start it up the next morning, as it was too late that night. They started up the next morning, threw on the vacuum, and guess what happened. It sucked all the material out of the cylinder and solidified it. It must have hit the resonant frequency of the tank. The tank imploded, and broke a couple of windows. Firemen and police were there in no time. Mr. Robinson had it! He closed the plant and said, "That's enough."

Mr. Robinson went to Staten Island. He was a seven-handicap golfer. It was a public course. They paired him with two other men. The first hole was a par five. He was on in three and six-putted. The second was a par three. He was on in one, and he putted off the green. The other two men saw that something was obviously wrong and asked what the trouble was.

Without knowing their last names, he told them the story of what happened with his plastic parts. I'm here because they were two of the five injection molders in the New York area. One of them said, "You're using the wrong material. You have to use Crystallite," which was the name of the Rohm and Haas [Company] acrylic at that time. Today it's Plexiglas. He said, "I'll send you my foreman with a 200-pound drum and you'll be running by noon tomorrow," which is exactly what happened. He wanted to send them a gift, and they said, "No. Take us out to dinner." He did. They told him that he had to hire somebody who had a really good technical background because there's no place to learn molding except by doing it, and that they would be glad to train the new hire if Mr. Robinson wanted.

Mr. Robinson knew I was looking for a job, and asked me if I wanted it. I said, "How much?" He said, "Twelve dollars a week." That was the minimum wage, thirty cents an hour. I said, "Look, I've got almost two college degrees. I'm good with my hands. I'm honest, I'm hard working, et cetera." He said, "What do you know about lamp parts?" I said, "Nothing." He said, "What do you know about plastics?" I said, "I never heard the word." "Well, if you don't know the industry and you don't know the process, you're not even worth the minimum." Needless to say he was correct. But he gave it to me anyway. And that's how my great foresight got me into the plastics industry.

The first day, Mr. Robinson told me that we were in business to make money as long as it was ethical and honest. This was the first of the many lessons that I learned from him. Another lesson occurred after I trained a molding machine operator, who was getting the same salary I was—she soon left for a job at thirteen dollars per week. I spent too much of my time training operators. Just when they were becoming more efficient, they would leave. Mr. Robinson said to raise the operators' salary by 50 percent, from twelve dollars to eighteen dollars per week. This was much more than they could ever get elsewhere. He said, "Remember they don't love you, they love the money." The improvement in attitude and productivity was enormous.

That week I opened my pay envelope expecting eighteen dollars, which I had already spent in my mind. I found only twelve dollars. I went storming into Mr. Robinson with steam coming out of my nose and ears and "explained" to him the superior quality of what I was doing compared to the operators. He waited patiently and asked if I would quit if I received only twelve dollars? I said "No!" "That is why," he said, "you are getting twelve dollars." [laughter] About eight weeks later I got the raise. I learned that lesson well and many years later when my secretary, Chris [Christine] Weekes, who was one of the smartest people I ever knew, asked me about my wage policy she said that because of that policy her loyalty to me was so great that she would even jump off the first step of the Empire State building for me if I asked her. As I came into the office less and less, she took over running the administrative part of the business.

To jump ahead, I was never really happy about molding the prisms in acrylic, as the material was so much more expensive. Later on whenever I had time I would put one of the prism molds in the machine and try to mold without the "bubbles." One night I spent three hours trying, and finally at midnight I threw the shot into the water tray in total disgust. The next morning the day operator called me first thing wanting to know what I had done. Every piece was perfect. To make a long story short, I realized that the water in the tray only half covered the shot. The bottom part froze, the top part sunk in. Because of the multifaceted surface, one could not see it unless one examined it very closely. It was a commercially acceptable part.

After a while I realized that the "bubbles" were really a vacuum because when the outside was frozen in place by the cold water, the shrinkage had no place to go except from the inside out creating a vacuum. I put a "bubbled" prism under water colored by raspberry jam and hand drilled a hole into the "bubble" while holding the piece under water. The vacuum sucked the colored water into the void. Everything grew from there.

Going back, Mr. Robinson wanted to buy the two golfers a present, but they suggested a dinner instead. It was so successful that they decided to meet for dinner the first Thursday of every month, and Mr. Robinson took me along. When I was sitting next to somebody and we were talking about things that happened, I might say, "My machine didn't close, and I just fixed this valve and it worked." They wanted to know, "Why?" I knew nothing about hydraulics even though I was running a hydraulic machine, so I went to the library and learned about hydraulics. It's not a very complicated thing. That's the way we were trained at City College. To answer the question I drew the hydraulic circuit for them and explained how it worked. Every month I had something to say. Finally, one month I said to my uncle, "Uncle Sol, you're lucky. Nothing went wrong this month." He said, "Make up something!" [laughter] The group later incorporated as the Plastic Molders Guild, Inc. and, I believe, became the first injection molders group anywhere.

TRAYNHAM: Could you describe the injection molding process?

RUBIN: One needs to have some understanding of the injection molding process to understand its history. I will describe the machine, the mold, and the process very briefly. There are many books at all levels for those who want to go further into the subject.

The IM [injection molding] machine has two functions (figure 2). The first is to open and then close the mold with enough force to keep the mold from opening because of injection pressure. Opening causes flash (material going where it shouldn't). The second is to melt (plasticize) the plastic material. They are called the clamping end and the injection end.

Almost all of the existing machines use hydraulics for operating both ends. In the year 2000, electrical machines and hybrids have become a significant part of new IM machine sales. I shall describe hydraulically operated equipment. In essence the operation is the same whether the power is by oil or electricity.

There are two types of clamping mechanisms. One is fully hydraulic (figure 3). The other uses a smaller hydraulic cylinder and multiplies its clamping force by means of toggles.

This is called a toggle machine. There are two platens on which the molds are attached. The stationary one is on the injection side and the movable one on the clamping side. When material is injected into the mold, a force is required to keep it closed. Clamping ends are rated by the maximum tons of force they can generate. The force in a fully hydraulic machine is calculated by multiplying the area of the back of the clamping ram by the oil pressure. The force is transmitted to the mold by stretching the tiebars (Hooke's Law). Approximately 2.5 tons for 1 square inch of projected plastic area is required for molding. Thus, if a 10 inch square plaque was being molded it would require a 250-ton press (10-inches-by-10-inches-by-2.5-tons).

There are three types of injection ends: plunger, reciprocating screw (figure 4), and two stage preplasticizing. They are all fed from the hopper. Injection ends are rated by how many ounces of polystyrene can be molded per shot. Most plants use automatic plastic material feed systems. The hopper contains a magnet to remove ferrous materials. In a plunger machine the barrel is a hollow tube with a nozzle on one end and a reciprocating plunger on the other end. In order to keep the thickness of the unmelted material to a minimum, an insert called a torpedo (because it looks like one) is placed in the center of the barrel. Heating bands on the outside of the barrel melt the material. As with all injection ends, heat is controlled by thermocouples and pyrometers. The characteristics of plunger machines are poor mixing and material temperature homogeneity. Plunger machines are still used when a mottling effect is needed.

The most common machine is the reciprocating screw. It uses a screw to melt the material. This gives a much better and more homogeneous material with great improvement in controlling the amount of material injected per shot. The screw rotation heats the material as in extrusion. The heating bands are used to compensate for the heat loss due to radiation.

Attached to the front end of the screw is a check valve (non-return valve) which allows material only to go towards the injection end. In operation while the preceding shot is cooling, its sprue bushing seals off the opening in the nozzle. As the screw turns, melted (plasticized) material goes through the non-return valve, forcing the screw rearward. When the preset amount of material is melted, it hits a switch and stops rotating. There is a valve that controls the pressure of the melt.

When the previous molded shot is removed, the hot plastic material that is under pressure will shoot out. Bill Willert developed and patented a system that made reciprocating screw machines possible. He called for pulling the screw back after it has plasticized the correct amount of material. This reduces the pressure in the barrel so that it does not shoot out. When the machine is ready for the next shot, either one or two hydraulic cylinders push the screw forward. This closes the non-return valve and the screw acts like a plunger forcing the plasticized material into the mold. Computers control its pressure and speed.

The preplasticizer has two cylinders. The first uses either a fixed or reciprocating screw. The fixed screw gives the best results because the plastic goes over the full flight of the screw. This cylinder feeds into the shooting cylinder that is a tube with the nozzle at the front end and a plunger at the rear that forces the melted material into the mold. A limit switch controls the amount of material in the shooting cylinder. For many reasons, this type of machine gives the best results.

The cycle starts by closing the mold, which has an air space the size of the part to be molded plus a shrinkage factor. The injection cylinder shoots the proper amount of plasticized material into the mold. The parts cool in the mold. While this is happening the screw turns melting the material. This sends the material through the open non-return valve and pushes the screw back further until it hits a limit switch and stops. The screw retracts to reduce the pressure on the material. The molded part is removed and the cycle is repeated. The best parts and fastest cycles happen when the machine runs automatically without the operator opening the safety gate to remove the parts.

The first attempt to mold thermoplastics used a rubber extrusion machine. This was a cylinder with a nozzle on one end and a reciprocating plunger at the other. This did not work because the plastic was so thick that the center did not melt. When a torpedo was added, it became the plunger-type molding machine. The second advance was when a Texan, whose name I believe was Nalle, invented the preplasticizer. Then came the reciprocating screw made possible by Willert's invention. The next change was using the computer to control the machine. Now we are seeing the introduction of the electric machine.

The injection mold serves two functions (figure 5). It establishes the shape of the plastic part and acts as a heat exchanger, removing heat, which solidifies the plastic. Almost all molds are made of various grades of steel. For short runs and special applications, aircraft aluminum or brass can be used. Originally mold makers had to manufacture the mold base. I. T. Quanstrom, owner of Detroit Mold Engineering [DME] originated standard mold bases and parts. They were better and less expensive. Now DME and its competitors make almost all of the mold bases.

There is a standard sized hole in the middle of the stationary platen into which the seating or locating ring is placed. It is counter bored in the center of the top clamping plate. This puts the sprue bushing's hole in line with the opening in the machine nozzle. The sprue bushing has a hole through which the plastic enters the mold.

The next plate is called the "A" plate. The cavities are attached in a milled pocket. The "A" plate does not move. It is attached to the stationary platen. The next plate is the "B" plate into which the core is similarly attached. The "B" plate and all the plates behind it are attached to the movable platen. The parts are molded between the "A" and "B" plates. The parting line is where the cavity and core meet. They are located by four leader pins and bushings, one of which is offset so that the mold can only be put in the proper way. Behind the "B" plate is a support plate. Behind the support plate is a boxlike structure, the ejector housing in which milled slots for clamping the mold to the machine are. Inside the housing are the ejector and ejector retaining plates that hold the knockout mechanisms, usually knockout [KO] pins. When the parts are ready for ejection, the knockout plates are brought forward to break the friction between the molded material and the mold. The four push back or return pins return the knockout plate to their original position when the mold closes.

The cooling system is a series of holes through which water is circulated with controlled temperature and speed. The profit of the molder depends on how many parts can be made in one hour. The efficiency and design of the cooling system control this.

The material flows from the heating cylinder through the sprue. In a single cavity mold such as a pail, the sprue goes directly into the part. In the case of multiple cavities, the sprues go into the runner and gate system. The runners and sprues are reground and reused at the machine. Plastic is probably the easiest material to recycle. If it is put in dumps, future generations will mine it and reuse it. Many molds are built so that the sprue and runner systems remain hot and are not molded. These are called insulated or hot runner molds.

TRAYNHAM: How did Robinson Plastics [RP] start?

RUBIN: Robinson Plastics started in 1940 at 345 West 40th Street, on the fourth floor of a steel-concrete building with one 6-ounce, two-tiebar molding machine. As I remember it, the area was about 4,000 square feet. He needed room for another molding machine, so in 1946 the plant was moved to a 6,000 square feet floor at 10 Grand Street, which was a wooden structure building, where he added a 12-ounce, four-tiebar Watson-Stillman [Company] injection molding machine. It was right at the plaza of the entrance into the Holland Tunnel. They condemned that building because they wanted to enlarge the plaza.

We moved to Dyckman Street where he bought a 10,000 square feet garage with an attached gas station, because it was the only building on the block. He figured nobody would bother him, but of course they did bother him. New York City condemned the block in order to build a public housing project, because it was easier to get rid of one garage than get rid of many other buildings. We were unionized when we were on Dyckman Street, when an itinerant union went by, saw our plant and unionized us. They later amalgamated with the teamsters' union. If you remember, Senator McClellan investigated the teamsters' union. Our union won the award for the most Fifth Amendments refusals. They were asked what happened to their pension and welfare funds—they had told me that it went to Swiss bank accounts. By the time of the investigation they couldn't remember very much about it! They were primarily interested in their pension and welfare fund, though in our twenty-four-year relationship with them, none of our employees ever retired. They also provided the minimum Blue Cross/Shield coverage.

We then moved to the fifth floor of a steel concrete building at 132 Lafayette Street—22,000 square feet of floor space. As our custom molding expanded, we rapidly added four 425-ton plunger molding machines from Watson-Stillman and its purchaser the Farrell Company in Connecticut. One was converted to a 60-ounce plunger type preplasticizer. They were all later converted to 2½ reciprocating screw machines when the technology became available. We also added a 250-ton reciprocating screw machine from Lester Engineering and a 75-ton machine from Guy P. Harvey for moldings small nylon parts. We had a fully equipped machine shop that could have been used to build molds. However we found out that the pressure for emergency deliveries made it impractical. The machine shop was used for repairs, building fixtures, automatic assembly devices, and experimental work.

After the Robinsons left the company in 1962, I owned half of the company. My partners were not interested in the day to day operation of the business. They evaluated the financial statements and were consulted if there was a major change in the business. I realized that I needed help. I hired a very close friend, Jerry Simonson, who had all the qualifications one could ask for. He was a good mechanic, a superb salesman, and very good with people. His wisdom was constructive and helpful and he stayed with me until he moved to Connecticut for personal reasons where he started a successful business fabricating large acrylic items, such as tables.

I also needed help in developing new business. I saw an advertisement in the *Sunday New York Times* stating, "Marketing manager for South American, American Home Products, has one week to spare. For a hundred dollars, you'll get one thousand in return. Call Monday morning." I called Sunday night and he was in my office Monday morning. He returned on Friday with about twenty leads, with the best ones first. At the top of the list was Gulton Industries in Metuchen, New Jersey. Dr. Gulton owned the NiCad [Nickel cadmium] battery patent and made all the batteries for airplanes and, later, the space program.

That Friday I called Gulton's director of purchasing and he gave me an appointment for 9:30 am Monday morning. It was a long trip since the Verrazano Bridge had not yet been built; I had to go via the Holland Tunnel and the New Jersey Turnpike. I arrived on time and waited and waited. The waiting room was filled with men with appointments with the same purchasing agent. At 11:50 am, he walked in and said, "Can't make it today. Come back at another time." I was incensed; I got up, and said, "You're a miserable bastard. Everyone here makes their living with their time and you have the guts to come out and say a thing like that!" He said, "You must be a boss." He apologized to us all and asked me into his office, explaining that Dr. Gulton called a special meeting unexpectedly. I suggested that next time it would be helpful if he had people notified as they came in. He made an appointment for the next day for me to see Bernie Herman, second in command to Dr. Gulton.

Bernie and I became good friends. We both were graduates of CCNY and spoke the same language. I did not know at that time that Dr. Gulton wanted his company's name to become better known so that his stock price would rise and enable him to sell his company at a higher price. To do this he went into the consumer market with flashlights and cigar and cigarette lighters that had rechargeable NiCad batteries.

I received the order for the first flashlight the "Imperial," in 1963. We provided the whole flashlight including the vacuum metalized reflector with a metal bulb holder staked in, installed the bulb, a clear stamped cover, the case, and the button. All they had to do was insert the battery. Our ability to deliver the assembled unit was a capability that they were looking for. We made many different models for them. We made more parts for them than for any other customer.

By coincidence, Dr. Gulton and Pincus Rothberg (owner of Montrose Chemical) jointly held the NiCad battery patent. Mr. Rothberg told me that selling his half to Dr. Gulton was one of his "great business decisions." Because I was a major supplier, Bernie introduced me to Dr. Gulton with whom I had many pleasant meetings. This stood me in good stead when the following happened.

Their very capable engineer in charge of plastics was Tom Dowling. One of their last projects was to manufacture a cigar lighter. I received the order for the case. I made a very bad mistake in the mold design that I did not realize until the mold was almost done. Samples had to be available for the July trades show in Chicago. To correct the error the mold would have to be rebuilt which could not have been done in time. My mold maker disagreed with me and thought the mold would work. I had no choice because of the time frame and told him to finish it. We put the mold in and ran enough shots for the samples when, as I had feared, a part stuck in the mold. This happened because steel in the mold shifted generating very large frictional forces which the knockouts could not possibly overcome. I realized that this twenty thousand-dollar mold would never run in production.

I told this to Tom and the new purchasing agent. Unhappily, he was the same purchasing agent that was at Emerson Electric [Company] when Dan [Daniel] Lewis and I threw out a sample we made for him. I don't think he ever forgave us. I will tell you about that later. I could see his eyes light up with glee at my situation. A week or so later he said he found another molder whom he said was much better than me and he would like to remove the mold. He asked me to come to a meeting with him, Tom, and Dr. Gulton. There he told me that the new molder needed three thousand dollars to fix the mold. I asked if I paid the money would I be relieved of all responsibility. The answer was a resounding "Yes." I took a check from my pocket and gave it to him on the spot. I expected some well-deserved criticism from Dr. Gulton. To my amazement he patted me on the back as he walked out, claiming that I was the type supplier he liked, one who backed up his mistakes! The mold never worked but that was no problem. A battery design error required the cigar smoker to recharge the battery each time he lit one cigar! They withdrew the item.

I would visit them often and go into their storage area with Tom to check on requirements. One day, I asked their stock clerk, Bruce Buchner, for their inventory of a particular item. From memory he gave us the inventory, date we started shipping, how many parts we made, and the status of the existing order. I said to him that if he ever leaves Gulton, please come to me. He soon was promoted and took charge of inventory control. He was superb in the technical aspects of the job, but being young and naïve was not willing to handle the typical corporate "politics." He wanted to leave, so he spoke to Bernie Herman who suggested he contact me. Bruce joined me, learned very quickly, soon took charge of all our production, and when Jerry left became second in command. When I sold the plant to Four Star [Plastics] he decided to leave. He set up and ran a million-dollar state of the art injection molding plant for Keystone Camera. Later I put him in contact with Tico Plastic, which he now owns. I knew of no one who knew more about injection molding than Bruce.

At Gulton, I was given an opportunity to quote on their nylon battery cases (figure 6). The parts were rectangular in cross section, with depths that ranged from 5 to 14 inches. They had a cover with a flange about ⅝ inch deep. It was a very critical job in two respects. To save weight, of major importance in the space program, the walls were as thin as possible. This required very little core shift on a long unsupported core in the mold. We solved this by shooting the material directly into the wall area in many places, using an oversized injection unit. The material filled evenly before the injection pressure built up which could have caused the core to shift.

The second requirement was a line-to-line fit between the cover and the case. They were using solvent cement to seal the cover to the base. If any of the solvent dripped on to the NiCad plates inside the battery it would poison them. Since these plates ranged from hundreds to thousands of dollars, the fit was crucial. We knew we could not mold nylon to such tolerances using separate molds for the case and cover. The differences in material and in cooling rates would make it impossible. We decided to mold the case and cover on the same mold, adjust the fit correctly and assemble the base and cover at the machine while still hot. This made the fit correct on every set because the material was the same and the parts shrank equally. After cooling you could not pull them apart by hand. The molding problem was that the case might weigh fifteen times as much as the cover which could make balanced filling of the two parts extremely difficult. We were prepared to mold blank slugs in addition to the cover to balance the fill. With some ingenious gate and runner design it was not needed.

Gulton used a hydraulic lift to separate the case and cover. They attached the battery to the cover using an automatic solvent application system. They sealed the battery on the same lift. They never had even one rejected battery because of our fit. I always had the policy of backing up the people we dealt with by taking the blame even if it wasn't our fault, unless there were major costs involved. Because of this we had their good will. Through Tom we found out later that our competition tried to separately match molded cases and covers by trial and error. Their relatively poor fit compared to ours led to very significant NiCad plate losses. They tried several suppliers with the same results. In those days very few molders really understood the process.

We got all of their nylon battery work because our battery cases never made them lose an expensive plate, so our nylon price was unimportant. Knowing we had a "monopoly," we gradually raised our prices. Ultimately, Dr. Gulton called me into his office and said "Enough." I said, "All right." It was a warm and friendly relationship. His office was adjacent to the main office and he would use their bathroom facilities. Once I offered to build him a private bathroom as a Chanukah present. He said, "No," because when he sat behind closed doors therein, he learned an awful lot about his business that no one cared to tell him.

We also received huge orders for nylon sealing gaskets for their line of small rechargeable batteries. These were up to 1 inch in diameter. We were not equipped to mold pieces that small. I went to William Plisco, owner of Peewee Molding and a very close friend, who specialized in this type of molding. He built his own molds with a watchmaker's precision. They never malfunctioned. He would run them at very high speeds, sometimes exceeding six-hundred shots per hour. Unless you knew him or some one like him you would not be competitive in your quotes. In the course of thirty plus years, he must have molded about one-third of a billion parts for us without one reject!

Dr. Gulton was successful with his publicity campaign and sold his business to the French company, SAFT [The Battery Company], the largest battery manufacturer in Europe. They moved the operation from Metuchen, New Jersey, to Valdosta, Georgia, in 1976. It was an extremely difficult transition because they had to train all new people and overcome the cultural differences between the French management and American workers.

It took three days to visit Valdosta and return, because of airline schedules. After a while I realized that we could not service them adequately from up north. I selected a molder near them and showed them what we did, and gave up the account. As far as I know it worked out very well.

I was very fortunate in finding excellent assistants like Marty Solomon, who stayed with me until he retired, and Richard Freundlich, who went to Campbell Soup [Company], left them and with an associate started a new company, which they sold at great profit. My son, Jesse was a great asset. In addition, Phil Levy, who took care of production in the latter years of the corporation and has continued in that field, was always of great aid. Moreover, my brother, Dr. Ephraim Rubin, who owns Optimal Analysis, has been a constant advisor.

From the beginning whenever we lacked capacity or the job was better suited for another molder, we would subcontract the work. This was economically feasible because our molds usually ran substantially faster than our competitors and we sold based on service rather than price. In the long run we found this more profitable than adding new equipment. We always had enough machines running on the outside so that if business slowed, we could recall enough jobs to keep us running at full capacity. We never laid off any workers. For this reason we stopped at ten machines.

When RLR Industries, Inc. [formerly, Robinson Lewis Rubin Industries, Inc.] started in 1958, I will tell you more about them later, we rented them some of our space until they got started. Relatively quickly they needed more space and they rented the 22,000 square foot floor beneath us. A year or so later they needed much more space and moved to Stanley Street in Brooklyn.

The owner of our building Saul Tepper died— his widow renamed the building after him—so his widow would come with her accountant every month to collect the rent. I would provide lunch. After many years she looked at me fondly saying that I was the kind of son she wished she had. One day in 1969 her accountant called and asked me to sit down. He said that Mrs. Tepper believed that her dead husband's soul now occupied the building. Therefore, every time our machines closed the vibrations caused her husband's soul to shake, and every drop of leaking oil dirtied his soul. He said she would pay us anything to leave before the end of our lease. I answered that we would move out as soon as we could without any bonus.

Living in Brooklyn, I wanted to move the plant closer to home and wrote to Mayor [John] Lindsay asking for help in relocating in Brooklyn. About seven months later we received a phone call as we were moving to Jersey City asking what our letter meant. We were having all kinds of trouble where we were because the Mayor was not interested in small business. We could not ship or receive on Fridays because of traffic going to the Holland Tunnel. Fluctuating electrical voltage caused severe production problems. My people suggested that we move to New Jersey where costs were lower, the services better, and it was within commuting distance for our employees.

I went to the Jersey City Chamber of Commerce, and, within two weeks, we found a place. They helped arrange a loan to finance the move. In December of 1969 we moved to 965 Garfield Avenue in Jersey City. This was a concrete building that had formerly been a laundry. The Oaken Palin Company, who owned it, had other industrial property in New Jersey including one that was rented to an injection molding company. Mickey Palin knew our needs and we had an excellent relationship.

We took a five-year lease with two five-year options to renew. We first leased 30,000 square feet and later expanded to 50,000 square feet. The second week we were there, the director of transportation of Jersey City came to my office to ask if we wished to alter the bus schedule to better coincide with our night shift. Imagine that happening in New York City!

In 1972 our union contract expired. The union's demands on salary were quickly resolved. The sticking point was their demand to raise our weekly contribution to their pension and welfare fund from eleven to twenty-one dollars per week. Years later RLR, which had the same union, paid over fifty dollars per week per employee. They were adamant. The parent teamsters' union was primarily in the pharmaceutical industry. They acknowledged that unions that had only plastic companies had much lower contributions, but claimed they could not make any exceptions.

My people believed that this amount would eventually escalate (which it did) and make us noncompetitive. Inasmuch as we gave out lots of molding, with our customers' knowledge, I decided to sell the molding plant and machine shop and give out all our molding. I placed an advertisement in the *New York Times* and *Wall Street Journal*. The next day Four Star Plastics answered it. Within a week the business was sold to them with the stipulation that they bring in their own union. They needed a turnkey operation and our facilities fitted their needs perfectly. They took over our lease, kept the molding and machine shop area and sublet the remainder of the space to us.

We, regretfully, closed the molding operation—we had many loyal employees, some of whom had been with us since 1940. Our union employees were very well trained and had no difficulty finding new jobs. The next day, Four Star was operating the plant and running our molds. In about a week we placed our molds elsewhere. The union and its welfare plan sued us to continue those payments even though our contract had expired. Even though they had no case we settled for one thousand five hundred dollars to avoid the cost of a trial.

Some years prior to our move to Jersey City, two Manhattan injection molders, Saul Blitz, owner of Tico Plastic, Dan Whyte of Whyte Manufacturing Company, and I decided to form one large company. This had many technical and business advantages. We even dreamed that each of us could vacation for one-third of the year. Unfortunately, because of my odd ball landlady, I had to move before we were ready.

Later the two of them amalgamated, forming Techniplast Inc. and moved to Little Falls, New Jersey. After I sold our equipment, I worked out an agreement with them to do most of our custom molding. I did not want them to mold our lamp parts which we dispersed to a number of molders. This worked out very well. One of the most important molders was Molding Industries of America, located in the Bronx. George Darnell had large equipment and molded many of our medical devices sold by the Irvin I. Rubin Plastics Corporation. I formed this company to handle all of Robinson Plastics' medical products.

This system gave me time to better service our customers, do more and better engineering, and take time off for lecturing, consulting, meetings, and traveling. Our profits increased significantly. The only time my people ever called me was when my wife and I were in the Antarctic. My people had a question about a multi-million dollar order they had just received. I agreed with their analysis.

Our lease was to expire in 1984. The only reason to extend it was the lamp parts business. I had already sold my injection molding plant in 1972. I had separated the lamp parts business as Robinson Lamp Parts. I always characterized it as the kind of a business that a very wealthy man would buy for a less than smart son-in-law. It was solid, the biggest in the country, and had an enviable reputation in the industry. I sold that business to Nick Ferrari and his associates, who wanted it for business reasons, for a seven figure amount. He was also my major American mold maker. He had molding machines. He later sold the lamp part business and to my knowledge the molds are still used. I couldn't sell the molding business because its value was basically my knowledge and reputation. I finally closed it down in 2001.

I relocated the office to 527 Clinton Street in Hoboken, New Jersey. This turned out to be unnecessary. From then until I closed the Robinson Plastic Corporation operation in 2001, I worked from home exclusively. The Irvin I. Rubin Plastics Corporation was closed in August 1995.

Robinson Plastics became the largest suppliers of our particular type of lamp parts in America and probably worldwide. We were copied worldwide. When I started, I had no idea of the enormous number of lamp parts sold. We had two 20-cavity molds making our 135 plastic prisms. Running them on three shifts five days a week produced four hundred fifty thousand pieces a week. We were almost always back ordered. Our competition was glass prisms. When the relative cost of raw materials changed so that plastic was cheaper than glass, we had to put our customers on allocation. For some reason I could never get Mr. Robinson to build a third mold.

The first finials, (the part on the top of the lamp that screws down to hold the shade), had a ¼-by-27 internal plastic thread. When the finial was cold it was impossible to strip the threads by hand. The finial is used on top of a bulb. The heat was enough to soften the plastic thread and strip it. Heating a brass bushing with an internal ¼-by-27 thread on a hot plate and forcing it into the finial solved the problem. As the U.S. prepared for war, brass became difficult to get. Either Mr. Robinson or Mr. [Myron] Maibrunn came up with the idea of using a stamped threaded ¼-by-28 steel lock nut instead. These were $^{1}/_{10}$ the cost of the brass threaded insert and readily available (figure 7). We altered the molds so that the locknut could be assembled while cementing the two halves of the finials together. We made many different parts for lamps, such as shades (figures 8, 9, 10) and other parts (figures 11, 12).

The largest finial order for a single finial, our 205, was a million pieces from the Lawrin Company who had a Green Stamp contract. Myron Maibrunn, our sales manager, who was with Mr. Robinson when I started, obtained it. He had been selling material for lampshades; was very well known and liked; and was in charge of sales. He covered the New York, Philadelphia, Connecticut, and Chicago areas, with occasional coverage of the Midwest. We had stocking distributors in Philadelphia, Chicago, Los Angles, and Montreal. After he retired, Jerry Simonson took over sales. I would periodically visit our major customers with our sales reps. The only area I covered was Florida.

There were very active Lamp and Shade Associations in New York and Philadelphia. Because of their meetings and outings I had a chance to get to know most of the owners very well. The nature of the business gradually changed because lamp manufacturers went to the Far East to save money. The net result was that they developed low cost foreign competitors for their lamps. Our parts were copied, but because plastic molding is not labor intensive we did not suffer. The lamp industry had a slow but steady growth rate so that our American volume did not suffer. We had competitors, but we had so many more items that it did not pay for a purchasing department to try to save a few dollars per thousand pieces.

Our quality and service developed a customer loyalty. Other ways helped too. Wherever I went I would ask my customers if there were any new lamp manufacturers near by. When in Florida I was told that the Cuban exiles (the first wave that left Cuba was primarily business men and professionals) were making lamps.

The first Cuban exile I visited was using my parts. He was in a small garage. In the morning he sold the lamps that he made the previous afternoon and evening. His hands were blue from the paint he had been spraying. I asked him where he got my parts. He said from a local lamp part store. I asked why he did not buy from us. His answer was he had no credit. I told him that he did. Anybody who came to our country like he did was certainly credit worthy. I gave him a two hundred-dollar line of credit (more than he needed for the size of his lamp operation) and told him that I would do the same for any of his friends in the lamp business.

I asked him to wait until I came back with a present for him. I had noticed a hardware store on the corner and went and bought him two cakes of Lava soap. He used it and his hands returned to flesh color. He said it was the first time that had happened in months. He was so excited about the soap that he kissed me on both cheeks and invited me home for dinner. I took a rain check, but we became good friends. He placed my parts with all his friends, most of whom became very large and successful. My competitors in the lamp part business could never understand why they could never sell them parts.

We developed two other items, an apple cutter, in 1947, that cored and cut the apple into six segments (figure 13), and a stocking and glove darner in 1949. Both items were in department and other types of stores and sold well. An interesting side light about the apple cutter. Mr. Robinson put "patent pending" on these items even though we had not applied for one. He somehow got a metal apple cutter from Japan that I converted into plastic. The *Sunday New York Times* always had an ad from Zoltan Polacheck who would get you a patent for ten dollars. I got Mr. Robinson's unenthusiastic approval to go ahead. We got about five claims approved. All that was needed was the thirty-five dollar government fee. He did not think it was worth it. Since that was two weeks salary for me, I didn't go ahead—a decision that I still regret. When I was a lad, I had five ambitions: to sleep with a girl, get married, have children, write a book, and get a patent. I still have not gotten a patent though I have had a number of patentable ideas including magnetic coupling of motors and pumps.

TRAYNHAM: Did you develop any other proprietary items other than lamp parts?

RUBIN: Yes, one more. Gulton had an excellent Japanese designer for their consumer products. We were looking for another proprietary line. He designed a series of Party and Patio polypropylene dishware for us (figure 14). The dishware consisted of large plate that could be used as a plate or a holder for a plastic or paper plate, a cup, which fit on an extension at the end of the plate, and two serving dishes with covers. We received a lot of publicity in the boating industry, as these dishes would not sink. His packaging design was faulty in that he used "see through" panels on the box which were too expensive and did not tell the story. A printed box would have helped sales.

The main problem was distribution. Many stores would not list one item, as the paperwork was too expensive. The stores that handled it found that it sold well. However the next season they wanted something new. We recovered our investment and more, but were convinced that the retail market was not for us.

Mr. Robinson allowed me to consult. I lost the first three jobs that I quoted. I asked the purchasing agent on the last job why I was not selected, since the consultant they chose really didn't know that much. He replied that I was much better qualified than his choice. He said that in case the consultant failed, his boss would ask him why he didn't get the "best." By the "best" his boss meant the most expensive. On my next quote I quadrupled my price and got the job. I rapidly became the most expensive consultant in the injection molding field! If a potential customer thought the hourly price was high, which they rarely did, I would suggest that I could do it in less time.

Consulting was either solving a problem or most often working with lawyers by evaluating and preparing a case. It occasionally led to testifying—most of the time the cases were settled before trial. A typical case involved an estate evaluation dispute with the IRS

[Internal Revenue Service]. The sole owner of a custom injection molding company died. He had a large number of customer's molds in his possession. Often customers would pay for the mold and have the mold cost amortized by increasing the piece part price over a given number of parts. Technically, the molder owned the mold. The IRS took that position and assessed the estate an additional five hundred fifty-five thousand dollars in taxes. I maintained that this was the industry custom. To substantiate this, I asked about fifteen different molders, each in a different state, who were friends, to write me a letter substantiating my position. This did the trick and the IRS withdrew its claim.

The following case has been in the newspapers for quite some time. I received a call from the head of the legal department of a major plastic material supplier relating to a suit they were defending because of the use of their material for plastic pipe fittings. Their question to me was whether a molder should be responsible for testing his molded parts. My answer was, "Of course." We arranged a consultation.

The problem was that, in Texas, the material was attacked by chlorine in the water at home hot water temperatures. They knew about it and tested it with Texas water, which was recirculated repeatedly. Chemistry 101 tells you that the chlorine will boil out very quickly. In effect, they were recirculating non-chlorinated hot water, which did not affect the material.

Contractors had built a large number of houses in Texas with plumbing made out of this particular material in the walls. Now they were beginning to leak. The liability was enormous. To answer their question of liability, I showed them their brochure, which was about twenty years old, with pictures of the fittings and how to make this special material just for that application. They had never seen it and were visibly shocked. They asked me where I got it. I told them, "Any good consultant has files for just such a purpose. No molder having that brochure would or should ever question using that material for fittings." I do not know the influence of what I said, but a year later they settled the suit for an enormous sum.

Another example was a royalty case involving plastic lenses and holders used in cataract operations. I was representing the company being sued for patent violation. There was an earlier expired Spanish patent that, if valid, would win the case for our side. The Spanish patent claimed that its claim was valid if the material used was plastic, but was not sure if it could be done. If we could show that it could have been done at that time, we would win the case.

Knowing the date of the patent, I found a mold maker who had worked at the time of the patent, found machine tools that were available then and had him build a mold to reproduce the patented part using those machines. I then molded the part on a machine built before the patent with material that was available then and now. As you can imagine a part that holds the lens in one's eye is very small. The steel mold inserts that made the part weighed about a pound. I put the mold inserts, molded parts, affidavits about the age of the machine tools, and molding machine on the judge's bench. We won the case.

My experiences with lawyers have not left me with a very favorable impression of some of them. I believe that a significant number of them are more concerned with their fees than the welfare of their clients. In a recent consultation, two companies made plastic wine corks, one by injection molding and the other by extrusion. They both had patents and were cross suing each other. The obvious answer was to cross license each other and in effect keep out other competitors. This is what eventually happened but not after a lot of expenses that could have been avoided.

I also had the unusual experience of having a lawyer deliberately misquote from my book for his advantage, not realizing that I was the author. This was noted in the trial records.

When consulting on a production problem, I initially had misgivings about my ability. I soon realized that when they called me in to solve a problem it was usually because they did not understand the plastic process or material. Their failed attempts to solve their problem made my work quicker and easier. I will tell of some of my experiences omitting the names of the people involved.

A company that used plastics in ammunition was attempting to set up experiments to understand the properties of plastic at high speeds and high impacts. They instrumented their "test" molding machine to the maximum state of the art. No matter how well they controlled the molding conditions, they were unable to get consistent results. The reason was that plastic material is not consistent. No two pellets are exactly the same. In order to minimize the material caused inconsistencies, I suggested blowing 5,000 pounds of material from silo to silo ten times. After some hesitation (they thought I was crazy) they did it and solved their problem.

Many of my consulting jobs were the result of the limitations of computer design technology. If you understand molding that can be helpful. If not, disasters occur. A basic problem is that some of the programs try to balance the mold filling by restricting the flow of material in the runner system. Simply put, material has to fill so that each cavity will end its fill at the same time. If not, gates will prematurely freeze causing all kinds of problems. The best way to have proper fill is to have the runner system large enough to bring the material to the gate with a minimum loss of temperature and pressure. Then balance the flow rate by controlling the gate size.

A classic example was when a custom molding company could not fill out a mold with a set of several different containers to be molded in Delrin. The containers held electronic parts for airplanes. They were late and desperate. In my seminars I always offered free help to my students if it could be done over the phone or took very little of my time. One of my students worked for this company and with a great deal of resistance got approval to call me. When he described the containers and runner system, I told him to open the runners to ⅜ inch round—balance the flow and it would work fine.

His superior called me and told me that it differed from the computer requirement. I asked him if he followed the computer instructions. He said, "Yes." I suggested that if the instructions were followed and it did not work, perhaps the computer instructions were wrong. I said, "You are wasting time and money by asking me to come out just to watch you open runners." He said that in the event it did not work, he wanted me to be there to solve the problem. Surprisingly, the design had been done by the material supplier using a computer. When the runner was opened up the parts filled out perfectly on the first shot.

In 1967 tobacco companies were confronted with the government requiring warning labels on their cigarettes. Lowering tar and nicotine became an important objective. [R. J.] Reynolds Tobacco [Company] decided to incorporate a filter in their product. The filter holder was to be made in plastic.

I was consulted to help decide whether they should mold the part or contract it out to custom molders. The answer depended on cost which was difficult to calculate. Cigarette manufacturing is completely automatic. Tobacco, paper, foil, cardboard, et cetera enter the line and packed cartons ready for shipping are the end product. Any interruption of the line is extraordinarily expensive.

Setting up their own molding plant had major objections. While initially the state of the art, management rarely spends the money to keep it so. There is no competitive pressure to be efficient. If the molder's plant can't produce (fire, mechanical reasons, et cetera) there is a good chance that the cigarette line would go down. Because of the huge volume of cigarettes produced, storing enough filters for such emergencies is impractical and financially prohibitive.

My recommendation, which was followed, was to have several custom molders run the parts. All the molds should be identical. They should make several spare molds and keep a three-week inventory of plastic filters.

In testifying a lawyer will tell you that the jury will only believe what they understand. The more they understand the more credible your testimony will be. An example of this was in a jury trial where the question of density was basic. The opposing side called as its witness a dean of a Midwestern engineering college. He had charts and correctly and fully defined terms in all their mathematical beauty. Our attorney couldn't understand him. When I was used as a rebuttal witness the judge asked me to define density. I said that if you have a liquid and you drop something into it, if it sinks it is more dense than the liquid, if it floats it is less dense than the liquid, and if it stays where you put it, it is the same density as the liquid. The jury applauded. We won the case. I found that in similar experiences, where I had to assume their knowledge was minimal, this practice was very helpful in testifying.

TRAYNHAM: How did you start custom molding?

RUBIN: We were one of the five or six injection molders who molded acrylic which was manufactured by Rohm and Haas. Any questions or inquiries from potential users that came to Rohm and Haas would be given to us as well as to the other molders. One inquiry was from *Petit Musée*. They were art people who were making a beautiful plastic bookend, which consisted of a hand carved acrylic plastic representation of the great god Apollo (figure 15). They mounted it on an alabaster column that was hollowed and placed on an alabaster base.

The hollowed part had a battery and bulb. The reflections really made it a museum piece. Their problem was that it took a girl one week to hand-carve one piece. So he came to Robinson and asked if we could mold it. I was called out of the shop, and I said, "I really don't know, but if you can engrave the reverse image in two pieces of steel, I'll try it." They said, "All right." I replied, "There's a steel yard not too far away. Do you want me to get the steel now?" He said, "No. I came by subway. I'll come by car tomorrow."

So the next morning, I walked over to the steel yard and told them the size of the steel I wanted, 8-by-8-by-6-inches. Two pieces flat and square. I paid them. They said, "Do you want us to deliver it?" I said, "No. I'll carry it. I brought two pieces of rope." Dead silence. They went into the back, tied my rope, and brought the steel out on a flat bed. Of course I couldn't lift them. They became hysterical. They put it on a hand truck and delivered it.

Petit Musée picked them up. A number of weeks later they came back with the two pieces of steel engraved the way we had discussed. I never heard of a lathe or of any machine tool except a drill press. I used the drill press to build a mold around the part. When I was ready to try it, *Petit Musée* sent their chief mechanic to watch. We put it in. It worked well but had flash (undesired material) around the edges. He showed me how to correct it. He put blue artist's pigment in heavy oil on one side, closed and opened the machine. Wherever the steel touched, the blue pigment would transfer to the other side. Using a hand grinder, he grounded off those spots. When the blue completely transferred, he knew that the parts mated. We took a sample shot and that was the case. He took the mold back and put in four leader pins and bushings, which keeps the mold aligned. He took me on a walking tour of Center Street and showed me machine tools and described how they worked. As a reward for building the mold, Mr. Robinson bought an Atlas lathe, which I now have in my basement.

We molded the part at a minute cycle or at sixty shots per hour. Mr. Robinson figured it cost *Petit Musée* twelve dollars to make one. He charged them seven dollars each. All they had to do was to buff away the parting line, which is where the two halves meet. You couldn't tell the difference between the molded Apollo and the hand-carved one. Sixty pieces per hour times seven dollars each produced four hundred twenty dollars per hour, an astounding amount in 1940. Today the equivalent price would be twenty dollars per hour! The machine hourly rate at that time was seven dollars! Mr. Robinson got about sixty times that rate.

I was a very naïve young man, and West 40th Street, where we were, between Eighth and Ninth Avenue, was one of the Red Light districts in New York. I would walk to the subway at night because I started at three in the afternoon and left at midnight. All these beautiful girls would sit on the stoops of the brownstones, wave to me, talk to me, and got to know my name. Upstairs, when I was running the night shift, I would look out the window and these girls would be bringing their customers to the brownstones. I borrowed my mother's opera glasses, and everything I've ever heard about sex in my whole life, I saw over there. As you might imagine, I found it absolutely fascinating. I'd sometimes watch too long, and when I opened the machine, I couldn't get the part out. I had to chip it out with a hammer and a piece of brass. It was such a big job that I never got caught too often.

About two months after we're running, Mr. Plume, the plastic salesman for Rohm and Haas, came in and saw the hand-finished god Apollo on Mr. Robinson's desk. He said, "Boy, if you could get rid of the undercut, it would be a great part to mold." Mr. Robinson called me in. I had known Mr. Plume. He introduced me again. He said, "Mr. Plume said if you remove the undercut, we could mold it." So I said, "What do I do with the thousands of pieces we've already molded?" So Plume looked at me and Robinson got pretty mad. Mr. Plume and I went to the molding room where it was running. You see, it's a very thick piece, almost an inch thick, so that when I took the piece out it was soft and it cooled on the table. Because it was soft, when it was knocked out by the machine knock outs, the head bent and relieved the undercut. That gave a line in the back, which I thought was muscle. So if I let it cool too much it wouldn't flex because it was too hard. Then I had to chip it out. So the great god Apollo taught me about, number one: undercuts; and number two: sex! [laughter]

Our second custom molding job was molding acetate over a wooden form for a toilet seat. Nobody told me it couldn't be done, so I did it. He sold it to Sears Roebuck [and Company]. One day we get a letter from him, the customer, that Sears is complaining that the toilet seat is not resistant to lipstick. Mr. Robinson turned it over to me and since it was too expensive to call, I wrote a letter to the chief of the quality control division of Sears, a huge operation as I got to know later. I wrote, "With all due respect, our marketing people never put the possibility of women kissing toilet seats on their agenda." He wrote back, "If the marketing people had some ability, they would notice that above toilet seats are medicine cabinets, which have mirrors, and that women, using the mirrors for makeup, sometimes let the lipstick fall and hit the toilet seat. This can be transferred to the human body. I still can't convince my wife how that happened to me!" So I turned it over to Eastman. The only other material that would have been good was butyrate, but that had a bad odor. They got a hold of Sears, and settled it. The Sears QA head invited me to see him when I went to Chicago for the lamp show. Occasionally Mr. Robinson would take me and I would stop over to see him. He showed me the place—just a fantastic place—and we became pretty good friends.

Before I left Robinson to go to Montrose Chemical [Corporation], we got a request to make a plastic part for the Norden bombsight, which I was later told was one of the first injection molded plastic parts used in the war effort. The bombsight contained a mechanism on top of which a whisker was placed. To prevent it from slipping during flight, they poured tar-like compound to hold it in place. The compound was contained within an aluminum cylinder. If the tar was poured incorrectly and it moved the whisker, it was an expensive reject. We were asked to make a clear butyrate part, which withstood the chemical effect of the tar, so that they could see whether the whisker moved or not. I wanted to know what the plastic fit on because I knew from experience, that you've got to know what you're doing. They said, "It's restricted." The part was about 2 inches in diameter. I think it was 2 inches plus or minus 0.015. I made my part minus 0.015, and the metal part was plus 0.015. So of course, it didn't fit. We remade the plastic part. This was my first experience with the government and plastic. I'll tell you a few more instances later.

TRAYNHAM: Please, tell them now.

RUBIN: All right. Right after World War II, the government decided to train soldiers to replace the GIs who served overseas. When you shoot a mortar, if you have the right inclination but the wrong direction, it's not going to go where you want it to go. They would kill quite a few GIs or wound them, and it didn't bother them, until one day a general almost got blown out of his Jeep. Then they decided to have safe-training procedures. Anchor Machine Products got a government contract to develop safe training devices for the pistol, the rifle, and the mortar. They subcontracted the mortar project to us (figure 16). We had a certain limitation. They had left over a very precisely bored tube with a 1 inch ID that he wanted to use for the barrel. It had to be realistic which included shooting off a blank cartridge when it hit the ground, had to be reusable, and the training device had to be such that it would train the GIs to fire live mortars. We knew nothing about firing mortars so the owner, Walter Bronster, who was a Major in the reserves, took me down to the firing range. I learned how to shoot mortars. I got all the tables and so on.

We had many problems. The strongest material at the time, acrylonitrile-butadiene-styrene, ABS, was selected. We had to explode a 0.22 cartridge blank. We couldn't explode the blank in plastic, because eventually the plastic would go, so we had to mold a stainless steel insert into the plastic with a thread on it to hold the nose cone which contained the inertial device that exploded the blank cartridge upon impact. We made handmade samples and found the plastic was too light, so we added metal to the nose cone so that we could control its trajectory. The projectile had to be gated so that the strength was in the longitudinal direction instead of the desired hoop direction. This weakened the part because we were limited in the diameter to 1 inch. In testing we found enough stress to cause us to preheat the metal bushing to the molding material temperature. This annealed the piece enough to solve the problem. To propel the mortar we used air because it was safe and always available to the GIs. The difference in fit between the molded part and the barrel was critical. Because of the elasticity of the ABS we were not able to broach it. It had to be centerless ground.

The final problem was accuracy and repeatability. We found we could hit within a diameter of 10 feet 99 percent of the time 100 yards away. So we set the standard for the projectile to land within a 40 foot diameter. We were never out of specs. In actual practice they could put the projectiles into a jerry can about a foot in diameter most of the time.

At the acceptance trial, the contracting officer said, "Plastic is no good. It's not going to last. Make it out of aluminum." I was smart enough not to argue. So we made an aluminum piece. We made two aluminum pieces. One aluminum piece we banged out so that it would not fit back into the shaft. Then at the second trial we shot the good aluminum one. It worked beautifully. One of our employees ran out and brought it back. The second time our employee switched to the dented aluminum projectile. The Major couldn't get the missile into the tube because it had a big dent. We had a clearance of about half-a-thousandth. So our man (this was all set up) said, "Why don't you use plastic? Here, I have a bad one, which happened during our tests". The officer tried dropping it into the barrel but it wouldn't fit because it had a "bump" on it. Our man took out a bayonet and shaved it off—the plastic "bump"—and dropped it in. It worked perfectly. Well, the Major said, "All right, we'll use plastic."

TRAYNHAM: That seems a little underhanded, doesn't it?

RUBIN: Very underhanded! [laughter] But you know, I couldn't really educate the guy because to them, plastic was no good. Now, this goes back a long time to the late 1940s.

Once during the Korean War we received a request for a small nylon part with a $^5/_{16}$ hole in the center. The outside diameter had a plus or minus of 0.0001, a tolerance in nylon that was virtually impossible to do. What I thought of doing was molding a hundred parts to get a few good parts out of it and regrind the rejects. I priced it accordingly plus the cost of inspection. We got the job because no molder in his right mind would ever think of quoting such a job. Then I called up the contracting officer and asked him, how he was going to measure the diameter of the nylon. He replied, "With a ruler." I said, "Would you please send me a ruler like that, because in New York we don't have such rulers." He responded, "What are you talking about?" I said, "I can't measure a ten thousandth of an inch with a wooden ruler." He said, "You're crazy. The part fits into a piece of rubber." He looked at the print. He said, "It should have plus or minus 0.100," a very easy tolerance. I said, "All right, then I can measure it with a ruler." He started to laugh. He said, "By the way, how much are you getting for this?" I had quoted a dollar and a quarter apiece. I replied that I'm only the engineering department. He said, "Well, you get off your behind and find out fast." I called him back and I gave him the price. He said, "That's ridiculous." I said, "All right. Let me refigure it." So we figured it at about forty-five cents. The whole thing was not worth more than fifteen cents. He said, "All right, you're a gentleman." He ordered a lot of them and we made out extremely well on that job.

Here is another time we quoted on a government request that ended up being very funny. The government was looking for radar chaff to train radar operators. They took our 1822, a lamp part, and copied it perfectly. They were going to shoot it from a plane to teach the radar operators to distinguish an airplane from chaff. Plastic material was on allocation and this seemed to be an easy job for us to get. I went to Mr. Robinson and quoted a very low price because we had a high production mold. In those days they published the contract winners, supposedly to prevent collusion. Someone by the name of Wynsocki won the job at the price of 5 to 10 percent above the cost of material which would mean running the job at a huge loss. I said to Mr. Robinson, "That's impossible. The guy's crazy." He said, "He's not crazy. You're not smart enough." So, I said to myself, "What does he know," and walked away.

About seven or eight years later, I was chairing a session at the Society of Plastics Engineers in Washington. Sitting next to me was someone named Wynsocki. I asked him, "Are you the crazy guy that won the job for radar chaff during the Korean War?" He said, "How did you know?" I told him. I asked, "How the hell did you do it?" He said, "Did you read the specs?" "What do you mean specs?" He said, "The specs called for virgin material only, which was totally unnecessary. So I made a mold where the runner system was five times the weight of the part and I used the regrind to run my factory during the Korean War." So Robinson was right after all.

My last encounter with the government was during the Vietnam War. I received a call from a company that wanted me to mold a fresnel lens in acrylic. Acrylic has the best weathering properties of all plastics. The customer had tried several other molders who turned it down as too difficult for them. He then went to both manufacturers of acrylic, Rohm & Haas and DuPont [E. I. DuPont de Nemours and Company, Inc.], who both recommended me.

The fresnel lens was about 14 inches in diameter by 8 inches high with a varying wall thickness of up to 1.25 inches. I asked what the application was and he said it was for the Vietnam War effort and he could not tell me more. I told him I was against the war and was not interested. About an hour later I got a call from an under secretary of the Navy who said the lens was to keep the infrared red rays used on landing strips and aircraft carriers from going skyward. Hanoi had received infrared red sensors and could locate our aircraft and airfields unless the skyward rays were stopped. He said that if I did not make the part, I would be audited by the IRS, investigated by the FBI [Federal Bureau of Investigation], and put out of business!

I spoke to my family lawyer and accountant all of whom said that I would be helping save American lives. After a few days I cooled off and realized that I had no choice. I called DuPont and told them since they got me into this, they should supply me with material at no charge for the experimental work. This they did.

From my point of view it was a difficult and tricky job. For one thing, the part weighed double the capacity of my largest machine. Molding a lens with such large variations in thickness posed a real problem because of its thickness and variation in thickness.

Because of the time frame we could only build half the lens and would cement two parts together. The problem here was that the environment was so harsh that the glass lenses the Navy tried first did not last. Bruce Buchner, who was in charge of all manufacturing, and I decided that the only way to fill a part twice the capacity of the machine was to change the machine circuit so that the screw would keep on turning and plasticizing the material as long as we wished. When the mold was filled we continued running the screw until the injection barrel was full and then control the amount and time of injection packing pressure. To Dupont's and our knowledge, this was the first time "extrusion molding" was ever done.

It took seven minutes to fill and cool the part. The part dropped into a temperature controlled water bath under the mold for annealing. Cementing the two pieces in the conventional way left stress marks in the lens. While it did not affect its performance we were afraid of failure in the field. Bruce solved the problem by dipping the ends of the pieces in a dip used to protect metal parts from rusting. After covering the two ends of the lens with the dip, he stripped off the surfaces to be cemented, cemented the two halves together, and hot air annealed the cemented parts. The parts solved the Navy's problems.

TRAYNHAM: Please continue with your narrative.

RUBIN: When I was running the plant for Robinson, I was drafted and called for induction on a Monday morning. Thursday night, my parents had a small gathering for my friends. Saturday morning, I got a call from the draft board saying that the President had called in my papers and I did not need to report for induction on Monday. I thought it was one of my girlfriends playing games with me. So I was a little less than pleasant with this young lady. I said, "Who put you up to this?" She said, "Young man, if you're so stupid come to the draft board." In those days, draft boards were local. So I ran twenty blocks. In those days I was in good shape! I come in sweaty, and she said, "Here. I'll give you a letter saying your papers were called in and you don't have to report Monday morning." I didn't have the vaguest idea what happened.

Sunday evening I got a call from a friend, Ben Rothberg, with whom I'd gone through high school and college. I knew him well. I stayed at his house. We were very close friends. His father, Pincus Rothberg, had been a large manufacturer of tricresylphosphate, TCP, during World War I. TCP is a plasticizer for electrical wire and cable. Ben informed me that the federal government made a mistake in two decimal points in the amount of TCP they needed. So when Kaiser [Company, Inc.], who was building ships, planes, and tanks for the war effort, called up the President saying that he had ships and planes that could not be finished because they didn't have electrical wire, Mr. Rothberg was given a 5A priority to set up a plant in Newark, New Jersey. He had made TCP before. They were about to call in chemists from England to help run the plant. Ben told his father about Thursday night. His father thought it better and quicker to hire me than call in an unknown chemist from England. So I went to work for Montrose Chemical in Newark, New Jersey.

Ben called me Sunday night to tell me what happened. They picked me up at the Holland Tunnel Monday morning. They were talking about overhead, and I said, "I have a good way of getting rid of the overhead." Pincus asked me how. I said, "Remove the roof!" [laughter] In addition to TCP they tableted aspirin and made DDT [dichlorodiphenyltrichloroethane]. An interesting thing: they kept health records. Nobody who worked in the DDT plant ever got cancer. They told that to the [Unites States] Department of Health and never got an answer.

I stayed there until VJ [Victory over Japan] Day when I was released by the draft board. When I started at Montrose one of my professors, Dr. Joseph Greenspan, at the graduate school of Brooklyn College, and I became good friends. He offered me a job which would "guarantee" my draft deferment. I declined. After the atom bomb was used in Japan, I found out that he was in charge of the instrumentation work being done at Columbia University for the Manhattan Project. I couldn't go back to Robinson as he could not get any more machines and he didn't need me.

TRAYNHAM: What did you do then?

RUBIN: I put an ad in the *New York Times*, "Injection molder released from draft board with a lot of knowledge and no money." I went to the *New York Times* to pick up my answers. They had three bags of answers. I took a cab home. Everyone was the same. An accountant or a lawyer: "I have a client with a lot of money. Can we meet?" I suspected that this was all black market money. I felt that they were not the kind of people with whom I wanted to associate.

I saw an ad in the *Times* from Columbia Plastic Manufacturing Corporation, at 484 Greenwich Street in lower Manhattan, looking for somebody to run the plant. I answered it. The owner was Mr. Edward Griffel who had a deal with Grumman [Aircraft Corporation] and other aircraft manufacturers. He bought the scrap that they had left from forming canopies for aircraft and other uses, and was making umbrella handles, because the scrap was irregular and umbrella handles are small. He had a large number of orders, but he couldn't ship anything because his foreman didn't really know what to do.

When I looked at the plant I saw his problem. In polishing fabricated plastic, you use cotton cloth wheels turning on a shaft. They were using pumice, which is a coarse cutting compound, to rough polish the plastic, and then on another wheel, they used a different compound to get the final very high finish on the piece. They had both wheels adjacent to each other so that the pumice would fly over to the polishing wheel over riding the attempt to get the final polish. They would never get a good part. Since I saw the problem right away, I told Mr. Griffel that I would be glad to work for him. He said, "When you want to start?" I said, "In two weeks." He said, "It has to be a week." I said, "All right." I went to the library and learned how to fabricate plastic parts. I called him up on the second day and asked him to please order two more polishing machines. The deal I had was for fifty dollars a week, which was a very good salary, plus ½ percent of the dollars shipped. I ended up making two to three hundred dollars a week, which was an enormous amount back then.

At Columbia Plastic I did a lot of interesting things. I put the ashing (pumice) on one floor and the polishing on another floor. Within two days we were shipping umbrella handles. There is a limit to what one can do by just cutting and polishing the acrylic handles. The customers were clamoring for something new. Because of my chemical background, I knew how to select organic dyes that would work on acrylic. The umbrella handles were ⅝ inch thick. We used thinner material. Our carver would carve flowers and other shapes on a flat piece of acrylic that we would dye. We than laminated it by cementing a clear piece of acrylic on top. When finished one could not see any seams. It was a great hit in the umbrella industry that significantly increased Mr. Griffel's profit and my commission.

We expanded to acrylic brush blocks. I bought and refurbished an old large hand-milling machine with which we were able to make the curvature on the block in one pass. It became a large part of our business. We also fabricated desk items such as perpetual calendars from cast Catalin thermoset blocks mounted on a clear acrylic base. The final item was a formed dish. I became a glass blower in graduate school because I could not afford to buy condensers and other such items. This taught me how to handle soft material. I took a square sheet of acrylic, heated it, and forced it down into a die. The result was a fancy dish. The items never sold very well. It was a forerunner of thermoforming.

After a while, fabricated plastics went out of style and Mr. Robinson was able to get more machines and I went back to him and I stayed with him until he retired. Ultimately, I bought the business. Do you want to know the history of that?

TRAYNHAM: Yes, I do. Please continue.

RUBIN: I went with Robinson in 1940, then I went back to him in 1945. Between 1945 and 1957, I literally built up the business. He ran the office, Myron Maibrunn took care of lamp sales, and I ran the factory. I knew everything that went on. The business was built up primarily because of my activities and presentations at SPE [Society of Plastics Engineers].

All of our custom molding business came in by referral. Rialto Products, my first big customer, was a typical example. In 1952 I was working in my office at about 8:00 pm, when a gentleman walked in wearing a thread bare coat and beat up hat. He showed me an absolutely beautiful fabricated plastic ladies handbag. He asked me if I could injection mold it. I said, "Yes." He asked for my price. In those days it was relatively easy to figure mold costs. I weighed the part, figured the cycle, and quoted him a firm piece part price and a plus or minus 15 percent mold quote. He agreed and took out a check and gave me a ⅓ deposit for the mold. The plastic industry requires mold deposits for two reasons. The first is that they need a deposit to give to the mold maker. The second is that it prevents the customer from canceling the mold order if he changes his mind about the product or if the mold is late. The standard terms are ⅓ with the order, ⅓ when the first piece from the mold is shown (even if it is not perfect), and ⅓ upon approval of the part. Another method was ½ down and the balance upon piece part approval.

Some years later he told me that he got my name, among others, from the Rohm and Haas salesman who sold him acrylic sheets. The reason he gave me the job so quickly was that he felt that someone who was working late would be watching the store and give him the quality he needed. This gentleman, Abe Rothman, who owned Rialto Products, was among other things a fabricator of plastic products. His plant manager, Harry Senzer, was a superb craftsman and designer. Mr. Rothman turned out to be one of the great innovators in the use of injection molded products. He created and had molded the first plastic pocket book, the first plastic tissue box (figure 17), the first plastic waste paper basket (figure 18), the first plastic cup, the first plastic soap dish, the first plastic towel bar, and the make-up mirror with lights around it that is still very popular today. Today his plastic handbags are in museums and command very high prices. During the twelve years of our association, we literally molded millions of handbags, tissue boxes, and other items for him and became great personal friends.

However there was no loyalty as far as business was concerned. We were molding his tissue boxes and most of his other items in clear polystyrene and became, for a time, one of the largest users of Monsanto's [Chemical Company] clear styrene in New York City. Being a chemist, I knew that if there was any significant amount of monomer left in the clear styrene, it would eventually turn yellow. I sat down with Ed Larkin, Monsanto's very capable salesman, and gave him a firm order for the year with Mr. Rothman's consent even though he didn't know why I wanted it. Monsanto put aside for me the polystyrene with the least amount of residual monomer. Fifty years later, we still use his tissue boxes in our home and they are as clear as when they were first molded. Their clarity has lasted as long as acrylic, which is a very good standard.

At one time, we were molding an acrylic handbag cover about 6-inches-by-8-inches and $^{7}/_{16}$ inch thick. It duplicated his hand carved one and after they cleaned and polished the gate, it was impossible to tell it from the fabricated one. He once overheard a competitor selling a similar handbag who obviously didn't know it was molded, say that it cost him more to make the cover than Rothman was selling the whole handbag for. One morning, just as I came in, my plant manager, John Gannon, came to me looking very upset. At night they had put in the aforesaid cover mold and forgot to change the material from polystyrene to acrylic. I could not visually tell the difference. I showed it to Mr. Rothman, told him what happened and quoted a considerably lower price in polystyrene. He was very happy to use the styrene but neglected to change his publicity.

The relationship lasted for many years. While his orders declined considerably because of competition, he was still a valued customer. When the price of raw material changed I would automatically adjust his prices in either direction. One day the price of styrene went up and as usual, I told him the price of the tissue box we were molding would go from twenty-three to twenty-five cents after we used up the material we had bought at the old price. When we started using the new material we billed him accordingly. His check, which was always on time, came in, but at the old price. When asked why, he said I was making too much money. We charged him twenty-three cents for that particular design of the tissue box. He provided us with tissues that we put into the tissue box for him at the machine and all the packing material. We drop shipped to his customers.

All his costs less overhead, commissions, and advertising discounts came to forty-nine cents. He sold it for one dollar fifty cents and it retailed for two dollars ninety-eight cents. We were making and shipping twenty thousand tissue boxes a week and had not taken the mold out since it was built. To say the least, this shook me up. After a lot of thought, I relied on the old philosophy that the first loss is the best loss. If that was the way he was going to act it would be much better to drop him even though he was a significant part of my business. I told him that unless he paid the increase, which was for Monsanto not me, he could take his business elsewhere. He either didn't believe me or didn't care, so he continued his deductions. A few days later, our truck man backed up to his loading dock with all his molds. While this caused me some temporary difficulty, it got me back to looking for new customers. Even in the short run it turned out very well. We remained good friends for a long time after that. He had more problems with other molders, though he saved money. I would like to jump ahead a bit because it will make the story less complicated.

I was active in the New York Section of SPE. There I met Daniel Lewis with whom I am still very friendly. He is a warm, friendly, happy-go-lucky person. I can best describe him by saying that if he sold a baby to its mother, the next day the mother would ask Danny to sell her the baby again.

He was employed by a large company to vacuum and pressure form lighting panels out of acrylic and vinyl to cover fluorescent fixtures up to 4-feet-by-4-feet. This was one of the first vacuum and pressure forming manufacturing facilities in the area.

I drove Danny back from the New York section SPE meetings. The only time I ever saw him look unhappy was during one of these rides. He had been promised an interest in the forming business as soon as it was up and running. When he asked for it, they replied that he had misunderstood them. At that time Robinson Plastics was looking for another proprietary line. This business sounded perfect for us. I asked Danny if he would join the two Robinsons and me for lunch the next day.

In November of 1958, at lunch, we formed Robinson, Lewis, and Rubin, now RLR. The two Robinsons and I invested all the money. The four of us each received 25 percent of the business. RLR started by renting office space, a desk, and a chair from Robinson Plastics. As the business expanded, we increased the area until it was large enough to move into the 22,000 square foot space that became available beneath us.

There were no commercial machines at that time. Danny and I designed a vacuum forming press that I automated similar to injection molding machines. I believe the automated vacuum former was the first one built (figure 19). We also built pressure forming machines using our machine shop and outside vendors (figure 20). The equipment was ready in about six weeks.

The business was very successful. Daniel is an extremely capable designer in the lighting field and introduced many new items. RLR branched out into custom fabricating.

One such job was statues of the Michelin [Company] Tire Man (figure 21), which was about 3 feet tall. Two halves were cemented together and the part decorated. The statues were mounted on top of the windshields of Michelin trucks. What no one anticipated was that children would throw snowballs and rocks to see if they could hit the Michelin Man. Many succeeded, some breaking the windshield. The item was an engineering success but a commercial failure. Another proprietary line was a set of beautiful pressure and vacuum formed party ware (figure 22). There were previous injection molded ice buckets, but to my knowledge these were the first formed ones.

Another job was for Emerson Electric. They had a new tape recorder and needed a plastic container for a trade show starting in three days. It was a very complicated part with deep undercuts. It required pressure forming. We agreed to make the case but not drill the mounting holes. We were not sure where to put them and had no time to find out. Since they had a huge manufacturing facility, the purchasing agent agreed. We worked around the clock and produced a beautiful part.

Danny and I proudly showed it to the purchasing agent who said it had no holes. We reminded him of his agreement. He said that he would not accept it without the holes. Danny and I looked at each other, took the sample and walked out. Outside we both agreed that this was a customer with whom we could never be happy. A New York City garbage truck was passing by. We threw the sample into the truck. In spite of their frantic phone calls we never made another piece. Unhappily, this purchasing agent turned up towards the end of my relationship with an important customer.

RLR outgrew the space on Lafayette Street in Manhattan and moved to a much larger facility on Stanley Street in Brooklyn. The new site did not have a sprinkler system. Over one weekend a fire started and the place burnt down. The fire was extinguished before the machinery and molds were badly damaged. RLR relocated to Farmingdale on Long Island. They expanded there adding a 3.5 inch extruder for their sheet forming business and injection molding machines. Andrew and Stuart joined their father in the business.

Eventually it outgrew those facilities and the state of Georgia floated a multimillion-dollar bond issue to relocate them near Atlanta in a 100,000 square foot plant. His sons ran the operation while Danny worked from Long Island.

Mr. Robinson brought his son, Irwin, my first cousin, who was a Wharton School [at the University of Pennsylvania] graduate. Unfortunately, there was really no place for him. I was running the plant, which did not interest him. He wasn't technically proficient enough to sell plastics. Mr. Maibrunn wouldn't give up any of his lamp accounts because he was on commission, and his father would have nothing to do if he took over the office. Notwithstanding what I just said, we both decided we wanted to build up and expand the business. Mr. Robinson wasn't interested. He sold each of us 24 percent of the business and he kept 52 percent.

In 1962, Irwin was not happy being in the business, as he had nothing really important to do. Mr. Robinson decided to retire. Irwin and his wife bought a metal bathroom-fixture business for four thousand three hundred dollars, of which twenty five hundred was inventory. Twenty years later they sold it for two million dollars, at that time an enormous sum. He's a remarkable man.

At that time, through Danny's efforts, we worked out an arrangement with Lighting Parts, a company in California, which sold items that Danny made, and with Chatham Metal Spinning, located in Manhattan a few blocks from us, which sold metal parts to the lamp industry and had several plastic lamp parts which were identical with ours. They also were part owners of a vacuum metalizing plant with Sidney Packales whose production we needed very badly. I will talk about vacuum metalizing shortly.

The results of those transactions were that the Robinsons sold their interests in Robinson Plastics and RLR. I ended up owning 50 percent of RP, and Chatham and Lighting Parts owned

25 percent each. In RLR, Danny, Lighting Parts, Chatham, and I each owned 25 percent. This was done with no cost to Danny or me. The owners of Chatham were David and Arthur Horowitz and of Lighting Parts, Nat Kirschenbaum. He was a very wealthy man. He owned banks in California, and so on. He distributed our lamp parts in the West Coast. I would visit him several times a year.

Once when I was there with my wife and he and his wife were driving us in Los Angles she said to her husband, "Nat, dear, they left the lights on in your bank again!" He was preparing his estate plan, and his accountant wanted him to get rid of all his smaller investments, because they might cause problems when he died. So he told us that any time (we had an agreement how to get out) he would be glad to get out. In 1966, he did go out. The company bought his stock, so I then owned two-thirds of RP and Chatham had one-third. In 1972, Chatham went out of RP and I ended up owning the whole business. At that time I sold my interest in RLR. Danny ended owning 50 percent of RLR at no additional cost and a new partner whom he eventually bought out.

TRAYNHAM: I was told that you started the seminar programs in the plastic industry. How did that happen?

RUBIN: When the New York Section of the Society of Plastics Engineers met, naturally, all the members of the Plastic Molders Guild joined. I joined in 1951. And whom did they call on to talk? Me, because of the talks that I gave at the Plastic Molders Guild. This led to some very interesting results. Dr. Herman Kaufman—a very good friend; he lived in New Jersey and was the chief of plastic research for Allied Chemical [Corporation]—and I would every so often have lunch together. We were both bemoaning the state of ignorance of the people in the plastic industry, and together we came up with the idea of an all-day seminar. We went to SPE and they agreed with us 100 percent. On a Tuesday, Herman gave the first all-day course on plastic materials, and on Wednesday I did the same on injection molding (figures 23, 24). It was so successful, that it spread out to many other subjects.

This did two very important things for me. It made me realize how little I and most every one else knew about the injection molding process. I could not answer some of the questions posed to me. It forced me to stop, think, and evaluate what the process actually was. I did a lot of experimental work in my plant to find out how things worked and the effects of varying moldings and other conditions. It also made me consider mold and piece part design. From this came *Correcting Molding Faults* (Addenda II), listing all the molding faults I and my people could imagine and how to correct them, *Mold Design Checklist* (Addenda I), which lists the points to be considered in designing a mold, and an article on *Piece Part Design* (Addenda III).

Secondly, I realized the low level of instruction in today's colleges as compared to the training I had received even though today's students are just as smart as those in my generation. What has changed is the teaching. Most of the seminar students had one or two college degrees.

To establish the average size of molding plants, I would ask the question, "There are forty thousand molding machines in four thousand plants, what is the average number of machines per plant?" I would get answers ranging from eight and a half to fifteen! After a while I stopped asking. It was too embarrassing. When it came to understanding Hooke's Law, almost all of them were lost. This helped me enormously when I wrote my book on injection molding. I wrote for people who had only a high school education, but could have gone to college.

One of the early and most successful competitors of the SPE seminar program was Plastic Seminars run by Leonard Berringer and Charles Chastain who gave all the courses. I knew of them because in 1969 I gave a one-week seminar on injection molding to Fortune Five Hundred executives arranged by Mr. Chastain. One day Leonard called me when I was not at home. My wife answered. Lenny explained that they had a three-day seminar on injection molds with fifty registrants to be given five days later. Unfortunately, Mr. Chastain had dropped dead the day before. He asked my wife if I could give the three-day course with no time for preparation. My wife said I could talk for three days on anything without preparation. My wife and I went to Atlanta and that was the beginning of a wonderful professional and personal relationship between the Berringers and the Rubins. Eventually, Lenny sold out, the seminars lasted for a few more of years, were sold again, and then the seminar programs were terminated.

The seminar programs instructors were a remarkable group of people. All were truly expert in their fields, successful in their vocations, had great senses of humor and the gift of being able to talk to people for seven to eight hours at a stretch for one, two, or three consecutive days and hold their students undivided attention. We met for dinner every night, an event to which we all looked forward. My wife would often come with me and we developed life long friendships.

From time to time, I would deliver in-house seminars tailored to the special needs of that company. In retrospect, my seminar experiences were one of the most rewarding of my business career.

TRAYNHAM: Was that why you wrote your book on injection molding?

RUBIN: And how! One day when I was giving one of my lectures for SPE, I said, "Somebody ought to write a book on injection molding." My dear friends at the SPE journal, all of whom were close friends—you know it was really a small group—put in a little box in the journal stating, "Rubin is writing a book on injection molding." I wrote back one of my famous letters telling them that if they wanted the title of "editor" they should check their information before they published it. About two months later, there appeared another squib, "Rubin has confirmed that he is writing a book on injection molding." [laughter]

So I did. I wrote the book titled *Injection Molding Theory and Practice*, published by John Wiley & Sons (figure 25) (3). It was a difficult job because when you start to write you have to answer a lot of questions, many of which you never previously considered. My first question was to whom shall I write? Who will be my audience? I decided that the book should be written at the level of a high school graduate who could have gone to college. Secondly, it had to be written in a way that people could understand, so that if there's a particular formula that governs something, you not only give the formula, but you explain what the formula is so that if you're not mathematically inclined, you can still understand what it means. Thirdly, I wrote the book as a businessman, because the purpose of molding is to make money, it's not a theoretical exercise. Finally, I wrote it from a safety point of view.

I would have written a totally different book, which would not have been too successful, I don't think, had I not been lecturing to people in the industry. The knowledge was just abysmal. They would learn in college, for example, that now we're going to study friction. So they knew the formula for friction and answered all the questions about friction by just plugging in numbers. Many never understood it. They knew nothing about chemistry. Actually, you had to start as if they had never gone to college. For example, they all knew what Hooke's Law was by name. Hooke's Law states that if you take a material and stretch it, but not enough to break it, and then let it go, it'll come back to its original position "instantaneously." I would stretch and relax a rubber band and let it go. They didn't have the vaguest idea that it represented Hooke's Law. If you don't understand basic concepts like that, you cannot understand injection molding, or any other material because they all obey Hooke's Law.

But in plastic, there's another variation. Defining a plastic is simple. It is a very large molecule. One starts with a very small molecule, the monomer, such as ethylene, which is about the size of two water molecules, and by using heat, pressure, and catalysts polymerize them to form very large molecules. They do not polymerize in straight lines but branch out. Because of the almost infinite possible variations when polymerizing, the chances that any two pellets are the same is nil. The material one gets from the manufacture is a blend of a number of different batches. They often have difficulty in sending you a similar mixture for a later production order. This gives rise to the two main differences between polymers and other materials. The first is that we are never molding identical material. Therefore quantitative results are not obtainable. The second is that plastics not only have Hookian elasticity, but also when they are subjected to stress, slide over each other changing the dimensions in a non-recoverable way. This is a difficult thing to predict. There are other differences that are not quantitatively predictable such as orientation, the effects of cooling rates and crystallization, et cetera. This makes computer programs helpful, but not always useful.

When I wrote the book, I went back to the fundamentals and stated them in terms that wouldn't insult my readers. I had to do a lot of experimenting in my own plant, because I did not know all the answers. They would ask me, for example, "How much force do you need to hold the mold together when you're injecting the plastic material?" Well I didn't know, so I ran a batch of experiments, had my friends do the same, and I came up with a figure or 2.5 tons per square inch of projected area. This is now the standard in use. I didn't know the energy exchange of the machine. I went back to my college physics and put all kinds of meters on the machine. I recorded temperatures, flow rates, and the outside temperature of the mold and machine to calculate radiant energy loses, and built a calorimeter to see how much heat came out in the plastic itself. I got a good energy balance of the machine. I kept on doing things like that.

When I was all done, I realized that it was not written as well as it should have been. So I spoke to one of my friends, Lou Naturman, who was the editor of SPE journal, and, for a fee, he rewrote the whole manuscript. He knew plastics. He didn't change the content, but he rearranged the order, put it into good English, so that it now reads like *Gone With The Wind* (4).

It was a runaway bestseller. The royalties it gave to my children are in six figures. I published in 1972; this is 2002, and royalties are still coming in. I was able to do business with the largest of companies such as RCA [Radio Corporation of America Corporation] and Pfizer as well as the smallest. Because of my lectures for SPE, I was very well known. In those days, they put our pictures on their publicity. My picture must have run, God knows, hundreds of thousands of times. Almost everybody knew of me. That led to consulting businesses as well. There was some personal gratification. I would get letters from people that, "I started a plant just by using your book." Or, "I doubled my profits because of the things that you said in your book." It really put me on the plastics map.

TRAYNHAM: You also edited a 1,745-page handbook [*Handbook of Plastic Materials and Technology*] (5).

RUBIN: Yes, the publishers of my book, Wiley, wanted an authoritative plastic handbook. I wasn't interested because I didn't need the money, exposure, or anything else that would come from it. It was also a huge job. They finally conned me into it. I knew I needed help and at their suggestion, I formed a board of directors. I went through the list of the thirty-two thousand members of the SPE and selected fifteen. I sent them the same note: "Dear Sir, I selected you and fourteen others out of the thirty-two thousand members of SPE because of what you can do, your intelligence, your ability, et cetera, and I'd like you to join me on the board of directors for this handbook." I explained why we needed the handbook. Two had good reasons for saying no. The thirteen who said yes were:

- Glenn Beall, probably the best plastic designer in the U.S.
- Leonard Berringer, plastic editor and owner of Plastic Seminars.
- John Hull, vice chairman of the Hull Corporation and authority on thermosets.
- Sidney E. Berger, authority on additives.
- Herman Kaufman, materials expert and educator.
- George Lubin, the father of reinforced plastics.
- Donald C. Paulson, innovator of computer based plastic education.
- George Pickering, senior staff assistant of Arthur D. Little's Plastic Technology Section.
- Dewey Rainville, owner of Universal Dynamics, Inc. and authority on blow molding and material handling.
- Alfred F. Schuster, president of Orbit Tool & Die Corporation, expert and lecturer on molds.

- Gerald D. Shook, consultant and authority in reinforced plastics.
- Parke Woodworth, manager of International Marketing for Dupont's Polymer Products Division.

Among them, they took care of the one hundred eighteen contributors (figure 26). They were the smartest group of people I have ever met. It was a delight to work with them.

We went through handbooks. The trouble with handbooks is that the information is helter-skelter. You never know what you're going to find, whether you'll find it, or where you will find it. So we came up with the idea of making all sections uniform. For example in the sections on plastic materials we broke it up into standardized divisions. Number one would be the chemical name, number two would be how it is made, et cetera. Number seven was the advantages of the material, so that if that is what you wanted to know, you could turn to number seven. We did the same with the processing section. It made the handbook extremely user friendly. It also made it much easier for the authors to organize their material.

We decided to go to the companies that manufactured the plastic materials, asking them to select an author. The processing sections were written by those considered by the board to be the best in the field. Each board member was responsible for a specific group of articles. We hired Deborah Golanty, an exceptional plastics editor, to rewrite the material for diction, readability, and have the articles conform to the same editorial style.

The original manuscript arrived. It was checked for content and conformity with our standards. When all changes were completed, it was entered as a word processing document and sent to Debbie for editing. It was rechecked and sent back to the authors for their final approval. The 1,745-page *Handbook of Plastic Materials and Technology* has been very successful (6). This was not my doing but the collective wisdom of some of the smartest and hardest working people in the plastic industry. It's remarkably useful, and is selling very well. It sells for over two hundred dollars.

TRAYNHAM: Both your books sound like their basic purpose was to teach. Have you had other rewarding teaching experiences?

RUBIN: Well, every teaching experience is really rewarding because you learn a lot about people. I've done a significant amount of in-plants, which is when you go into a plant to teach instead of the plant sending individuals to my lectures at a very high cost. They'd gather five, ten, fifteen people, and I'd come there and deliver the lectures tailored to what they really wanted. You also teach, for example, when you're consulting. Lawyers, by nature, would not know anything about plastics. Most of the time when you consult, what you're really doing is teaching the lawyers enough so that they know how to handle the case. When you consult about a mold or mold problem you not only correct the problem but teach as well. So the idea of teaching is tremendous.

One of the things that happened, which was very interesting, was during the time of President [Lyndon B.] Johnson. If you recall, we always paid our operators more than they could get elsewhere. I had learned a valuable lesson. Pay people more than they can get somewhere else and your profits will increase. And I always did that.

The people knew that the more we made, the more they would get, so they always worked as hard as they could to get the most production and best quality. We had ten machines and if something went wrong, they'd bang a hammer on a tiebar for the foreman to come, because they were not allowed to change the molding conditions. If he was busy somewhere else, it might take him a few minutes, and they could be making rejects.

Another thing about Mr. Robinson was that he would hire anybody, red, yellow, green, black, or purple. He didn't care about the color of the person. If you did the job, you stayed. So we had mainly African American employees. They never left because they could never get a better job. They were wonderful people, really nice people, and we had warm personal friendships. I knew everybody by name, the names of their children, their grandchildren, and so on. So they came to me, and said, "Look, Mr. Rubin, we can make more money if we can change the conditions on the machines and put those parts aside, and then if they're okay we can use them. Then when the foreman comes, he can straighten out anything that has to be straightened out." So I said, "All right, let me think about it."

I always consulted with my employees, on whatever the level, because two heads are always better than one. Even though I took responsibility for decisions, I would very rarely go against them. I came up with the idea of running a school, and they thought it was a terrific idea. When I say "I" I mean our management group. We broke down the molding faults into fourteen different categories. For example, we would focus on one category, "short shots," or "material not filling out in the mold," and anybody who came to me with a reason for a mold not filling out, in writing, such as "no material in the hopper," got five bucks. If everyone came in, all with the same reason, each got the five bucks. So for several weeks the whole plant was buzzing with how many conceivable ways you could cause parts not to fill out and how to correct the problem. Because we ran three shifts, I ran small meetings at time-and-a-half, where we considered all the possible reasons why it happened. When we were all done, we typed the list of molding faults and distributed them to our operators. We did this with all of the fourteen sections. My operators knew more than 95 percent more than the foremen, because foremen learned by trial and error and rarely understood the process. When they passed my verbal test, they got a twenty-five-cent-an-hour raise. That was a lot of money in those days.

After about two or three months the union heard about this. They came to me, and, probably correctly, said, "You can't give them a raise, because that's a negotiable item in the union contract." I said, "I thought the purpose of the union was to give better conditions to the workers. So what are you complaining about? They're getting more money." They said, "You can't do it." I said, "In your tootsie!" I knew this union for a long, long time. Our discussions got nowhere and it finally went to arbitration.

Now, in New York City, small companies don't stand a chance in a union arbitration against a teamsters' union. You and the union each appoint an arbitrator and they appoint the third arbitrator. It is a cozy system for the union. This was right after President [John F.] Kennedy was shot, and President Johnson was pushing anti-discrimination laws, if you remember. Kennedy did not do much about it. Johnson was the one that did something. So, I walked in. One of the union delegates was Jewish. The other was Italian. Both white. I said, "Look, gentlemen, let's make this very short. I have a statement to make. Here you are a white Jew and a white Italian, and my people are black. I am doing everything to advance them, and I am giving them more money. You're raising objections because of power. You're raising objections because you're white and they're black—just exactly what President Johnson is against. If I don't win this arbitration, I'm going to take a full-page ad in the *New York Post*. I'm going to name you by name; I'm going to name the union by name; I'm going to name the arbitrators by name; I'm going to state my case; and if you don't like it, you can sue me." I got up and I walked out. They knew that I meant it. That was the last I ever heard of it.

The molding fault checklist was, I believe, the first time that anything of its kind was ever done in the plastic industry. When I taught I gave them out for free with no restriction. They've been changed, advanced, and so on. But all of this came from my teaching and my book. If you write a technical book with the idea of helping the reader make money, you have to be able to provide answers on how to correct problems.

TRAYNHAM: How did you help start the use of vacuum metalizing on plastics?

RUBIN: A major distributor of lamp parts was Walter Freeman. One day he came to us with information about a new process called "vacuum metalizing" where you could get a finish like brass or chrome on plastics. He thought it would be a great idea if we could copy the brass parts in plastic. You see, the way a lamp is built is that you have a base, a $^1/_8$-inch iron pipe in the middle, you drop things on the pipe, and screw a socket and a harp on the top. The harp holds the shade. He thought a plastic part that looked like brass would be a lot cheaper. This turned out to be the case. He told me of a company, Vacuum Metalizing Corporation, in Green Point, Queens. I went to see them. I went back to Walter and I told him my suggestion would be to take two of his largest selling parts and let us make a two-cavity mold, one of each, so that we could try and see if the process worked. He agreed. The owner was Harold Messberg and he knew very little technically, but he had two people there, Alan Shaw, who did sales but was technically knowledgeable, and Paul Gang, who was the expert on vacuum metalizing. The process sounds very simple but is not so.

You take plastic parts and put them on a rack that rotates so that all of the part will eventually face the center of the machine. The machine is a big tube, perhaps 6 feet in diameter, closed on one end with a door on the other. In the center are an aluminum wire and a tungsten wire which heat up the aluminum, so that the aluminum vaporizes as water vaporizes when it boils. In order to do this, you need a very, very high vacuum in the chamber. Since the racks are turning inside the chamber, you can deposit two or three molecules of aluminum all over the plastic so it looks just like chrome. You have to put a lacquer coating on the plastic parts before you start evacuating the chamber or else the plastic will emit enough gas to make it impossible to maintain the high vacuum. After you remove the parts, which still were on the rack, the aluminum would rub off with your fingers. A topcoat of acrylic lacquer took care of that. If you wanted a brass color, you dyed the topcoat brass.

There were many technical problems with the adhesion. There were some technical problems in the dye. But with my knowledge of chemistry and Alan's and Paul's knowledge of the process, we eventually got a coating that worked. The topcoat protected the aluminum so that it couldn't rub it off with your fingers and could withstand the normal cleaning of the lamp. Later Bee Chemical [Company] started manufacturing the lacquers for other people.

It was so successful technically that Walter went and had us build molds for those two parts and many others. He could not sell them because his customers said that brass was "good enough for my father, good enough for my grandfather, and good enough for my great-grandfather, so it's good enough for me." Then the Korean War came and they couldn't get brass. So the customer forgot about his great-grandfather. Besides the price difference was tremendous. A 6-inch break (that's what they're called) in brass cost three dollars fifty cents plus it's very heavy, and tarnished. We sold the same part, identical, in plastic, vacuum metalized for twenty-five cents!

That led to a very interesting result. They couldn't get brass, so they had to use plastic. But that caused another problem. People who bought lamps saw that the plastic part never tarnished. So they went back to the stores, Gimbel's [Department Store], Macy's [Department Store], and so on, and said, "We want lamps we don't have to polish." So what they had to do was to vacuum metalize the metal parts, instead of electrically plating them brass, which would tarnish. So they vacuum-metalized the steel, so it wouldn't tarnish. The vacuum metalizing plant of Chatham Metal Spinning, which they were using for their metal lamp parts, was what made the deal interesting to me because we needed more metalizing capacity. In the interim we found a metalizer who used the silver nitrate process. This worked very well for us except that he had a minimum order requirement of three hundred thousand pieces per part, which caused scheduling problems.

Once the metalized parts were accepted, we added a number of finials to our line. These required inserting brass bushings with an internal thread. Assembling them by hand was a slow process with an average of one thousand two hundred pieces per day per girl. The sales took off and the thought of all the extra employees did not appeal to me. I suggested to Mr. Robinson that I build an automatic bushing insertion machine. He asked me how much it would cost, how long it would take to build, and how fast would it run. I said, "About two months, twenty-five hundred dollars, and nine thousand per day." I was correct only in the production rate. The machine cost ninety-two hundred dollars and took seven months to build (figure 27). I learned an awful lot about automation. It ultimately led to me automating whenever possible. It not only made me more competitive, but because it lowered the cost, it increased the customer sales, and ours too.

We had a vacuum metalizer in New Jersey, who did most of our metalizing, decide that he could make more money vacuum metalizing glass bottles. He didn't realize that glass bottles come packed in hay. They were very expensive to handle, and unless you cleaned them perfectly, little bits of hay got into the lacquer tank and prevented a smooth finish. Consequently, he was not able to properly take care of us. His foreman, Jose Hernandez, came from Puerto Rico. He was an excellent technician and a very nice person. He phoned me one day. He became more and more upset by having to lie to me about deliveries. He said, "Look, you're never going to get your parts. I found a small plant, which has enough capacity for you. You buy it. I'll run it for you." He gave me the economics of it and a good business plan. I said, "No way. You're going to buy it, because I don't want to own any more plants." He said, "I have no money." I said, "You don't need any money. I will give you a Robinson Plastics guarantee so that you can get all the money you need." And that's what happened. We were rated $B^{+}1$, which was a very high rating, so there was no problem getting a bank loan. Eventually he paid us back in merchandise. When he needed money, I lent it to him. You won't find a better supplier than that. He's done remarkably well. He has ranches all over the Caribbean.

We provided hot stamping capability. We found it more economical to farm out large volume jobs with vendors who were more automated. We also had a line of extruded white tubing that was widely used. Jesse Rubin suggested vacuum metalizing the tubing, which could compete and be cheaper than the highly polished metal tubing, another high volume item. This did not work well enough to compete with metal. He then suggested hot stamping.

I went to Kensol-Franklin Inc., one of the major hot stamping machine and material vendors. Marty Kensol had never heard of anyone hot stamping in that manner. We developed a round tubing hot stamping machine. Using an extremely durable foil, we were able to stamp up to 12 inches in length. It became an important part of our lamp part division. We built plastic check rings (retainers) for the tubing. We also had two stock square boxes, one 4 inches square and the other 6 inches square. We hot stamped the boxes with the same foil used for the tubes (figure 12).

We were now able to duplicate wood grain that substituted for wooden lamp columns on lamps. We used a marble foil that looked so real that we had to discontinue it. Lamps made from it looked like the real thing. When customers found out they were plastic, they returned the lamps claiming they were cheated out of real marble.

As you can gather, custom molding became a very important part of our business, and before long, it was bigger than the lamp part business. It eventually became more profitable. My attitude in selling injection molded parts was number one: you'd make more money spending time improving your own business than trying to save a few cents on a molded part. Number two: just like a doctor, where you put your life in his hands, you're putting your business life in the hands of the molder, because if he doesn't know his business, you can get an awful lot of rejects and problems. I would explain that a nickel lamp part, if it fails, the lamp comes back. It costs the manufacturer twenty, thirty, or forty dollars with a lot of dissatisfaction. So while we don't make perfect parts, we just try to ship them. And we did. We had a great quality control system, and the people had an incentive to make good parts. We had no problem getting customers who really wanted good parts and were willing to pay for them.

TRAYNHAM: Please, tell me about them in any order that they come to your mind.

RUBIN: Good idea. I'll list the names as I go along.

TRAYNHAM: All right. You mentioned that you had molded a tray for matchbox cars.

RUBIN: Yes, when I was writing my book on injection molding, I wanted to find out the physical characteristics of molding machines, so I left my card at all the molding machinery manufacturers' exhibitors at the National Plastics Show in Chicago. They'd always send somebody to see me. So I would see them and explain my reason for the inquiry. They sent me the material I requested. One fellow came in, and, just for the heck of it, I asked him how much his 2½-inch, 300-ton machine was. He said, "I don't know." I said, "How come you try and sell me a machine and you don't even know what they cost?" He said, "I'm a canvasser. I check inquiries to see if you're really interested, and if you are, I set up a meeting with a sales engineer." I said, "What do you know about injection molding machines?" He said, "I've never even seen one." I said, "Come into the plant." I thought I'd show him a machine and he would be gone in five minutes. It turned out to be one of my one-hour lectures. When he left, he thanked me profusely. He said, "You don't know, how much better I will feel when I see a potential customer."

About fifteen minutes later I got a call from Lesney Products. You know what matchbox cars are? They're little metal cars— they were the American arm of a British company. Lesney Products needed a tray for twelve plastic cars and asked if I could make them. I said, "Yes." He said, "When can you see me?" I said, "I don't know. If you're in Alaska, it will take me a couple of days. Where are you?" He was a five minutes subway ride away. So I said, "I'll be there in about half an hour. Is that all right?" He said, "Fine."

He showed me the tray (figure 28). I looked at it. He said he needed about three million of trays. That meant thirty-six million cars. When I hear three million, I always jump back. When I hear a hundred thousand, I know I might have a customer. It turned out that he really needed them. He gave me the weight. The material was blue polyethylene; I figured the material at twenty-two cents a pound. I estimated a four-cavity mold running at ninety shots per hour. The size of the part was 6-inches-by-8-inches-by-$1\frac{3}{16}$-inch.

I gave him the price. He asked how many cavities I was figuring on running. I told him four. He said, "I don't believe it. In England, they can only make one at a time. I've had other quotes here and the maximum they'll make is two at a time." I said, "I withdraw my quote. Let me look at it again." So I did, and could see no reason whatsoever why I couldn't make four at a time. So I said, "What I'll do is I'll raise my price 10 percent, because I could be wrong. But I will guarantee you four hundred thousand pieces at my price, and if I can only run two, then you'll have two extra cavities to make another mold."

He said, "Wait a minute." He looked up my D & B [Dun and Bradstreet] Rating, which would certainly cover that, and said, "Very good idea. Let me think about it." I said, "You've got ten minutes." He said, "What are you talking about?" I said, "You're not going to know anything more in eleven minutes than you're going to know in ten minutes. Now, either you want me to do the job—and I'll take it. If not, forget it, and give it to your two-up guys." He said, "That's a hell of a way to do business." I said, "That's right, but you're dealing with a hell of a business man." He gave me the job right then and there. In those days I could figure mold prices and quoted him a price plus or minus 7 percent. I quoted him about twenty-six weeks for delivery, and he was very upset. He said he had to have it faster. I said, "Look, I'm not going to lie to you. I'll try and make it as fast as I can, but the way this looks, it might take some time."

I was concerned that other competent molders said that four cavities were too many, but I felt almost sure that I was right. When I got back to the office, I call up Rogerio, my friend in Portugal. He was the son of the owner of Emidio Maria de Silva in Marinha Grande, the best mold makers I have ever used. They had state of the art machinery some of which I had never seen in the United States. They had computer controlled lathes and milling machines, the first wire EDM machines I ever saw, hobbing presses, and did their own hardening. Their concept (eventually adopted in the U.S.), was that the mold should be designed in engineering. Prints were made for each machining operation. When all the parts were done, they were assembled by a master mold maker and sent to the molding room for testing. The designer was always there at the test. This concept allowed for faster deliveries as more than one machinist could be working on the job at the same time. It also developed a highly experienced engineering staff and testing group. This contrasted with the American way of assigning the mold to one master tool maker and essentially being at his mercy.

Rogerio was an engineer and ran the operation. I told him the whole story. He knew what I was talking about because they had matchbox cars there. He said, "Come on over." So I got on the four o'clock plane that afternoon. The next morning I was in Marinha Grande, and we sat down. He called a conference of all his design engineers in the drafting room. Nobody could see why it shouldn't work. I stayed two more days to approve the mold design and went home.

About nine weeks later, incredibly, he called me up and said, "Sit down." I said, "What's up?" He replied, "The mold is done." Their curiosity had been so peaked that they put as many men as possible on the job. I said, "So, how does it run?" He said, "I've got good news and I've got bad news." He said, "The good news is it runs beautifully at two hundred forty shots an hour." I had only figured about ninety. "The bad news is that you are going to need two operators, maybe three." I said, "That's the bad news?" He said, "Yes." I said, "I love you tenderly." So he said, "You want to come over and see it?" I said, "Do I have to?" He said, "You really don't."

The next morning the mold was on a TWA [Trans World Airline] plane; about a day later it was in my machine. I went to my customer about ten weeks after he placed the order, threw the parts on his desk, and said, "Look." He almost dropped. He came down to my plant to see it running. But there was one problem. There were twelve compartments and two of the main dividers had a very slight bend in them. They weren't absolutely straight. He didn't see it at first. I said, "We have to work this out." He says, "You're a dead man if you waste time trying." It bothered both our engineers and the operators. The operators eventually solved the problem.

The real problem with the job was that you couldn't stack the parts in the carton, so when you ran around the clock, you had to stop production unless the cartons were shipped every day. We arranged with the building superintendent to use the elevator at five o'clock in the morning. We hired a guard to stand outside because we had the street covered with boxes. We had polyethylene sheeting on top of each box in case it started raining. The mold ran so quickly that we had one operator removing the parts and putting them in the carton, and another one making and sealing cartons and regrinding the runner system. Lesney immediately ordered more molds as one mold could not satisfy his needs.

I was at an SPE meeting sitting next to the Esso salesman for the area. The salesman was selling polyethylene. He had heard about the job and asked me if he could get an order. I said, "Give me your price." He said, "Well, what price do you want?" I said, "I'm a nothing, and you're one of the biggest companies in the world. You tell me the price." I had figured twenty-two cents, with the coloring. He came up with a price of nine cents a pound, colored. I didn't know at the time that they had a warehouse full of stuff that they bought from another supplier until their production started. They had overestimated their needs and had to move what they had at almost any price. So I gave him the order, and we used an awful lot of it. With the material cost 60 percent lower than our estimate and running almost three times faster, it became our most profitable job.

TRAYNHAM: I heard that you were one of the first molders of Lexan.

RUBIN: One day a salesman, Hank Singer, came in with two 25-pound metal containers of a new plastic material from General Electric [Company, GE] called "Lexan." This was their trade name for polycarbonate. He explained its great properties and asked me if I would like to try it. I said, "Certainly." We went into the plant and he selected a water pump impeller, which we were molding out of ABS, the strongest plastic available at the time. I called in my molding manager, John Gannon, and asked him to mold the impeller in Lexan. He asked what the material was and I replied, "Floor sweepings, just dump it in, and let's see what happens."

About ¾ of an hour later he came in with about ten beautiful parts in Lexan. Hank who later became one of the top executives in the GE plastic division, told me that GE was about to start a multimillion dollar advertising campaign for the new material. He asked if I would mind if he brought in other molders to see the new material run. In those days, we only had plunger machines and I said that was no problem. Just clear it with John so he could schedule them in. In return, I asked if we could keep samples of the Lexan parts that we ran and that for a limited amount of time we get all their local inquiries on a non-exclusive basis. He agreed. That is what actually happened.

A significant number of molders came in and we accumulated a large number of samples that we literally molded in our plant from Lexan. We would get inquiries from GE, see the potential customer, and if the application was good, we would ask permission to quote on it. They would always ask about our experience with Lexan and I would dump fifteen or so different pieces on the table and honestly say we molded them all in our plant. This gave us an enormous advantage over our competitors. For a time we became the largest molder of Lexan in the metropolitan area.

One of the first applications was a computer cardholder for RCA (figure 29). Since we did not have EDM machines at that time, the mold was made up of many different pieces held together in a frame. The fit was as tight as we could make it. However plastic pressure in a plunger molding machine is difficult to accurately control so that sometimes it became so high that it would expand the frame and flash between the inserts. This required taking the mold out of the machine and taking it apart—a several hour procedure.

To solve the problem, I bought a pressure transducer, mounted it under a knockout pin and attached it to the circuit so that it reduced the injection pressure when activated. This worked very well except that the transducers were not designed for this, were very expensive, and did not last very long. I believe that this was the first feedback system ever designed and used in injection molding. A typical Lexan job was a centrifuge cover (figure 30).

The relationship with Hank led to a very funny experience years later. My wife bought new deep pile carpet in our bedroom. My old, faithful, electric alarm clock had to be retired because its color didn't match the decor. At that time our plant was near Canal Street in New York City where you could buy almost anything at low prices. I bought a beautiful GE ivory alarm clock for one dollar and ninety-eight cents. The next morning when the alarm went off, I reached for the old clock and accidentally knocked the new clock off the end table and broke the case. The problem was poor design and the wrong material.

I sent the clock back to GE via UPS [United Parcel Service] telling them what happened, and since the design was so bad, I was entitled to a new case. I received a letter from GE that for ten dollar plus four dollars for handling and shipping, they would send me a new clock. I then received a post card from GE saying that if they did not hear from me they would throw out the clock. At lunch one day, I told this to my lawyer who had a great sense of humor. He sent GE a letter stating that in New York it was illegal to dispose of one's property without the owner's permission.

A week later I got the broken clock back from GE with a letter explaining that they made the clock out of shiny material because that is what consumers want even though shiny plastic is very weak. Obviously, they were saying that general purpose styrene that they used was shiny which is much weaker than high-impact styrene that is dull. When the mail came I was reading *Modern Plastics* [*MP*] and the page was open to a full page color ad with the picture of a beautiful construction helmet made in shiny white GE Lexan. I tore out the page and sent it to them with all the previous correspondence and wrote a funny letter describing the disaster that might happen if anybody used this helmet made out of the white shiny plastic material that they used on the clock, which broke when dropped two and a half feet onto a plush, soft carpet.

About a month later, I received a top-of-the-line GE clock with no paper work. I had hardly unpacked it when I received a phone call from GE saying that I should be just as fast to say thank you as to complain. It turned out that the call came from Hank Singers' secretary. The repair department thought the whole incident so funny that they published it in the GE house journal. When Hank saw it he had the clock sent to me.

Another very good customer was American Machine Products [AMPRO]. They manufactured brass pumps and swimming pool parts. The lamp industry did most of its manufacturing in the middle of the year. After November, retail stores had the entire lamp inventory they needed for the Christmas season and only bought more if they ran out of stock, a relatively small volume. This left us with a lot of unused molding time. I looked through the yellow pages for industries that would be selling in the spring, as they would be manufacturing during our dead time. The one that seemed most appealing was swimming pools.

I went to the library and read their trade magazines. A major problem was corrosion. The parts were made of aluminum die-cast that was being attacked by the chlorinating agents used to purify the pools. From United Way and UJA [United Jewish Appeal Federation] fundraising dinner invitations, I found the names of the important companies in the swimming pool parts (pumps, valves, filters et cetera.) business.

I bought a die-cast pump and took it to Tony Santori, who made all our models. He was an artist, an engineer who understood plastics, and a superb craftsman—a rare combination. We adapted it to plastics and made a sample pump out of acrylonitrile-butadiene-styrene because Lexan sheet in the thickness we needed was not yet available. I chose to see AMPRO's owner Stanley Huppert. I walked into his office, and, after the usual pleasantries, put the plastic pump and my business card on his desk and said, "Try this ABS pump. It will never corrode. I will be back in a week." I turned around and started to leave his office. He said, "Wait a minute." I replied, "Perhaps you are deaf, I just said, try this ABS pump. It will never corrode. I will be back in a week" and walked out. His plant manager was Eddie Tessler, extremely competent and a perfectionist. He and Stanley tested it, threw in pebbles, checked with Marbon for chemical resistant and found it to be all right.

They gave me an order for the pump made in Lexan. After testing the hand made pump for about a month with water containing about ten times the normal amount of chlorine, and samples of Lexan, I received orders for several other parts (figure 30). Stanley explained to me that if a part corrodes, the swimming pool installer has to go back and replace it. This is a very costly procedure. If he could come out with a line of corrosion proof parts he would make a quantum leap in his business. He also estimated it would take at least a year and a half for his competitors to catch up. By then he hoped to keep most of his new customers. That was what happened.

One of the items that we made for Stanley was a four-way valve for pool filtering systems (figure 33). We converted the die-cast valve into plastic, but for tolerance and economic reasons had to mold the whole valve on one shot. To do this we had to have a three-plate back gated mold with pinpoint (restricted) gates. Since all the parts we previously molded in Lexan had large gates, we were not sure if a pinpoint gate would work. It was theoretically all right. We called the powers that be at GE and their answer was, "Try it and let us know what happened." It worked beautifully and GE spread the word. I am fairly certain this was the first time a restricted gate was used with polycarbonate. At that time, I probably knew more about injection molding polycarbonate than GE did, so they would refer many people with questions to me. This greatly expanded my consulting business.

Stanley and I had a long business and personal relationship. Unfortunately Stanley died very young from a heart attack. The business was successfully taken over by his wife, Sheila. We are still friendly with Eddie Tessler and his wife.

TRAYNHAM: You mentioned that you molded for Clinique [Laboratories, Inc.] and had an unusual experience in getting the order.

RUBIN: You bet! The company was Clinique. They're part of Estée Lauder [Inc.], the so-called Cadillac of the cosmetic industry, and deservedly so. They developed an item for a mascara applicator. It was a rectangular sleeve 4-inches-by-1¾-inch-by-$^{7}/_{16}$-inch deep, with a sliding drawer. The material was metal platable ABS made by Marbon. Inside the drawer were the mascara and the brush. Clinique wanted to use the metal plate exterior of the sleeve as a mirror. A woman could use that as a mirror, and hold the sleeve that holds the extended drawer with the mascara, all with one hand. She would use the second hand to apply the mascara. This is a lot easier than needing a third hand for the mirror. They made the mistake of giving the job to the molder and plater separately. Because of the cumulative tolerance they could not get the proper fit between the sleeve and drawer. It was either too tight or too loose. The molder blamed the plater; the plater blamed the molder.

We were one of the molders that tested Marbon's metal platable ABS before it came out. This material can be metal plated with a chrome finish. Clinique used it rather than the less expensive and less durable vacuum metalizing. Marbon correctly felt that it was a high volume usage. They called me and Nick Annis, owner of Plated Plastic Products with whom we have worked very closely. They suggested one of us take the responsibility for the whole job. Nick asked me to see them and take his new salesman with me so that he might learn about the customer. I said, "Fine."

So I meet this crazy nut. He kept me waiting for twenty minutes. We drove along and he didn't talk. So I ask him one of my favorite questions, "What are your favorite hobbies?" He replied that one was predicting what people were like from their names. Neither of us had ever seen or spoken to George [S.] Johnson, whom we were scheduled to meet. I said, "What is he like?" He said, "He's a WASP [White Anglo-Saxon Protestant] from the old school." I said, "All right."

We entered Clinique's building on Long Island. They had a big waiting room, and stairs leading to a second floor balcony. One couldn't go in unescorted because one could put something in their pocket worth one hundred dollars as they walked by. The door would open and the person with whom you had an appointment would say, "Mr. Jones, Mr. Smith," and take you in. While we were waiting, this nut showed me plastic parts that Nick plated. Many of them were my parts. I said, "For goodness sake, shut your case and wait."

Just then, the door opened and somebody said, "Mr. Rubin." I looked up, and there's George S. Johnson. This nut stood up and hollered across the whole room, "You can't be George Johnson." George who was unflappable said, "Why not?" The nut said, "You're supposed to be a white WASP, and you're as black as the ace of spades!" [laughter] When he got up, all his parts fell to the floor. He got on his hands and knees while trying to explain what he meant. Everyone started to laugh in embarrassment just as you are, except George and me. With forty or fifty people laughing hysterically, those on the balcony floor rushed out to look and were caught up by the laughter. The three of us walked to George's office. George didn't say a word. I didn't say a word. He showed me the part. I immediately saw the problem. I said, "If you give me a half a dozen samples, I'll come back in a week or so with a part that I guarantee will work at no charge to you." He said, "Fine."

While the sample was being made, a very close friend, who owned a Holiday Inn in which I owned a very small portion, was going into another venture, in which I was not interested. Other mutual friends were interested, and because I had nothing to do they sent me down to his house in Sarasota, Florida, to get the information. I knew this person very well. We were close friends. I knew him since he was sixteen. After twenty-five years he told his wife that he'd "outgrown" her. He divorced her and remarried. He would always ask me, "What's new in my business?" I told him the story about Clinique and that I was having a sample made. His wife quizzed me up and down, left and right. The Lauders, who owned Clinique, and her father were going to start the business together, but her father thought it too risky and dropped out. Now he has a major position there and does very well, but it's not the same as owning one-third of a billion-dollar business. She said, "When you get back, talk to my father, because he's never met my husband."

I brought the part to George. He liked the part. He said, "All right, let's go ahead." I said, "I need a ⅓ mold deposit." He said, "We don't do that." I said, "I need it because that is what the mold maker requires. But I'll give you a letter than if you're not pleased with the piece, even if it's because you had a fight with your girlfriend, I'll give you your money back." He said, "All right." I told George about the coincidence of knowing Dave's daughter and asked if I could talk to him. Just then Dave walked by and George asked him in. Dave questioned me for half an hour in front of George about his daughter and her new husband. Then he said, "Next time you're here, son, be sure you come and see me." George and I had a close relationship. I had to rewrite the letter because I had to leave out the part about his girlfriend.

The part was very successful. During our relationship we made millions and millions of them. The quality standards were extremely difficult. It was defined as a mirror finish that could not be quantified. We ultimately worked out a system, unknown to them, to reduce the rejects to an acceptable amount. After quite a number of years, other competitors were able to produce acceptable parts. This made the business less profitable, so we had to consider whether to continue the relationship. I learned never to give any company more than 20 percent of my business other wise they become your boss. We parted company very nicely.

TRAYNHAM: Did you have any other large customers?

RUBIN: One of my major customers was Deknatel.

A very good friend, Dr. Herman Kaufman, who was head of plastic research at Allied Chemical and later dean of a technical school at Rutgers University, called me in 1978 to ask me to determine the feasibility of molding a part for one of his consulting clients.

I met with him and the owner, Dr. Leonard Kurz, a thoracic surgeon. When there is a lung problem it is sometimes necessary to extract fluid and maintain proper pressure in the lungs. Hooking up several bottles together with rubber tubing regulated this. The process was slow, expensive, and prone to error. Hooked up incorrectly by the nurses, a dangerous situation could develop. Dr. Kurz received a patent for combining the bottles into one unit plus some other improvements so that all the surgeon had to do was connect one end to the patient and the other end to the vacuum system. This was the first of the Pleur-evac line of thoracic instruments.

I told him that it could be done. It was a large piece 18-inches-by-19-inches and 3 inches high with many parts and configurations. I refused to be paid for the consultation because of my friendship with Herman. A few days later Dr. Kurz, a truly remarkable man, called me and said he was ready to go ahead. I redesigned the part for injection molding and made it impossible to assemble the internal parts incorrectly. Emidio Maria de Silva in Marinha Grande, Portugal, built the two molds. The quality of the molds were so high that aside from normal maintenance, there was no mold caused downtime, even though we ran hundreds and hundreds of thousands of pieces. The unit was sealed to make it air tight with an extruded silk screened plastic sheet. The parts were molded in CYRO [Industries] XT-375, a rubber modified styrene-acrylonitrile, on two 425-ton machines. We supplied the molded parts and they had about twenty-five people silk screening, fabricating, and testing the finished parts (figure 33).

The product was extremely successful. They had other units that were vacuum formed and made in Japan. I was asked to quote the vacuum-formed parts that I did through RLR. We were much lower than Japan and received an order for those parts. While delivering these parts, it occurred to me that injection molding would be much better and cheaper. Dr. Kurz agreed and gave us an order for the injection mold. This also worked very well and in the course of our fifteen-year relationship we received orders for all his parts.

When President [Ronald W.] Reagan was shot, he was rushed to a Washington hospital. The chief of thoracic surgery heard about the shooting on the radio and rushed to the emergency room. They had not yet removed the President's clothing when he saw that the President was drowning because of internal bleeding in his thoracic cavity. The doctor immediately inserted a Pleur-evac into the President's thoracic cavity, drained the blood, and then did whatever was medically necessary. He later said that five minutes later and our country would have had another assassination. Reagan had been shot under the armpit and the bullet penetrated his thoracic cavity. Deknatel informed us that we had made that particular Pleur-evac unit. A television reenactment of the event showed the Pleur-evac.

Deknatel was the third largest American manufacturer of medical needles in Queens, New York. In spite of many attempts it was not unionized. The Pleur-evac operation was much smaller and located in Farmingdale, Long Island. It was a hand operation and not very efficient. Since the item was patented, cost was not a problem. Not long after we started molding our first item for them, the union organized the Farmingdale plant. Dr. Kurz asked me to quote on fabricating the item. My price was about ⅓ of their cost.

He then told me that the place was unionized and he wanted to shut it down because he feared the Queens operation might be affected. Under NLRB [National Labor Relations Board] rulings he could only do that if he stopped the operation completely or could show substantial savings by farming it out. He asked me to recheck my price because the NLRB would inspect my operation. My price was all right and the subsequent NLRB inspection settled the matter.

RLR extruded the sheet, a commercial silk screener provided that service, and Gotham Plastics [Company] in the Bronx, owned by Lester Suss, did the assembly. As more items were added, we added other fabricators. One of the items we made suddenly developed crazing and cracking during the sterilization process. Deknatel called in the material manufacturer, CYRO, who went to Gotham and selected unfinished pieces at random. Their report said that their engineers could not make parts that were as good as ours. The problem was caused at Deknatel by a change in the lubrication used to help insert the rubber hose that was attached to the Pleur-evac.

Deknatel became so large that they wanted a second source. They tried several suppliers including Lear Jet, but none were satisfactory. They decided to manufacture themselves. We cooperated in starting their operation. Dr. Kurz sold his operation to Pfizer. Pfizer moved the operation to Massachusetts. Their profit margin was not as large as their drug operation so they sold it to the management. It was difficult to service them from that distance and eventually we stopped making parts for them.

Steve Rogin was another interesting customer, but very much smaller. One day, Steve Rogin, an industrial designer, who appeared to be very young, came to the office. He had a hand made sample of a flower pot and saucer about 7 inches high, made in beautiful sparkling clear acrylic. I stared at him and the pot in amazement. The only flower pots that I had ever seen were those made of reddish brown clay.

He asked me what I thought. I told him "You're crazy! Who would ever want to see the dirt in a flower pot?" But I added, "If someone had come to me with the hula hoop (one of the biggest toys ever), I would have said the same thing." He said that while I might think him crazy, he had money. I replied that he was the sanest person in the office.

My quote was all right. He gave me the mold deposit. About eleven weeks later we were in production, molding the pot and saucer in acrylic. They were beautiful to look at. Needless to say, it became an instant success. Steve ordered different sizes including a window box. We very quickly changed from acrylic to polystyrene, which was much less expensive. I believe that this was the beginning of the plastic flower pot industry.

Circulars Crib was another small but very interesting account (figure 34). A person from Dallas, Texas, came to me asking if I could make a full sized circular crib. I said that while I could do it, the tooling and piece part would be very expensive. He said, "No problem." I was told that a significant number of infants get hurt in a rectangular crib when they end up with their head in a corner. This could not happen in a circular crib. More over, a psychologist testified that since the world was round, infants would grow up much better if they started life in a circular crib! I still find that hilarious.

It was a difficult job. This same man later said that he also wanted the crib to act as a play pen. It ended up being a safe crib. All the plastic was FDA [Food and Drug Administration] approved. A teething child could not get splinters as it might from a wooden crib. The metal parts were molded in the plastic so that they could not come out and be swallowed. Since the color was in the plastic, the child could not eat it. It was easy to keep clean. It had no sharp edges. Very important to my Texas friend was that no one else sold round sheets and blankets.

The first problem was mechanical. Four vertical shafts supported the crib. Calculations and experience showed that plastic alone would not be strong or durable enough. We molded the leg with a ⅛-inch iron pipe inside. We used aging tests to determine if the metal-plastic combination would stand up. The pipe provided strength and an anchor for some of the mechanisms. The circular section was molded without reinforcement. The material used was FDA approved ABS. Emidio in Portugal built the molds. George Darnell at Molding Industries in the Bronx did the molding.

The crib was very expensive compared to the wooden ones. They called it a "grandfather's crib" because only grandparents could afford it. It was a financial success. They were so pleased that they invited my wife and me for a New Years weekend at their home in Dallas. While we were there Dallas had a rare ice storm that left the city streets covered with ice. Dallas natives had no experience driving on the ice. I drove and we had a great tour of the city with no traffic at all.

I have a number of other customers whose experiences I would like to relate.

TRAYNHAM: Please continue.

RUBIN: Industrial designers recommended many of our customers. There was a period when adult games and puzzles were very popular. We made many, some of which were so "artistic" that they were selected by the Museum of Modern Art in New York for their permanent collection. Two of the nine adult games, 3-D tic-tac-toe and Quintessense were in a book-of-the-month Christmas brochure.

One of the designers called me right after President Kennedy was assassinated. Rose [F.] Kennedy wanted to use the event to raise money for her retarded children's fund. He asked me to mold a small, clear holder in polystyrene for free. I replied that I would be glad to do it for just the cost of molding and material, with no overhead and profit. He sent me the part drawing. I would never make a part unless I knew what it was for. This helped me in the plastic design and gave me the opportunity to perhaps suggest improvement to the part. Most important it made sure that it was safe to use plastic. I never realized how important that was until this application. It was to be a candleholder! The children would put two in a box with candles, which were sold.

I called the designer and told him that polystyrene was inflammable and that when the candles burned down it could start a fire. He thanked me very much and had the contractor, a candle maker in Hyannisport, call me. I explained the problem. He said that it was pretty stupid of him not to realize that and he took care of it by making the wick short enough so that it went out before the candle reached the bottom. I said, "What if someone puts in another candle?" He said he would put in a notice, "Blow the candle out when it reaches 1 inch above the holder." I called the original designer who contacted the Kennedy family.

About an hour later the candle maker called me and said, "I wish I had your connections." I replied, "You are wishing for the wrong thing. You should wish for my brains!" It was a rocky start, but he knew his business. He designed the bottom of the candle so it could only be made by casting and had me change the bottom of the whole configuration to fit. To our knowledge there were no fires.

We became involved in other products such as toys because we had one of the first ultrasonic welding machines made by the Branson Company. Typically we would mold, decorate and assemble toy rifles. Because of Bill Plisco, we were low bidders on small parts that were used in games.

One day I was crossing a street with the light in my favor in Tel Aviv. I walked in front of a stopped charter bus. The driver blew his horn and I must have jumped 2 feet. I started to tell the driver my thoughts when I saw an old friend in the bus grinning from ear to ear. Danny Pressner owned Pressner Toy Company and he and his family were touring Israel. I spent the rest of the day with them. He was a major importer of wedding, confirmation, and baby items that went on cakes and were used for table decorations. He was having problems with his overseas suppliers and with the injection molding plant he owned in New Jersey. The result was that I duplicated his major items made in Asia. He followed my suggestion and closed his molding plant. The quotes I obtained for him were lower than the real costs of his imported items.

A customer from Florida, Milart, had a small glass bottle shaped like a gay nineties dancer on which he put an appropriate red garment. He filled the bottle with what we graciously called "Eau de Biscayne Bay." We molded the base. He covered it with a glass dome. It retailed for ninety-eight cents. One night he was at the plant to pick up some samples and bemoaned the fact that he could sell it easily to the stores, but it did not move over the counter. I suggested he ask the sales people. They told him that it was priced incorrectly. Women assumed that cologne at that price would be inferior. At their suggestion he changed the color and raised the retail price to one dollar and ninety-eight cents. It became a best seller.

From this and similar incidents, I learned the value of getting good marketing advice and, if possible, market testing a product. We were molding a handbag for Rialto Products that was a big seller. My wife was in Gimbel's and saw a duplicate handbag made by a competitor. She bought it and I rushed to show it to Abe Rothman. He said he knew about it a month ago and that it would never sell. I asked him why. He, in his gracious way, told me to stop bothering him with nonsense. I took the copy and went to return it, not for the two dollars and ninety-eight cents, but to see how the copy was selling. The sales person said she couldn't understand why the original sold as fast as they got them and the copies didn't sell at all.

I went back to Abe and he finally told me why. In designing the handle, he had insisted that I make it so that the parting line would not touch the woman's hand. Such a mold was more expensive than molding it flat with the parting line cutting the piece in half. But it kept the parting line from touching the woman's hand. His competition put the parting line right in the middle of the part that touched the woman's hand. He told me that no matter how well one molds, the woman will feel the parting line and it will not "feel" right to her, so she will not buy it.

Such experiences led me to write an article on how to design a part (Addenda III). I used this in my seminars and it has been circulated extensively, as was *Correcting Molding Faults* and the *Mold Checklist.*

A most unusual custom molding job happened this way. A good friend worked for a plastic toy company. They decided to make a sewing kit for kids. Never realizing that a mother was not going to let a five year old use a needle, they had about a million thimbles made out of white styrene that were in the same color we used for our lamp parts. Monsanto had adopted that color as a standard. He asked me if I would regrind the material, use it, and pay him whatever I thought it was worth. I said, "I'll pay you at the regular price of the material less the cost of the grinding." He started shipping the thimbles that took up an enormous amount of space. I was just about to start to regrind them when a friend Buddy Lowenfeld called. He was working for Cohen, Hall, and Marx [Cohama Fabrics]. They had just come out with a machine washable fabric. They had a little brown card, which they wanted to put in a white thimble.

In those days, the washing machine was an open tub, similar in shape to the thimble, so they wanted to imprint the word "Cohama" on the thimble and give it away as a promotion. I got permission from the toy company to use the thimbles that way instead of regrinding them. I quoted Buddy a price without any mold cost with delivery in two-and-a-half weeks. The molds would have taken months to build. My molding was zero. He came back to me a few days later and said, "You're crazy." I said, "Come on over for lunch." I told him the whole story and he gave me the order right away. In about three weeks we were producing these parts for him. All my competitors couldn't understand how I did it. I told Buddy, "If they ask, just show them my invoices."

The oddest experience I ever had was many years ago with Samsonite [Corporation] luggage. In my lecture courses I always made the offer that if I could solve a problem easily over the phone or by looking at samples or drawings, I would be glad to do it at no charge. I still get such requests. One day I got a telephone call from someone who gave me his name and asked if I remembered him. I said, "No." He was quite miffed because he said he was in my class some years ago. I said, "All right, what's your problem?" He said they were getting too much breakage caused by luggage being dropped as they were being loaded into airplanes. He wanted to know how thick to make the luggage. I told him that I didn't know how to calculate it. My suggestion was to alter a luggage mold so that he could mold pieces of different thickness and pack it, as would a typical flier. Then find the height of the loading door to the ground of the largest commercial plane and add 25 percent as planes would get larger. Get a ladder that high and drop the different thickness bags. You can then come to a business decision as to the most profitable wall thickness. He was insulted and said that this was not the way he thought a consultant should act.

About a month later one of my friends who consulted called me. He got the job and asked me for suggestions. I told him what happened. He thanked me and said he would send me a copy of his report. Several months later I received a large box of paper, which was the first time I saw computer printouts. Accompanying this was a letter saying that because of the nature of plastics, Samsonite should build a mold where they could alter the mold thickness, et cetera. There was also an invoice for twenty thousand dollars.

A bit later my ex-student called me again. He wanted me to evaluate their molding plant. I told him that I would do so only if he intended to listen to me, not like he did on the luggage wall thickness which cost him twenty thousand dollars. To say that he was flabbergasted would be one of the world's great understatements. We agreed on a consulting price and I went to visit him.

When I arrived there he was not very pleasant. I later found out that was the way he was. He certainly rubbed me the wrong way. It is important to give a consultant as high a status as possible. This breeds cooperation among their employees. He did the opposite. I went through the plant with the general manager and molding supervisor. It was a huge plant because at that time they did all the operations themselves. These two men were not particularly fond of him. The main problem was that he did not have a knowledgeable mold designer. They were using four ¼-inch knockout pins to eject a molded luggage half about 36-inches-by-54-inches. This caused a seven-minute cycle because a faster cycle caused white stress marks from the ¼-inch pins. Their in-house mold designer only had experience on small parts where ¼-inch knockouts were all right. I explained the problem to them and the operator and suggested that if they would use four 1-inch pins instead of the ¼-inch pins they could cut the cycle by at least half.

We came to another machine molding a much smaller part with the same results. I asked if they could do put in larger KOs while I was out with the boss for a long lunch. They said, "Yes," and I informed them of my plan. I was sure that the cycle would increase by at least 25 percent.

Before we went out to lunch, I told the boss that I could cut the cycle of one of his machines by about 25 percent, but I would have to call on witches. He thought I was crazy. I told him that if they did not do it, he would not have to pay me for my trip. But I added that if I had to use them I would raise my consulting fee 25 percent as they had to be paid. He didn't know what to do. I clinched the deal by saying the increased production would pay him back many times over, so he had nothing to lose. He agreed. We went out to the plant where I took out my handkerchief and waved it over my head a number of times, which was the go-ahead signal for the mold change, and mumbled some nonsense.

When we came back from lunch, I walked towards the machine and the operator ran towards the boss screaming in Spanish that a miracle happened: all of a sudden the mold ran twice as fast. He ran with her to see. They had the old production records there to show him. I hid behind another machine because I couldn't control my laughing. The end result was that he paid the extra 25 percent, and whenever I came into the plant everybody waved a handkerchief or a rag. In the short run he saved a lot of money by changing the sizes of the knockout pins on all his molds. Nobody would tell him what happened. They all said, "Ask the witches."

Another experience, in 1962, was less than brilliant. Tensor Lamps was the first to sell high-intensity lamps. The base and the small swivel parts were being molding in ABS by another molder and they were getting breakage on the small swivel connectors that were used to direct the light. Marbon, the material manufacturer, recommended me for the job. Tensor Lamps was on Eastern Parkway in Brooklyn. I saw their engineers, and I told them that I could immediately correct the base part. That was no problem. But correcting the swivels required a redesign and a lot of mold work. They needed the swivels so badly that they asked me to mold them as best I could and they would throw out the defective parts. I did that, but they returned the defective parts for credit. I went back to them and said, "This was not our agreement." They said, "We don't care. You shipped us junk." I replied, "Take the credit, and take back your molds." The owner of the company asked me to come and see him, which I did. He asked me to stay on, and I told him, "Number one: I don't think this is a great item; and number two: I can't operate this way. I need people whose word I can trust without putting everything into writing." Of course, it became one of the largest molding jobs in the country for years. Even if I could do it over, I would do the same thing because in business, you have to have trust in the people with whom you deal with, and if you don't have that, forget it.

TRAYNHAM: One of your largest customers was Craftool [Company]. How did that come about?

RUBIN: In 1962 Marty Miller came into my office, recommended by Rudolph Bass, a large retailer of machine shop equipment and small tools whom we both used. He was the founder and owner of Craftool (Shop-Vac), which supplied craft items to schools and the wholesale market. He saw the need for and designed a semi-commercial vacuum cleaner that could be used both in schools and homes. He had a molder make the plastic fittings.

The molder in Cleveland was not very satisfactory and the distance made communication difficult. He brought me a shot that was molded in gray high-impact polystyrene. I could see the problem: the runners were much too small. I offered to fix the mold at no charge. My price was considerably lower than what he was paying. He had the mold sent to us. A long and mutually fruitful business and personal relationship started. In addition to being a great businessman, he was an art connoisseur and collector.

Together, he (with the idea) and I (who converted it into plastic for him), developed a number of different items including a powerful hand vacuum cleaner and his largest item, the 5-gallon Shop-Vac. One item was, technically, particularly interesting. It was a lapidary device for tumbling and polishing semi-precious stones (figure 35).

The item was molded in gray high-impact polystyrene. To save money, the plastic material was colored by tumbling the dye and styrene in a steel barrel. The assembled lapidary tumbler was about 8 inches tall. The four parts, body, rim, cover, and threaded hub had to be molded on one shot because it was impossible to consistently color the plastic material and have a perfect color match in the molded parts if they were molded separately. The match was required because the item was destined for Sears and I knew their quality standards.

Even though it was to be molded in a 60-ounce plunger preplasticizer with a 425-ton clamp force, there was not enough room to mold all the parts on one level. Three-plate molds were, then, fairly common, but all that was molded on the third plate was the runner system. Logically, there was no reason to prevent molding a part on the third plate runner level. We did this, molding the cover and using air operated knockout pins to knock it out. It worked perfectly. The hub had an internal thread to match the one on the motor. Rather than building an automatic unscrewing mold, which was expensive, we molded the hub on a removable pin and unscrewed it on the table. The operator inserted a new pin into the mold, started the cycle, cemented the rim to the body, unscrewed the hub, put it in the body, put on the cover, and sealed the cover with scotch tape. This gave a perfectly matched set of parts.

An interesting thing happened. The only plastic magazine for many years was *Modern Plastics* considered to almost be the plastic bible. The editor, Mr. Hy McCann, would visit different molding shops looking for material to publish. He and Mr. Robinson became friends, so when he arrived out came the Shivas Regal to lubricate the occasion. I was not around on one occasion when he first saw the lapidary tumbler being molded. He immediately sent his draftsman down, and published an article about it (7).

Normally, he would show me the article before publication. This time he did not. Mr. Robinson gave him the particulars and that it was for Sears Roebuck. Mr. McCann credited Craftool, us, and Sears. What Mr. Robinson did not know was that Craftool told Sears that they were doing their own molding. Marty told me that and asked me not to divulge that we were the molders. As soon as the article came out both Sears and Marty saw it. That caused me a lot of woe.

MP's artist drew both a hole for a retainer that could not be possibly done physically and with the mold chained together. The next time Mr. McCann came in, he said he had lots of letters asking how one could drill that hole and how one could run a mold with a chain connecting both halves of the mold (of course you can't. It was on to prevent the mold halves from separating when the mold was put in and taken out of the machine). Still furious, I told him we drilled the hole with a right handed rubber tipped carbide drill (figure 36) and that the machine ran faster with chains! Then I stormed out of the room. Later Mr. Robinson properly upbraided me.

The next time Mr. McCann came in, I apologized and gave him the correct answers to his questions. He was completely astounded. He said that he replied to the letters, many of which came from some of the largest companies in the United States, using my original explanation and not one wrote back and asked where to get such a drill. He called his office and his secretary came with copies of these letters before he left.

This was the first time I really understood the power of the printed word. Being a photographer it was easy for me to make slides. More than once I would make a slide of a graph or drawing and show it to a customer using my hand viewer with exceptional results.

One of the companies who sold our lamp parts was Angelo [Brothers Company]. This was also one of the largest suppliers of switch plates (figure 37). Angelo was having them made overseas, so the problem was that they were out of stock all the time. For a parts distributor to have to back order and reship, with all the paperwork and dissatisfaction, was a disaster. So Angelo took their best selling ones and had me build molds for them. We produced many switch plates for Angelo most of which were hot stamped. One of the problems with the switch was that the plates were used in the kitchen or the bathroom. The products you use there can leave enough grease on your hand to affect the hot stamping. So I came up with an idea, which was not new, but I had never heard of it. I took foil that was preprinted on rolls of very thin plastic. I put the roll of foil on top of the press and then I pulled it down so that the imprint we wanted was directly over the mold. The machine closed and molded over it, so we had a switch plate which had the colored design protected by plastic. Then the roll would move down again. I used a photoelectric cell to locate a black spot printed on the side of the foil. We made a very large number of parts like that. As a matter of fact, any high volume hot stamped decoration is really cheaper to do that way because even though the foil is more expensive than hot stamping foil, there was no secondary operation.

TRAYNHAM: You mentioned that you had an interesting experience with the Chinese method of birth control through the United Nations [UN].

RUBIN: The United Nations was called upon to help Mainland China because at that time China was considered a Third World country. Their huge population explosion made birth control a necessity. As is well known, China adopted its "one child" policy. They did a study to find the most effective birth control method. They chose the intrauterine device [IUD], because it is safe, easy to train people for its insertion, reliable, and inexpensive. It is 95 percent plastic and 5 percent copper with a plastic string to be used for removal. China needed hundreds of millions IUD's and asked the UN to provide them with the expertise to build the molds and run them. When you stop to think about it, China has about a half-billion women of childbearing age, and if you figure four IUD's per person (extras were needed for storage loss, et cetera), that amounts to two billion units. They wanted to build one experimental plant, and if it was all right, replicate the plants throughout China.

The UN wanted me to set up a school to build and run the molds in China. This was at least a three-month job. They had selected me because my book had been translated into Chinese. I asked my publisher if we received Chinese royalties. The answer was a resounding, "No!" Since I wanted to recoup my "lost" royalties and did not intend to spend three months plus in China, I quoted a million dollars. After they got over gasping, I suggested that it would be a lot cheaper to bring the Chinese technicians here where I could set up an injection molding school while they built the molds. We eventually agreed to this at a much lower price.

I set the technicians up in a motel in New Jersey very close to Orbit Tool. Mr. Al Schuster, the owner, arranged for permission from the union and insurance company to allow them to build the molds in his plant. We tested them on the American machine that was to be used in China. The seven technicians returned to China after building the molds and testing them here. They established a number of plants in different parts of China. It was a fascinating experience. These men were extraordinarily bright. They had an interpreter, but each man understood English very well. I often told a joke or two to relax the group, as it is difficult to learn without a break. They would laugh before the interpreter could translate.

Notwithstanding, they insisted on using him. I think it was a matter of national pride and obeying orders. As part of my teaching technique, I always ask students questions. It is not important that the answers be correct, but their answers tell me how well they understood what I am trying to teach. I urge my groups to answer even though they might have to guess or even if they are not sure. These men were so trained to be careful in what they said that I could not get them to reply unless they were absolutely certain.

Another interesting experience happened when I made the statement that 99 percent of hydraulic problems are the result of dirty oil. The Chinese technicians politely disagreed with me, a rare occurrence. The next morning we started later so they could watch the launch of a space shuttle on television. The mission was scrubbed because NASA [National Aeronautics and Space Administration] had forgotten to replace the oil filters on the shuttle's hydraulic system and everything clogged up. It took a month to fix. The next morning I received a scroll from them in Chinese saying that I was now considered to be one of the world's great teachers.

TRAYNHAM: Your plant was in New Jersey rather than in Brooklyn?

RUBIN: Yes, at that time it was in Jersey City. Setting the technicians up near our plant was not possible because we were in an industrial area without motels. Additionally, China has a huge injection molding industry and they were familiar with injection molding. They wanted to be able to build the mold themselves, so being near Orbit was very important. I took them on an orientation tour and we went into a huge supermarket that had food and almost everything else, similar to a Wal-Mart. They never realized how many things were made of plastic. They were flabbergasted, as such stores did not exist in China. My wife, being an excellent travel agent, took the crew on a tour of New York City including Chinatown. Their comments were that except for the Chinese writings, it had little to do with China. She also pointed out less safe places. One of them said, "You don't have to worry about us."

I returned to China to check their operations. They wanted a mold making shop in some of their molding facilities at the UN's expense, because they claimed there were no mold making facilities available. When I arrived at my hotel I looked at the English edition of the yellow pages in my room and noticed a large number of mold makers. I suggested to them that there was no reason not to use local mold makers. They replied that there were none in the area. I returned to my room to make copies of the yellow pages, but, to my amazement, the pages had been torn out. The concierge copied them for me from another book. Needless to say they got a lecture about underestimating Americans and a refusal to agree to their request for mold making facilities, a decision with which the UN agreed. The project was exceptionally successful.

TRAYNHAM: How did you become involved in the Plastics Pioneers Association, Inc. [PPA] history project and the Chemical Heritage Foundation [CHF]?

RUBIN: I joined PPA in 1993. The membership is limited to two hundred fifty, all of whom have been in the industry for a long time. These are the people who really started it. Candidates are rigorously screened for their contributions to the plastic industry. PPA's main function is plastic education. It meets twice a year in February and September.

TRAYNHAM: What's going to become of the Association?

RUBIN: We keep on getting new members as the old ones die. There is a waiting list.

TRAYNHAM: Will they be pioneers still?

RUBIN: Hopefully. I know most of the members. Being an activist, I felt that PPA should do more than establish scholarships. I had been receiving calls from widows of plastic friends asking what they should do with their husband's papers and artifacts. In 1995 I contacted the National Plastic Museum in Leominster. They, correctly, had no interest in the project. As I later found out, this was a project for historians with special expertise, state of the art computer facilities, and people to program them.

PPA formed a committee with me as chairman and John Hull, the PPA president, Glenn Beall, Guy Martinelli, Mel Kohudic, and Harry Greenwald. The latter two resigned and Dewey Rainville became the fifth member and Terence Browitt the sixth. Frank Nissel just joined us. It became evident that there were two separate items, collecting the business histories of those who started the plastic industry and collecting plastic artifacts. Our proposal for the history project was approved by the PPA's board of governors and primary funding provided by several board members. This took several years.

It became evident that it was one thing to collect information and another thing to make it useful. Through the committee's efforts, PPA joined the Chemical Heritage Foundation located in Philadelphia. CHF is the historian and librarian of the chemical industry and was uniquely qualified for this project. They agreed to take the material we acquired, and make it useful and available to historians and researchers. The committee selected six PPA members who represent the major plastic manufacturing processes. These members were Glenn Beall, John Hull, William McConnell, Frank Nissel, Dewey Rainville, and I. We arranged and paid CHF to conduct oral histories of which this is one.

The program now includes the PPA, the Plastics Hall of Fame, and one thousand senior members of SPE. We expect to expand our coverage to all the major plastic organizations and people in the United States, Canada, and Mexico when we become more experienced. We will relate our experiences to the plastic groups in Europe, the Near and Far East, and suggest they might do the same.

The project is so important, as I see it, that I would like to include our initial invitation to our members to join in this project (Addenda IV).

TRAYNHAM: That's a good idea. Can you tell me about your artifacts program?

RUBIN: In collecting plastic history the question of artifacts arises. I have half a garage full of plastic parts. I thought a lot about collecting artifacts. It expanded to collecting all parts—or as many as possible—made in the United States and putting them into an enormous database. Then you could give, via CDs, a visual plastic museum to every classroom in the country. You could use the parts to set up museums in every college, high school, and public school as well as in museums. However, the cost of physically collecting all those parts is enormous, beyond our capacity, physically, as well as financially. Things changed about a few years ago when digital cameras came out. Now we can collect the pictures of the parts, and by knowing what we want, get all the information on-line digitally so that we wouldn't have to handle anything. If there's a part we want to collect for a museum or school, we could just ask the person to give it to us. I've spoken to the Chemical Heritage Foundation because they're absolutely perfect for this type of project, and they asked me to write a proposal, which I'm in the process of doing.

Such a database has enormous potential. Education, engineering, technology, medicine, design, art, history, and marketing are but a few exciting areas where such a database would be invaluable. It would have great commercial potential. For example, if you're in the plastic industry and you want a certain part that someone else has, instead of making it yourself, at maybe a tool cost that can go as high as a hundred thousand dollars, this database would bring buyer and seller together with a benefit to both. The owner would be glad to sell it to you because he would be making money and removing a potential competitor. The buyer could save a lot of money and time. The database has a great impact in many other ways. If you're designing something and you can buy a database with similar parts, it would certainly help you in your design. Imagine how your grandson would feel if you gave him a CD-ROM, containing a listing of all the toys made last year, so that he could pick out one toy and buy it. Such a database would reflect the industrial history of the United States because plastic is the second-largest material we use, and the third or fourth largest employer.

It's going to be impossible for people to make intelligent decisions about their environment and their life without really knowing about plastic. Do you remember the big problem surrounding converting glass eyeglasses into plastic? If people understood that a broken glass lens could blind you while your eye is protected with plastic, there would have been no resistance. The same thing is true about plastic pipe. It's been in use for decades almost all over the world, yet New York State refuses to permit its use because of the plumbers union. I guess the plumbers union contributes more to the governor than the ordinary homeowner. So again, educating people about plastic is very important. A database like this where you could get almost any information you want would be of tremendous value.

That is part of the reason, I suppose, that I got into the Hall of Fame. I'm not always the one who comes up with an idea, but I don't believe ideas are worth much unless you put them into practice. I was known as a doer, and I've been chairman of a lot of committees. Every one of them has been quite successful for a simple reason: I look upon myself as a chairman, not the boss. I'm the executive arm of the committee. I do what they say even if I disagree, which happens on occasion. When they come to a decision, I follow it as if it were my own because I've learned that two heads are better than one, and six heads are certainly better than one. That's why I got the handbook done so easily even though it was a lot of work, and why this plastic history project is going well. The people who work with me know that their information and input counts. They're just not on there for their good looks.

TRAYNHAM: Are there any people in the plastic industry that you would care to mention?

RUBIN: Yes, two, the first is George Lubin and the other is A. Reynold Morse.

In 1942 the United States was in a difficult position because of the proliferation of magnetic mines used by the axis powers. Metal mine sweeping boats could not be used as they detonated the mines.

While wooden boats did the job, there were not enough facilities or personnel to make the large number of mine sweepers quickly enough. To solve the problem they went to a new and unproved technique for manufacturing large structures—glass fiber reinforced plastics. The government turned to George Lubin, considered the "father of reinforced plastics," and who, if I recall correctly, was then working for Whitman Corporation. He was a lifelong friend and I heard this story directly from him.

They made the mold for the hull. To this day it is one of the largest parts made in this process. George directed the casting of the gel coat and the reinforced glass layers. He had a deadline, as the wife of the assistant secretary of the Navy was to dedicate the boat within the next twenty-four hours. Having been up thirty-six hours in a row, he and his crew left the pouring of the last coat to other Whitman personnel.

Then came the great moment when the wife hit the prow of the fiberglass boat. It slid down the ways and beautifully sank to the bottom of the river. It turned out that the Whitman crew never heard of plastic and cast the final layer with concrete!

In designing a boat, the launch is critical. Knowing the dimensions and weight of the boat, the angle length, and friction of the ways enables the designer to be sure that the boat doesn't sink on launch. After the concrete was laid, the workmen put the boat on the angled ways to be ready for end-launching the next morning. The concrete did not stick to the plastic and slid down and collected at the stern. This added weight and increased the momentum of the boat so that it went under water and sank. The extra tilt caused by the concrete in the stern did not help.

After raising the boat, chipping out the concrete and casting it correctly in plastic, the launch was perfect. George's calculations were correct. This was the first of many such plastic boats. As the process improved and costs came down, many new applications developed. The fiberglass boat hull was one of the first.

George was a remarkable and fascinating man. Born in Russia, he came to the U.S. as a young man, became an American citizen, and, for one person, made and was responsible for an extraordinary number of advances in American technology.

He went to work for Grumman on Long Island. He introduced tbe first plastic reinforced parts for use on warplanes. This led to the enormous use of plastics in today's planes. He was in charge of plastic materials used in the construction of the lunar excursion module [LEM]. It was the only part of the space program that never had a failure. It brought back the only damaged Apollo mission. Even though he was technically the director of plastics, be was the *de facto* director of the project.

He was the only Russian-born American citizen that was allowed complete freedom to travel and photograph in communist Russia. He visited almost all of the Russian Space Program construction sites and other sensitive areas because they learned more from him than he could have possibly stolen from them.

George also accidentally acted as "interpreter" in the famous Nixon-Khrushchev "kitchen debate" at our exhibit in Moscow. Knowing both of them, he was standing near them as they toured the exhibit. For some reason they got into a heated confrontation and started swearing at each other. As George told me, they were pretty good at it. Both interpreters were so scared they kept quiet. George, who spoke Russian as a native, translated. Instead of translating idiomatically, he deliberately translated literally, making it sound so funny that they started laughing which defused the situation.

He received so many awards. I remember his wife, Bea [Lubin], telling me and my wife that she wished he would "quit with the awards" as they had no more room left on the walls of their den.

Ren Morse, founder of Injection Molders Supply Company [IMS] was born in 1914, received a degree in geology from the University of Colorado and an MBA from Harvard [University]. In 1941 he started his career working for Reed Prentice, a major injection molding machine manufacturer. He established and directed their Cleveland office. In 1943 he charted the Cleveland section of SPE.

While working there he realized the need for plastic accessories and replacement parts on a timely basis. In 1949 he established IMS. They provided a product line with a vast selection of quality accessories. He helped develop such items as mold chillers, at the press granulators, hopper dryers, vacuum-type hopper loaders, screw tips with ball-type shut off, and augur grinders. His products were superb; deliveries were usually from stock (very important for molders because downtime is so expensive) and sold from a remarkably clear and complete catalog.

He had his own newsletter, *Injection Molding News*, in which he focused on his own products. As important, he stated his views about the injection molding industry and the plastics world in a dynamic manner. Many of his "controversial ideas" proved to be true. He gave space to replies as well as disagreements. Usually I would put plastic publications aside to be read at my "leisure," but *IM News* always got my immediate attention.

Ren was a man of many interests. I have a book of his poems. He and his wife Eleanor met Salvador Dali when he was a struggling painter. They helped support him. Their support resulted in a life long friendship and a collection of Dali paintings through all his stages. Ren exhibited them in his office building. The value appreciated to hundreds of millions of dollars. Estate taxes would have bankrupted his family. He established a trust and donated the collection to it. In conjunction with the city of St. Petersburg in Florida, he established The [Salvador] Dali Museum. It is now the second largest tourist attraction in Florida, the first being Orlando.

There was a non-public side of Ren. He firmly believed that people should be judged on their merits. To this end, he established a West Coast distribution center in the Watts district of Los Angles. He employed local help. This was typical of the man. He knew what he believed in and acted accordingly.

TRAYNHAM: Were you the first to put plastic educational material on tape?

RUBIN: I think that is correct. Another thing that I did with Lou Naturman, the person that rewrote my book and edited it, was to put our lectures on tape. Then the only system available then was 1-inch tape. We started a company, Visual Learning, in 1973, where we put plastic lectures on tape. They were:

1. Introduction to Polymer Science by Dr. Herman Kaufman, Director of Physical and Applied Science at Ramapo College of New Jersey.
2. Real Properties of Plastics by William T. Frizelle, President of Applied Plastic Technology, St. Louis.
3. Injection Molding by Irvin I. Rubin, President of Robinson Plastics Corp., New York City.
4. Rotational Molding by Jack M. McDonagh, marketing specialist, Celanese Plastic Company, Newark, New Jersey.
5. Reinforced Plastics by Gerald D. Shook, Consultant, Huntington Station, New York 11746.
6. Encapsulation with Plastics by Julius M. Schiller, Advisory Engineer, IBM Components Division.
7. Plastic Materials, Sheldon Atlas, Professor of Chemistry, Bronx Community College.

The real problem was that nobody had machines on which to play them. The VCR was not yet publicly available. We did all right with it. Incidentally, an interesting thing was that we thought our major customers would be manufacturers. It turned out to be prisons. We sold a significant number to prisons, because in the plastic industry, if you want to work, we don't care what you did before. So the prison industry found that out, and trained their prisoners. Some of them did very well.

TRAYNHAM: When they left prison, did they find employment in the plastics industry?

RUBIN: To my knowledge, nobody was adverse to hiring them.

TRAYNHAM: So it was a very effective rehabilitation program.

RUBIN: Yes, because the trouble is, they have to get a job. If not, they're going to continue their criminal activity. Some of them were really smart and became foremen. Some of them were not, but were fully capable of removing parts from an injection molding machine.

TRAYNHAM: Tell me something about your work with the Society of Plastics Engineers.

RUBIN: I became a member of SPE in 1951. My aims were to meet my peers and to learn from their excellent programs. It was a great group. Eventually, I became program chairman. Next I became the New York Section president—I was so honored in 1957—the only political office to which I aspired. In that same year, I became vice chairman in charge of all arrangements for the Annual Technical Conference of the Society of Plastics Engineers [ANTEC] that was held in New York City. This was the first of the large and very profitable ANTEC. Many innovations were introduced, such as a keynote speaker, Dr. Herman Marks, the first speaker's breakfast, bulletin boards, and the first ANTEC presentation of what is now the International Medal. The Medal was in memory of one of the New York members and developed by Dr. Alex Sachar, who was also the program chairman of that ANTEC. It was a joint venture of the Newark and New York Sections and run by the sections rather than from the national office as is done today.

On the national level, I was chairman of the publications committee from 1966 to 1968. Before I became chairman of the publications committee, the staff operated on their own. I became involved, saw the budget and advertising statistics for the first time and made sizable contributions to the program. We started publication of *Plastic Abstracts* which lasted only two years, as there were not enough subscriptions to cover the costs of production.

I was technical volumes committee chairman from 1968 to 1970. Virtually no books had been sponsored by SPE. Our goal was to get a large number of books published by standard publishers and then develop our own book publishing business. We completed or started twelve books in that two-year period. Towards the end of the second year, the national office demanded written operating procedures and a lot of other bureaucratic requirements. The members of this committee were only interested in publishing books. They did not want to waste their time on anything else. Although the committee continued without them, there were no more books produced by SPE for about ten years.

I was the liaison between SPE and the American Chemical Society [ACS]. I was also chairman of the I. T. Quanstrom Foundation. Mr. Quanstrom was founder and owner of the Detroit Mold Engineering Company, which invented and pioneered standard injection molds and mold components. Prior to that, one had to buy steel and construct the mold from scratch. He made mold bases better and cheaper than a mold maker. By standardizing mold parts, he made mold repair and maintenance much better and easier. He endowed this foundation to promote plastic mold making and mold design. This group is under the aegis of the mold makers division of SPE.

I was elected a fellow of the Society of Plastics Engineers in 1989. I am a fifty-year plus member of the American Chemical Association and a member of the American Association for the Advancement of Science [AAAS]. I was a consultant to the New York City Board of Education on plastics, adjunct professor at the New York Institute of Technology, president of the Injection Molders Guild, member of the Plastics Pioneers Association, and chairman of the PPA's history and artifacts committee.

TRAYNHAM: What do you think contributed to your success in the plastic industry?

RUBIN: The main reason is that I was given an exceptional set of genes from my parents, both of whom came from a long line of scholars. They taught me by word and example the importance of study. For as far back as I can remember I wanted to know how things worked. This curiosity served me in good stead in my plastic career.

When I was young, America had a different work ethic. Hard work was essential to success. I feel that hard work plus great genes were the major factors in whatever I accomplished. There was no such thing as going home at night and not having all the machines running. There were times when I slept overnight at the plant or didn't get any sleep until the next day. Another reason was that I was basically extremely inquisitive. I always wanted to know why and how.

Whatever I learned I always wanted to impart to those that it would be most valuable. I started teaching in Sunday School and still love to teach. In the long run you learn more by giving information than by receiving it. When you are open, most people fully reciprocate. It is the old saying, "A good deed brings on another good deed."

My plant was always open and I don't think a month went by without having visitors from the United States and foreign countries. We occasionally had Japanese visitors who had hidden cameras through their tiepins activated by squeezing their shoulder. My molding manager, John Gannon, noticing this, and came out with a flood light and suggested that it would give them better exposures on their film.

As an example of inquisitiveness, I often wondered how much energy was used in an injection molding machine and where the energy went. I completely instrumented a reciprocating screw injection molding machine, recording all energy that went in and out. We measured the temperature and volume of the cooling water going in and out of the mold and the machine heat exchanger, measured the mold and machine temperatures to calculate radiation losses, and built a calorimeter to measure the heat left in the molded part. This gave me a much clearer understanding of the process and improved our mold design and cooling efficiency.

Another example came when we were molding DAX frames. DAX frames are clear polystyrene boxes with cardboard boxes that snap into the plastic to hold the picture. We were molding an 11-inch-by-14-inch frame when we noticed a distortion running the length of the frame. It was caused by the waterline being too close to the molding surface. The pressure of the material was above the yield point of the steel. Even though the core sank only about 0.0004 it showed up very clearly. We had to have a new core built which took almost a month. I took the damaged core and drilled cooling lines at different levels beneath the molding surface and continued to run the mold, regrinding and reusing the styrene. I was then able to determine a safe distance to be used in mold design.

The other basis for my success is that I tried to give our customers the best plastic advice and quality that I could. Because of our contacts with so many different customers and industries, our people accumulated a wealth of knowledge which was shared with the customer whenever possible. This included help not related to our plastic products. Even though we were very small, we were able to service some of America's largest companies.

TRAYNHAM: Mr. Rubin, you've given us a very interesting overview of your business career, including examples of your business acumen and your business philosophy in dealing with other business persons. As you look back over your career, what would you pick out as being, in your estimation, your chief contribution to the development of the plastic industry?

RUBIN: I was honored by being elected to the Plastics Hall of Fame in June 1994. This is the most prestigious award in the plastic industry. There are only thirty-three living members world wide. Since so many people have made huge contributions to the plastic industry, it is very hard for me to understand why I had been selected. An honor such as this forces one to ask what one did to deserve it. It took me quite some time to sort that out.

I was walking in a hallway at the SPE Annual Technical Conference in 1991, when one of my friends said to me, "Congratulations." I said, "What for?" He said that I had qualified to become a member of the Plastics Hall of Fame. I said, "Fantastic." He then said that I would not be inducted. I asked, "Why was I selected for this signal honor?" He replied that they had ten equally qualified candidates, but only nine openings. They elect nine members every three years at the National Plastics Exhibition in Chicago. They figured that I was the most likely one to be alive three years later. Happily, that was the case.

I had never understood why when a Nobel Prize winner was awakened in the middle of the night by the newspaper reporters telling him he won the prize, he would ask "For what?" You don't win a Nobel Prize unless you've done something absolutely remarkable that is recognized worldwide. But on a much lower level, when I was told that I was going to be inducted to the Hall of Fame, I didn't really understand why for a long time, because you really are doing the same thing every day. You see the same face in the mirror everyday when you shave. But after that eight or nine years of thinking about it and receiving comments from others, I think the most important thing that I did was that I established a theory of injection molding based on scientific principles. Before it was a black box operation—you tried this, you tried that, and by experience you learned what to do, but you never understood why. I was able to explain that in my book and in my lectures.

There was a rippling effect from it. For example, as I mentioned, the check lists for *Correcting Molding Faults, Mold Design* and *Plastic Design* spread worldwide in the plastic industry. That I would say was also a major contribution. Another was starting the SPE seminar program. Dr. Herman Kaufman and I conceived the all-day seminars in the late 1950s or early 1960s. The seminars were eagerly accepted by SPE and proliferated to other groups worldwide. I did a lot of lecturing for SPE, Plastic Seminars, and other in-house programs. Literally thousands of students have gone through my courses. I have received many letters telling me how much they helped.

Another thing was in vacuum and pressure forming. The plant that Danny Lewis and I built was one of the first plants in New York City. I knew a little about forming as I did some at Columbia Plastic. When I built the machines at RLR, it never occurred to me not to make them automatic. I think ours was the first automatic vacuum forming machine where all you had to do was to clamp the cold plastic sheet on to the frame and push two buttons to start the machine. The operator could be cutting or doing something else. I designed the electrical circuits. I built all the equipment in our machine shop. Another thing was introducing internal carving and coloring in fabricated plastic parts.

Much more important was developing vacuum metalizing on plastics. The process was there but it was not practical in plastics because of poor adhesion. Its main use we found was for throwaways. We did a lot of interesting work in the medical field by developing, molding, and assembling medical items with customers.

Finally, I'm an activist. In New York, there are these "one-minute bytes," where people are able to speak their mind. The station WPIX allowed time for rebuttals. At that time, Nassau

County was trying to ban Styrofoam cups because they had a problem with their landfills. A woman used a minute to blame all the landfill problems on Styrofoam. That really got me. So I wrote the station a letter saying that if plastic cups never existed, they still would have the same problem with their landfill. And I made a number of suggestions on how to solve the landfill problem. They had me on the air to give a two-minute rebuttal. They would have programs on plastic and use me from time to time. One example was on a half-hour interview program on the Styrofoam cup issue. On the side of abolishing the cups was a very attractive young lady who I found out later was an actress employed by the paper cup industry. She made all kinds of absurd statements like, "When Styrofoam cups are on the ground little tots pick up pieces and eat them." The comment by the moderator to me privately after the taping was that I demolished her. Any time I saw something incorrect in *Business Week*, *The Times*, and so on, I wrote the appropriate letters and got results.

I'd like to talk for a very brief time about the plastic industry.

TRAYNHAM: Please, go ahead.

RUBIN: The plastic industry was made up of men who never asked, "Can you make the part?" They asked, "How can you make the part?" They did what was really unimaginable. Is that the right word?

TRAYNHAM: Yes.

RUBIN: The plastic industry started to become important during World War II. Returning GIs found this brand new industry intriguing and full of promise. They had no money, but brains and vision. They went into an industry about which nobody knew very much and whose future was uncertain. They started with one easily financed machine in their garage, ran it with family and friends, expanded to two machines and grew to provide this country with one of its most remarkable growth industries.

If you divide history into fifty-year periods, there's been no fifty-year period in history compared to the fifty years from 1950 to 2000 where the way we live has changed so drastically. Essentially, it happened because of plastic even though you might not easily recognize it. For example, the women's liberation movement, as we know it today, would not have been possible. My mother had to go to the butcher, the baker, the grocer, fruit and vegetable store, the dairy and the drug store—all separate stops. Then she had to take the food, prepare it, and cook it. Now, because of plastic packaging you can buy everything in one store. What a time saver. You don't even have to cook anymore. You can just heat. Then there are things like plastic diapers and wash-and-wear clothes. I remember my mother had a washboard in the sink. After washing, she had to hang the clothes out to dry. Then she spent hours ironing. Today because of plastics we have wash-and-wear, which is not only stain resistant, but you just throw it in the machine and take it out. Things like that gave women the time to have a job, raise children, and have a husband or live-in, if they so desire. They could not have done this without plastic.

You take any field and you will see the results of plastics. Take the medical field, for example. Hospital infection has been cut down to approximately 20 percent of what it used to be because everything is now disposable. Disposable sheets, disposable food service, disposable syringes, et cetera. Take just a very simple thing. When my mother had a cataract removed many years ago, they put in a glass lens held with a metal holder. She had to lie on her back for two weeks with a weight compressing her eye so that the body could grow around the heavy piece of glass and metal. Now, I had a cataract operation. In twelve and a half minutes, the lens was out, an acrylic lens went in, held by a polypropylene holder about the thickness of your hair. And in twelve and a half minutes I went from virtually blind, where I thought my doctor's assistant was an American Indian, who turned out to be a bleached blonde to vision that is now correctable 20/20. These are just some of the minor miracles wrought by plastic. It was difficult, it was hard work, and many times you're really up a tree and aggravated, but it was a wonderful learning experience. It was just a great experience. Would I recommend it to my children? No. It's too competitive now. Assuming that the idea of business is primarily to make money, one can find many better ways than in the plastic industry.

I have been most fortunate in that within fifty years I have been able to see an industry grow from nothing to the second largest user of material and the fourth largest employer in the United States. The sense of discovery, the newness of the problems every day, the exhilaration of doing things and making things that no one ever thought about before has made my business career an absolutely engaging and fascinating experience. I cannot imagine any other occupation that would have come close to it. And finally, my wife and I are indebted to this industry that has provided us with lifelong friendships with exceptional people.

TRAYNHAM: Mr. Rubin, this has been a fascinating session. You have many more stories, I know, to tell to give a complete record, but this overall view will certainly give all interested persons a sampling of your extraordinary career and your success as a business person. It's particularly striking that a person who had to start at minimum wage in a company where he didn't know what the product was or anything about the industry, could come to own the company, and become a member of the Hall of Fame in the industry. This is a genuinely impressive accomplishment for your career, and I hope that your projects that you have underway will continue to fruition. On behalf of Chemical Heritage Foundation, I want to thank you.

RUBIN: You're welcome indeed.

[END OF INTERVIEW]

NOTES

1. Johann David Wyss, *The Swiss Family Robinson* (Cleveland: M. F. Tokker & Co., 1853).

2. Robert Louis Stevenson, *Treasure Island* (New York: Charles E. Merrill Co., 1909).

3. Irvin I. Rubin, *Injection Molding Theory and Practice* (New York: John Wiley & Sons, Inc., 1973).

4. Margaret Mitchell, *Gone with the Wind* (New York: Macmillan, 1936).

5. Irvin I. Rubin, *Handbook of Plastic Materials and Technology* (New York: John Wiley & Sons, Inc., 1990).

6. See Note 5.

7. "Impact Styrene Out-Performs Metal," *Modern Plastics* 41, no. 4, (December 1963): 88-89, 165.

ADDENDA

ADDENDA I

Mold Checklist

Piece Parts

1. Is this piece part drawing approved?
2. Have you read all the notes pertaining to the job?
3. Is the type of plastic material indicated?
4. Are the function, location, and use of the piece understood?
5. Can any changes be recommended to make a simpler or better piece?
6. Are the number of cavities correct?
7. Are tolerances indicated on all critical dimensions?
8. Can these tolerances be maintained?
9. Are the dimensions including or excluding shrinkage?
10. What shrinkage factor is to be used?
11. Has adequate draft been specified?
12. Where does the draft start?
13. Have tapers been specified?
14. Has the parting line been approved?
15. Has the gate location been approved?
16. Is the gate location in the best possible place for maximum physical properties including orientation and packing?
17. Is the gate location in the best possible place for finishing?
18. In locating the gate, will anticipated weld lines prove objectionable esthetically or mechanically?
19. Will the piece hang (stay) on the ejection side?
20. Has the ejector mechanism(s) been decided?
21. Has the location of the ejector mechanism(s) been approved?
22. Is the ejection mechanism(s) sufficient?
23. Has the polish been specified, using the SPI system?

Machine

1. Will the mold physically fit in the presses to be used?
2. Is the mold thicker than the minimum thickness?
3. Is the stroke of the machine long enough to allow for part removal?
4. Is the ejection stroke of the machine long enough to allow for part removal?
5. Is the clamping capacity of the machine large enough for the parts?
6. Can the mold be clamped onto the press?
7. Is the injection capacity correct for the shot size?
8. Do the ejector holes correspond with those of the press?
9. Are knockout mechanisms needed on the injection side?

10. Are waterlines located so that they will not be in the way of the way of the operator?
11. Do waterlines interfere with tiebars or other mechanisms?
12. Do waterlines interfere with each other or are they too close to the platen?
13. If heating the mold is needed, are the electrical elements and controls safely placed?
14. Have the dimensions of the locating ring been shown?

Mold Design

1. Are the mold plates and component parts strong enough for the piece?
2. Is there sufficient steel surrounding the cavities and cores?
3. Are there sufficient support pillars?
4. Is one leader pin and bushing unsymmetrical?
5. Will the leader pins enter before any other part of the mold?
6. Is there ample clearance for the leader pins on the other side of the mold?
7. Is there sufficient travel for the ejector plates?
8. Are the ejector plates on their own leader pins and bushings?
9. Are the ejector plates strong enough?
10. In a stripper plate mold, is the stripper plate properly supported?
11. Have push back pins been provided?
12. Does the sprue bushing fit the machine?
13. Can the sprue bushing be made shorter? (Especially in three-plate molds)
14. Have the dimensions of the sprue bushing been shown?
15. Are there sufficient cooling channels in the cavities and mold?
16. Do the knockouts clear the waterlines?
17. Are the runners specified and VENTED?
18. Have gates been specified? If so ignore and gate at tryout.
19. Have run-offs been provided when required?
20. Has venting for the cavities and runner system been specified?
21. In cam acting molds, have provisions been made to harden all moving parts?
22. In cam acting molds, can cams be tightened without removing the mold?
23. In cam acting molds, can pins be changed without removing the mold?
24. If there are any electrical parts on the mold, are they safe?
25. Can the electrical parts be changed without removing the mold?
26. Have provisions been made for closing openings and depressions which might be filled up by a flashed shot?
27. Are steel and metal specifications shown?
28. Are heat treating specifications been shown?
29. Are surface specifications shown such as chrome plating?
30. If the mold is to be heated, have provisions for differences in expansion been made?
31. Have eyebolt holes been provided on each side of the mold and on heavy plates?
32. Where there are expendable parts such as springs, "O" rings and switches, has a specification list been shown?
33. Are bolt sizes specified either as US or metric?
34. Are mold parts such as sprues, leader pins, and bushings standard?

35. Have spare parts to be ordered been specified?
36. Can mold and cavities be disassembled in a minimum time?
37. Are all the component parts numbered and/or located for proper reassembly?
38. Has the mold been properly marked for identification?
39. Are the dimensions on the print the same as the dimensions on the mold?
40. Are there identifying marks on the side of all plates for easy assembly?
41. Is the type of steel marked on each piece?
42. Is there enough support on the "A" side under the locating ring?
43. Is there a schedule of completion dates for each stage of the mold building?

ADDENDA II

Correcting Molding Faults

Molding problems are the result of machine, mold, material, and management difficulties. They have been categorized by the way they appear on the molded piece.

I. Short Shots
II. Flashed Parts
III. Sticking in the Mold
IV. Sink Marks
V. Voids
VI. Poor Welds
VII. Dimensional Control
VIII. Warping
IX. Shrinking
X. Material Discoloration
XI. Splay-Mica-Flow Marks
XII. Sticking in the Sprue Bushing
XIII. Nozzle Drool
XIV. Excessive Cycle

It is not possible to present the items in each category in any order of importance or frequency. In most instances the fault will suggest the remedy. Referral to standard plastic reference works, the literature and manufacturer's publications will be helpful.

Before starting any corrections, short shoot the mold to make sure that all parts are filling evenly. If not, balance the gates. It is useless to proceed unless you are able to mold consistently, without mold release, regardless of the quality of the piece.

In injection molding, the quickest and least expensive way is to do the job correctly, without so called "short-cuts."

I. Short Shots

Short shots are usually caused by insufficient effective pressure on the material in the cavity. It may require increasing the nozzle-sprue-runner-gate system, increasing the temperature and pressure on the material, improving the mold design, and redesigning the part.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. No material in the hopper.

5. Machine capacity too small for shot.
6. Insufficient feed.
7. Sprue too small.
8. Gates too small.
9. Insufficient number of gates.
10. Incorrect gate location.
11. Material temperature too low.
12. Nozzle temperature too low.
13. Injection pressure too low.
14. Injection boost time too short.
15. Injection hold time too short.
16. Injection speed too slow.
17. Back pressure too low so that material not fully plasticized.
18. Feed system operating incorrectly.
19. Temperature control system operating incorrectly.
20. Thermocouple inoperative.
21. Heater band(s) inoperative.
22. Loss of injection pressure during cycle.
23. Non-return valve in front of screw leaking.
24. Nozzle clogged.
25. Magnet not clean.
26. Obstruction in hopper.
27. Material or colorant too wet.
28. Flow properties of material too low.
29. Wrong material.

II. Parts Flashing

Parts flashing are usually caused by a mold deficiency. Other causes are: insufficient clamp pressure, excessive material temperature, and material left on the mold surfaces.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Cavities and cores not sealing because of improper fitting.
5. Mold not sealing because foreign material is between surfaces.
6. Cavities and cores are out of line.
7. Mold plates are not parallel.
8. Insufficient support for cavities and cores.
9. Projected area of parts too large for machine clamp tonnage.
10. Land area too large around cavities and cores.
11. Insufficient venting.
12. Vent clearances are too large—which looks like flash.
13. Machine not set correctly.

14. Clamp pressure setting too low.
15. Clamp pressure not maintained.
16. Feed setting too high.
17. Injection pressure too high.
18. Injection hold time too long.
19. Boost time too long or pressure too high.
20. Injection speed too fast.
21. Material temperature too high.
22. Mold temperature too high.
23. Return pins too high.
24. Material or colorant too wet.
25. Material flows too easily.
26. Wrong material.
27. Machine platens not parallel.

III. Sticking in the Mold

Parts stick in the mold primarily because of mold defects, insufficient knockout (KO), and packing the material into the mold.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Improper mold surface for material being molded.
5. Short shot not engaging KO system.
6. Insufficient KO. Consider air ejection.
7. Improper KO location.
8. Improper operation of KO system. i.e. cams loose, plates not moving in proper sequence.
9. Insufficient KO stroke.
10. Undercut(s) in mold.
11. Non-flat mold surface.
12. Burring, scratching, and pitting of mold surface.
13. Polish in wrong direction.
14. Insufficient taper on cavities and cores.
15. Vacuum not broken. Use movable spring loaded vent pin.
16. Adjust KO force.
17. Slow down mold opening speed.
18. Reduce feed.
19. Reduce injection forward time.
20. Reduce injection boost time or pressure.
21. Reduce injection pressure.
22. Adjust mold temperature.
23. Reduce mold temperature.

24. Increase cycle.
25. Decrease gate size.
26. Relocate gate.
27. Add additional gates.
28. Steel moving during injection.
29. Cavities and cores not aligned.
30. Radius all over and reinforce under KOS.
31. If part remains on the wrong side, undercut other side, change tapers, change direction of polishing, provide mold temperature differential, and consider chrome plating.
32. Not enough lubricant in material.
33. Contaminated material.
34. Material or colorant too wet.
35. Part degrading and losing mechanical strength.
36. Redesign part.

IV. Sink Marks

Sink marks are usually caused by insufficient effective pressure on the material, insufficient material, piece part design, and heavy sections—particularly those adjacent to thinner sections.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Insufficient material in mold. (See Short Shots)
5. Nozzle flow too low. Enlarge nozzle hole, reduce nozzle land.
6. Sprue diameter too small.
7. Runner size too small.
8. Gate size too small.
9. Not enough lubricant in material.
10. Injection pressure too low.
11. Injection forward time too short.
12. Boost time or pressure too low.
13. Injection speed too slow.
14. Adjust back pressure.
15. Cycle time too short.
16. Material temperature too high causing excessive shrinkage.
17. Material temperature too low reducing pressure transmission.
18. Injection capacity of machine too low.
19. Mold temperature too high.
20. Material or colorant too wet.
21. Core pins too hot.
22. Non-return valve in front of screw leaking.
23. Uneven wall thickness (ribs, bosses). Core where possible.

24. Redesign part.

V. Voids

Voids are caused by insufficient plastic in the cavity. They are caused by thermal shrinkage (volume reduction) when the outside hardens and the shrinkage is internal. This produces voids (vacuum) not bubbles (air).

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Insufficient material. (See Short Shots)
5. Nozzle flow too low, enlarge nozzle hole, and reduce nozzle land.
6. Sprue brushing too small.
7. Runners too small.
8. Gates too small.
9. Non-return valve in front of screw leaking.
10. Gate in wrong location.
11. Material temperature too high.
12. Injection rate too slow.
13. Injection hold too short.
14. Injection boost time too short or pressure too low.
15. Injection pressure too low.
16. Venting too small.
17. Clamp pressure too high preventing venting of volatiles.
18. Back pressure too low.
19. Air is entrapped. Vent, relocate gate. (See Poor Welds)
20. Material or colorant too wet.
21. Piece cooled too long in press preventing shrinking from the outside.
22. Parts cool too quickly. Cool parts in hot water.
23. Cycle too short.

VI. Poor Welds

Insufficient temperature and pressure and too much air cause poor welds at the weld location.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Nozzle opening too small or land length too long.
5. Sprue brushing too small.
6. Runners too small.

7. Gates too small.
8. Gate too far from weld.
9. Number of gates too few.
10. Gate(s) in wrong position.
11. Insufficient venting of piece.
12. Insufficient venting at weld location.
13. No run-off at weld location.
14. Adjust injection speed.
15. Increase injection hold time.
16. Material temperature too low.
17. Nozzle temperature too low.
18. Mold temperature too low.
19. Back pressure too low.
20. Material and colorant too wet.
21. Non-return valve in front of screw leaking.
22. Material contaminated.
23. Walls too think causing premature freezing.
24. Shifting cores causing thin walls.
25. Injection capacity of machine too small.

VII. Dimensional Control

Dimensional variations are caused by inconsistent machine controls, wrong molding conditions, and poor part design.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Feed mechanisms malfunctioning.
5. Non-return valve in front of screw leaking.
6. Inconsistent screw stop function.
7. Large differences in material particle size in hopper.
8. Large variation of particle size, batch to batch.
9. Variations in material as it comes from supplier, such as melt index.
10. Heater cylinder temperature control system malfunctioning.
11. Thermocouple inoperative.
12. Heater band(s) inoperative.
13. Uneven mold temperature control.
14. Back pressure control valve malfunctioning.
15. Inconsistent screw speed during melting.
16. Inconsistent screw injection forward speed.
17. Variations in injection pressure.
18. Cooling channels in mold are dirty.
19. Injection pressure too low.

20. Injection forward time too low.
21. Material temperature too high.
22. Mold temperature incorrect.
23. Cycle too short.
24. Gate size incorrect.
25. Part distorting during ejection. (See Sticking in the Mold)
26. Parts solidifying too slowly. Cool part in water.
27. Parts not maintaining their shape. Cool part in fixture.
28. Inconsistent cycle caused by operator.
29. Incorrect mold dimension causing part to be out of tolerance.
30. Change mold dimensions to give more parts within tolerance.
31. Injection capacity of machine too low.
32. Clamp capacity of machine too low.

VII. Warping

Warping is caused by molding conditions, part design, improper gate location, and heavy sections. High stress levels are a major factor in warping.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Feed too high.
5. Injection forward time too long.
6. Injection booster time too long or pressure too high.
7. Injection pressure too high.
8. Back pressure too high.
9. Incorrect injection speed.
10. Material temperature too high.
11. Incorrect mold temperature.
12. Insufficient venting. Consider movable spring loaded vent pin.
13. Insufficient knock outs.
14. Uneven ejection.
15. Improper location of knockouts.
16. Knock out system moving too fast.
17. Adjust gate size. Gates too large can cause packing with high stress levels. Gates that are too small do not allow enough material and cause shrinkage.
18. Change gate location.
19. Reinforce warping sections by thickening walls and adding ribs.
20. Cool in water.
21. Cool in fixture.
22. Anneal parts immediately after molding.
23. Check on parts handling after molding.
24. Incorrect packaging can cause post mold warping.

25. Redesign part.

IX. Shrinking

Shrinking is the result of insufficient material. It is usually caused by molding conditions, improper gate location, heavy sections, and poor part design.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Adjust feed to control size.
5. Adjust injection pressure to control size.
6. Injection boost time too long or pressure too high.
7. Injection forward time too low.
8. Adjust injection speed.
9. Adjust back pressure.
10. Adjust material temperature.
11. Mold temperature too high.
12. Ejection system moving too fast.
13. Core pins are overheating.
14. Adjust gate size. Gates too large can cause packing with high stress levels. Gates that are too small do not allow enough material and cause shrinkage.
15. Relocate gate.
16. Add additional gates.
17. Increase venting considering movable spring loaded vent pin.
18. Insufficient knock outs.
19. Uneven ejection.
20. Reinforce warping sections by thickening walls and adding ribs.
21. Cooling is uneven.
22. Cool in water.
23. Cool in fixture.
24. Anneal parts immediately after molding.
25. Use faster setting material.
26. Incorrect mold dimension causing part to appear out of tolerance.
27. Consider additive to change shrinkage. (Talc in polypropylene)
28. Redesign part.

X. Material discoloration

Material is discolored by burning, degradation, poor housekeeping, and contamination in the original material.

1. Unequal filling rates in cavities.

2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Dirty machine, hopper, magnet, or dryer.
5. Dirty mold including knockout system.
6. Dirty atmosphere. Colorants can float in the air and settle in the hopper and grinder.
7. Dirty cylinder. Purge cylinder with purging compound.
8. Dirty cylinder. Clean cylinder, disassembling if required.
9. Remove and clean nozzle.
10. Reseat nozzle.
11. Contaminated or dirty material.
12. Material may be releasing volatiles.
13. Material may be degrading.
14. Colorants may be degrading.
15. Additives may be degrading.
16. Material or colorants too wet.
17. Increase venting or add run-off.
18. Temperature control system malfunctioning.
19. Thermocouples malfunctioning.
20. Heater band(s) malfunctioning.
21. Injection speed too fast.
22. Injection pressure too high.
23. Injection boost time too long or pressure too high.
24. Material temperature too high.
25. Clamp pressure too high.
26. Screw speed too high.
27. Gate size too small.
28. Gate location incorrect.
29. Too few gates.
30. Injection capacity of machine too large.
31. Cylinder cracked.
32. Damaged screw. Chipped or sharp parts burning material.

XI. Splay-Mica-Flow Marks

Splay, mica, and flow marks are caused by contaminated or degraded material, improper flow conditions and flowing around or over projections.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Clean machine, hopper, magnet, or drier.
5. Cylinder dirty. Purge or disassemble.
6. If there is burning see material discoloration section.
7. Poor mold surface which looks like defect. Compare successive shots.

8. Polish sprue and runner and debug gate.
9. Increase runner extension.
10. Increase cold well slug.
11. Vent runner.
12. Nozzle opening too small or land length too large.
13. Clean nozzle.
14. Clean mold and knockout area thoroughly.
15. Remove water from mold surface (leakage and condensation).
16. Contaminated or dirty material.
17. Material may be releasing volatiles.
18. Material may be degrading.
19. Colorants may be degrading.
20. Material or colorant too wet.
21. Increase venting.
22. Increase runner size.
23. Increase gate size.
24. Change gating pattern.
25. Add more gates.
26. For splay marks at the gate, install localized heating.
27. For splay marks at the gate, reduce injection speed.
28. For splay marks at the gate, increase gate size or flare gate.
29. If imperfections are at one spot, try localized heating.
30. Adjust injection speed.
31. Adjust injection pressure.
32. Adjust injection forward time.
33. Adjust boost time or pressure.
34. Screw back pressure too low.
35. Screw speed too slow.
36. Reverse cylinder temperature profile.
37. Mold temperature too low.
38. Large differences in material particle size in hopper.
39. Excessive fines in material.
40. Variations in mold temperature.
41. Flow around obstructions.
42. Flow over raised or depressed parts.
43. Injection capacity of machine too low.

XII. Sticking in the Sprue Brushing

Sticking in the sprue is caused by improper fitting of sprue-nozzle interface, nozzle opening larger than sprue opening, inadequate mold pull back and packing.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.

3. Inconsistent cycles—operator, mold, or machine caused.
4. Check nozzle-sprue bushing seating.
5. Sprue opening must be larger than nozzle opening.
6. Polish sprue.
7. Increase strength of mold pull back system.
8. Eliminate "Z" type sprue puller.
9. Increase sprue taper.
10. Radius sprue-runner connection.
11. Decrease sprue diameter if it is not cooling fast enough.
12. Use sprue break on machine.
13. Injection pressure too high.
14. Injection hold time too long.
15. Injection boost time too long or pressure too high.
16. Feed too high.
17. Material temperature too high.
18. Back pressure too high.
19. Mold temperature too low.
20. Check for material contamination.
21. Material or colorants too wet.
22. Nozzle heater system malfunctioning.

XIII. Nozzle Drool

Incorrect nozzle and operating conditions cause nozzle drool.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Use positive-seal type of nozzle.
5. Use "nylon" nozzle (reverse taper).
6. Reduce nozzle orifice diameter.
7. Increase "suck-back" setting.
8. Nozzle temperature is too high.
9. Material temperature is too high.
10. Injection pressure is too high.
11. Injection forward time too high.
12. Nozzle heater system malfunctioning.
13. Material or colorant too wet.

XIV. Excessive cycles

Excessive cycles are caused by poor management, insufficient plasticizing capacity, inadequate cooling channels, inadequate cooling water, and erratic cycles.

1. Unequal filling rates in cavities.
2. Interrupted flow in cavities.
3. Inconsistent cycles—operator, mold, or machine caused.
4. Management does not care.
5. Cycle set too long.
6. Low-pressure closing time too long.
7. Insufficient plasticizing capacity.
8. Water channels not clean.
9. Insufficient water cooling channels.
10. Inadequate water cooling capacity.
11. Platen slow down excessive.
12. Machine malfunction.
13. Mold temperature too high.
14. Material temperature too high.
15. Material too slow in setting up.
16. The operator has too much to do and is not ready for the next cycle.
17. Operator fatigue (automate operation).
18. Reynold's number below 5,000.

ADDENDA III

Piece Part Design

Part I: How it Starts

This section is based on the following assumptions:

- The purpose of business is to make money.
- All products must be safe to use.
- The success of a product is judged by customer satisfaction.
- The design process involves many disciplines within the business besides the design department.
- These other disciplines must be involved throughout the design process.

This section presents a formal, flexible design plan with the goal of creating a safe and profitable product.

The Design Concept

The historical concept of a designer isolated in an office, designing without considering how the product will be manufactured and shipped is gone! Businesses recognize that good design makes money and government regulations have found out that bad design can be dangerous and expensive.

Among others, this has led the FDA to issue its "Preproduction Quality Assurance Planning Recommendations for Medical Device Manufacturers" in 1987 and its revision in 1994 of its GMP (Good Manufacturing Procedures) regulations to require medical device manufacturers to establish a detailed design control system with adequate documentation. The Consumer Product Safety Commission has acted similarly.

Definitions:

- Customer: The user, either within or outside the business.
- Designer: The one in charge of design (esthetic and mechanical).
- Molder: The one who produces the part by molding, extrusion, lay-up, fabricating, et cetera.
- Mold Maker: The one who builds the tooling for the molder.
- Packaging: The package designer.
- QC: The quality assurance engineer.

THE PURPOSE OF BUSINESS IS TO MAKE MONEY.

Many designers forget this. Yet it states very clearly that we are not out to make the strongest part, the longest lasting part, or the most artistic part. We want a part that will, on balance, produce the most profit. Strength, life expectancy and attractiveness are some of the elements in achieving this goal. The ultimate design question is, *will the part make the most money?*

The market is full of parts that break too soon, others that would last many times their useful life, and others that have five colors when three would do. As a result they are not as profitable as they might have been.

One of the hardest things that a designer must learn is to automatically asses the design in terms of business profitability.

This implies that a designer must understand cost of production, marketing, corporate finance, and consumer behavior.

ALL PRODUCTS MUST BE SAFE

This is a moral imperative. It also has great financial consequences for the business and the designer. The law clearly states that one is liable if they did or did not do what someone else in their position would have prudently done. There is no business barrier to protect the designer.

Safety is very difficult to determine. There are many safety information resources available including loss prevention plans, insurance companies, and industrial and consumer groups involved in safety.

CUSTOMER SATISFACTION

Unless the customer is satisfied, the product is a failure. Therefore the first thing to be done is to find out what the customer wants. The second is to find out what he needs. They may not be the same.

I view the role of plastic personnel as converters of the needs of their customers into a plastic product. We are supposed to know what our materials and process can do. For example a customer might want a part in polystyrene for use at 270° F, but he needs a different material.

Customer satisfaction, which is called "Usability Engineering," is an expanding field. It is not to be taken lightly. To repair a leaking four-way valve in the first Watson-Stillman molding machine that I worked on in 1940, I had to remove all the oil from the tank, lie on my back, half inside and half outside the tank, and try to loosen four frozen ⅝-inch bolts holding the flange. Moving the flange 90° would have resulted in a much easier repair.

Usability Engineering sets up goals, concepts, and specifications. It inquires from and about users such things as who they are, their physical and psychological makeup, how they use the part, what tools they use, familiarity with this or similar parts, what they expect from the part, et cetera.

Understandably, there is not always the time or money for this kind of study, but knowledgeable consultants do exist. Therefore the use of outside sources for all kinds of information and assistance is strongly recommended.

After the item is in use, a full marketing survey should be conducted. This might lead to improving the product. But more important, it will also build knowledge for future projects.

The first step in every design project is a full detailed listing of as much pertinent information as is available. A typical questionnaire is shown in Table 1. It might also be necessary to know more about the system within which the item will function.

If required information is not available, procedures are to be developed to obtain it from existing knowledge or experimentation.

DISCIPLINES INVOLVED IN DESIGN AND DURING DESIGN

Six heads are better than one! The disciplines listed under DEFINITIONS are all to be included in the proper design procedure.

The designer should be the "*maître d'*" and have the responsibility for coordinating the project. He should call meetings with the various members individually or jointly as required, until the design process is completed. Everybody then signs off on the final product design.

I could give a hundred examples of the value of this process. It results in a much better product often at a lower cost therefore at a greater profit. The parts almost always work and they get into production much earlier. Since everybody agreed it would work before tooling was started, they are all committed to make it work and 20/20 hindsight is abolished. It fosters better relationships within the company—and with the customer.

The reason? Six heads are better than one.

THE ORIGIN OF THE DESIGN

The need for a part to do something results in the request for a design. The designer should never forget this. The ultimate point to the design process is to accomplish an identified goal.

It is up to the designer to make sure the goal is clearly stated and understood. It is up to the molder and mold maker to produce the part to meet this goal. It is up to the packager to make sure that the part reaches the customer in proper condition. It is the function of QA people to establish procedures to make sure that the parts shipped stay within the stated goals.

Designs start from many different points. Some are verbal descriptions, crude sketches, drawings, photographs, samples, computer graphics, mock-ups, patents, and parts in use.

In the case of modifications even if they appear to be "minor" the process should be the same.

Part II: Information Retrieval

First accumulate information about the product, its environment, its cost, its life expectancy, and other relevant factors. Table 1 is a checklist with some comments. It is recommended that you transfer this list and Table 2 to your computer in a chart form with space to fill in information. It should be expanded and adapted for your particular requirements.

TABLE 1*

GENERAL INFORMATION

1. Identify the part.
2. When is the production of the part required?
3. How many parts are required?
4. How many parts are required per week?
5. How many parts are required per run?
6. What are the cost limits for the product?
7. How many runs per year?
8. What information is available about the part?
   Information source might be from conversations, descriptions, sketches, part drawings, computer programs, physical parts, mock ups, samples, similar pieces, et cetera. The plastics literature should be searched. The company and public librarians are extraordinarily helpful in finding information.
9. What is the function of the part?
10. What is the physical system in which the part will operate?
11. What is the physical system in which the part will be subjected?

Cosmetic containers operate in women's hands but are subjected to one of the harshest environments, a handbag.

12. Who will be the users of the part?
13. What is the required service life span of the part?
14. What is the required service life span of the system?
15. What happens if the part fails?
16. Can the part be altered?
17. Can the system be altered?
18. Are there any size specifications?
19. Are there any volume specifications?
20. Are there patent requirements?
21. Are there potential patent infringement problems?
22. Are there specific standards, tests or certifications requirements?
    These would include OSHA, UL, UL-94, UL-746, FDA, ANSI, DOT, UPS, USPS, NEMA, MIL SPECS, FCC, CSA, ASTM, ISO, SAE, NSF, State codes, and other regulatory bodies.
23. Are there flammability requirements?
24. Are there any warnings that need be put on the part?
25. Are there any warnings that need be sent with the part?
26. Are there any instructions to be prepared?
27. Is a LOGO to be used?
28. Is cavity identification required?
29. Is a molded date stamp required?
30. Will the production be automated?
31. How will it be automated?
32. If the product is to be exported, what are the further requirements?
33. What are the QA requirements of the customer?
34. What are the non-mechanical tolerances required by the customer?
    This would include items such as color, surface finish, feel, et cetera.
35. What secondary operations will be perform?
    These would include, decorating (list the possibilities), vacuum metalizing, metal plating, machining (drilling, milling, routing, turning, et cetera) assembly (solvent cementing, adhesives, ultrasonic welding, vibratory welding, hot gas welding, hot tool welding, electromagnetic bonding, snap fitting, mechanical fastening, threading, et cetera).
36. Will any bonding be required?
37. What are the requirements of the bond?
    Reusable, leak proof, permanent.
38. Will the part be used immediately or stored?
39. What will the storage environment be?
40. Are there any packing requirements?
41. How will the part be packed?
42. Are there any shipping requirements?
43. Are the shipping containers to be returned?
44. How will the part be shipped?

MECHANICAL INFORMATION

1. Is the load static or dynamic?
2. Is the load constant or changing?
3. Is the load continuous or intermittent?
4. Is the load concentrated or distributed?
5. What is the magnitude of the load?
6. What is the direction of the load?
7. What is the rate of application of the load?
8. Are there any size limitations?
9. Are there any shape limitations?
10. Are there any weight limitations?
11. Are there any volume limitations?
12. What are the possibilities of outside (non-designed) forces?
13. What is the maximum deformation allowable?
14. What is the maximum deformation for part failure?
15. What is the effect of friction on moving parts?
16. What is the effect of abrasion (wear) on moving parts?
17. What mechanical tolerances are permitted?
18. What are the mechanical tolerances required for the function of the part?
19. If the mechanical tolerances required for the function of the parts are such that the molding process may produce significant rejects, what post molding operations can be performed to use these rejects?

ENVIRONMENTAL INFORMATION

1. What is the temperature range within which the item will operate?
2. What are the effects of time versus temperature?
3. What is the temperature range within which the item will be subjected to?
4. Will it be subjected to both temperature and other stress, such as dishwashers, sterilization, autoclaving, or hot filling?
5. Will humidity affect the part? Nylon, for example, will change its size.
6. What are the permeability requirements?
7. What chemical environment will the part be exposed to?
   This is not simple. For example, the chemicals in a barbershop might well preclude the use of ABS for an item used by the barber.
8. What is the length of time the part will be exposed to the chemical environment?
9. Will the part be used outdoors?
10. Will the part be exposed to indoor infrared radiation (incandescent bulbs)?
11. Will the part be exposed to outdoor UV radiation (fluorescent bulbs)?
12. Will the part be exposed to other types of radiation?
13. Will the parts be recycled?

14. What recycling code is required on the plastic?
15. Can reground be used?
16. Is material separation required for recycling?

ELECTRICAL INFORMATION

1. What type voltage and how much current will be in contact with the part?
2. What frequency is being used?
3. Are there any arc tracking requirements?
4. Are there any conductivity requirements?
5. Are there any surface and volume insulation requirements?
6. Does the part have to be electrically conductive?
7. Will the part be used in an RF environment? i.e. (microwave oven)
8. Are there any EMI/RFI shielding requirements?
9. Are there any other requirements?

APPEARANCE AND ESTHETIC REQUIREMENTS

1. If the product is transparent, is transparency to be measured, and if so, how?
2. If the product is colored, how is the color defined?
3. Is the surface finished defined using the SPI, NTMA, or other system?
4. Does the part have to match or blend with anything else?
5. Are there any designs that will be part of the mold surface?
   This would include photo etching, sand blasting, EDM surfaces, logos, engraving, and lettering.
6. Will there be in-mold decoration?

DESIGN CONSIDERATIONS

It is obvious that to discuss each design step for each of the different disciplines in all of the manufacturing processes would make this section overly long and less useful. Therefore we will refer mainly to injection molding for which the largest number of parts are designed, and mention other processes where appropriate.

The designer always prefers to have uniform thin walls, adequate coring, generous radii, no undercuts, et cetera. This seldom happens. In fact, usually the choice of fabrication technique depends more upon the cost of production than anything else. The designer must know the advantages and disadvantages of each appropriate process.

Table 2 lists (in no particular order) most of the items a designer will consider in designing a part for injection molding. He should consult with the other five members of the team throughout the whole design process. This eliminates a lot of mistakes that would have to be corrected expensively after the mold was built. Similar lists and information are available in books and the literature for the other processes.

TABLE 2*

1. Parting Line
2. Wall thickness
3. Coring
4. Entrapped material
5. Taper of mold parts
6. Draft of cavities and cores
7. Radii
8. Gating
9. Weld lines
10. Venting
11. Trapped air
12. Ejection system
13. Reinforcements (ribs, fillets)
14. Holes
15. Threads
16. Undercuts
17. Inserts
18. Orientation
19. Warping
20. Surface finish
21. Surface decoration
22. Degating
23. Tolerances
24. Postmolding operations
25. Postmolding decorating
26. Functional aspects of the shape of the part.
27. Esthetic aspects of the shape of the part.
28. Safety aspects of the shape of the part.
29. Safety aspects if the part burns.
30. Safety aspect if the part fails.
31. Have the color and design been used to promote safety.

Part III: The Design Process

The thing to remember is that we are dealing with a system with extremely complex multiple phase transitions, poorly defined boundary conditions and non-isothermal conditions. The reasons are beyond the scope of this section. Therefore much of the data we use is qualitative, not quantitative. Hence to a great extent plastic design is still fundamentally trial and error.

Because design is a creative and inventive process, it is difficult to begin with, and further complicated by the realization that often there is more than one acceptable result.

The process starts by giving the completed Table 1 and a list of the design parameters of Table 2 to all six people involved in the design process. They should review the table, meet, make any changes, and obtain any additional information. All six participants should initial the final tables.

The next step is to produce something that is tangible enough for the group to discuss. The size, sbape and characteristics are fairly well determined from the information in Table 1.

It is not the purpose of this section to describe how to, but rather what to. What is needed now is probably a sketch, though it could be a mock up, a model, an artist's rendering, a drafted drawing, a computer drawing, or in other forms.

Its purpose is to determine potential processes and materials. Usually the selection of a process is clear and immediate. If not, this has to be the first decision. It might mean comparisons of two or more methods. The selection could even be two production methods. The first at higher cost to quickly get the product on the market and the second being a full, low cost production mode.

Costs require information. The internal costs for labor and overhead are available. Purchased labor and applicable overhead can be found. Anything else (time or product) can be quoted. The approximate cost of material is given in weekly publications. The purchasing department can get exact quotes.

Properties of materials are available in many forms. Material databases exist. Campus 3.0, for example, compares materials based on ISO standards, others are based on ASTM. These give information at one particular point in the performance spectrum of each material and are helpful for comparing materials and preliminary screening.

Very useful guides are handbooks. Reference (1) contains detailed information on 76 materials, 17 process, and 25 related topics.

Mechanical properties such as creep curves, stress/strain/temperature information, et cetera are available from material manufacturers and the literature. Computer programs can be helpful but are not definitive.

A few examples will suggest how the design process works.

MATERIAL

Let us consider one small aspect of material selection—wall thickness. The goal is lowest total cost for the finished system—not the lowest material cost for the part. A few of the many considerations are: a thinner wall molds faster, however a thinner wall is weaker. A thinner wall uses less material, therefore it might weigh less making it easier to handle/use—the shipping costs less and possibly the material costs less. But you should consider that a thinner wall might look "cheap." If there is a hole, the thinner wall will have reduced weld line strength and a thinner wall might not be strong enough for decoration.

These are some of the decisions facing designers. Sometimes there are remote but important considerations. For example, if a thicker wall will raise the weight to just over an ounce on an item mailed first class, a stronger, thinner, more "expensive" material that could bring the weight down to one ounce would save twenty-three cents each in postage. Remote but important.

The more "expensive" thinner material might cool so much more quickly in the mold that the higher production rate will save money compared to the thicker, "cheaper," slower cooling material. In addition, because it is thinner, it uses less material than the thicker piece and the finished part cost might be less.

Notwithstanding all of these considerations plus many more, you might still find that the thicker, cheaper material will be the most cost effective and make the most money.

A HOLE

Consider a hole in the final product. How can it be made? It could be molded (with weld lines weakening the part), it could be drilled (expensive, unless done automatically, it will eliminate the weld line, it can cause stresses and fracturing, the operation will generate dust/chips), it could be made with an insert (costly, and this too sets up internal stresses), it could be punched, water jet cut, made by assembling two parts, et cetera. However long the list, each choice creates positive and negative considerations, but each is necessary to evaluate.

If the hole causes an undercut it might require a cam in the mold and this raises a new series of questions.

Finally—do we really need a hole?

A GATE

The gating system, location, and size are extremely important decisions. Gates affect orientation, part strength, weld line location, part filling, internal stress, warping, shrinking, venting, entrapped air, surface finish, decoration, secondary operations, and down stream handling—none are independent variables. For example if you gate a part based on efficient filling, you could also affect orientation, strength, warping, and venting.

For whatever reasons the move towards automation has accelerated to the point so that by 2000, 85 to 90 percent of injection molding processing machinery will be run automatically and other processing methods will not be far behind.

Therefore the designer must design with automation as a pervasive concern.

In selecting gating systems automation becomes important. For example, in a two-plate cold runner mold, automatic machine operation almost always requires automatic degating, usually by a submarine gate or by a two stage knockout system. The runner system can fall or be taken by a robot and dropped into a grinder.

If there are different parts on the same runner (i.e. a family mold with knives, forks, and spoons) the robot might place them over an automatic degater so that each shape would fall into a separate container and then deliver the runner to the grinder. In this instance the gate location and the distance between the parts would have to be correlated with the degating fixture design. These considerations could also be true for secondary operations, such as packaging or automatic assembly. Again, a discussion of gates and how they affect the part could be the subject of a detailed chapter.

PROCEDURE

It should be clear that the designer could not and will not have all the answers to every problem that must be solved in order to create a product that will make the most money. That is why there are five other disciplines involved in the design process.

ALL SIX MEMBERS OF THE DESIGN/PRODUCTION TEAM MUST GIVE OF THEIR EXPERTISE, AS NEEDED, WHILE THE PROCESS IS IN PROGRESS—AFTER THE MOLD IS BUILT, IT IS TOO LATE TO PREVENT COSTLY CHANGES.

The first design should be made, reviewed, and changed as often as is necessary.

Design is the abstracting and refinement of ideas, not the product of digital computers. Designs develop in different ways depending on the designer, the environment, the design tools, and the assistance available. Inspiration, experience, experimentation, computer, or other analysis or some combination can drive design. It depends in some measure on the part, the time frame available, and the money allocated.

Finally the point is reached where all agree that it is time for testing. Testing is an elusive thing. Sometimes the collective experiences of the group will say, "We don't need to test, the product is all right, let's build the mold." The other end of this spectrum is prototyping.

Whatever the method, there will be a final version of the product design which has all the information required for the molder and mold maker to design and construct the tool. From it the packaging engineer can design the packaging. It will also contain all the information needed for QA. QA standards do not imply shipping 100 percent perfection. A lower standard might produce larger profits. Consider, for example, shipping 99 percent perfect parts and replacing 1 percent or less of rejects might result in a significantly larger profit. However, QA decisions are not within the scope of a design section. The final version of the design should be dated and initialed by all six participants.

When the production part is finally made, the same group should evaluate the results and decide if there is further need for their services.

CONCLUSION

The fundamental point is that design decisions must never be made in a vacuum. They encroach on many different phases of the production cycle, many of which the designer cannot be aware. This is why the other five groups must be intimately involved in the design process on a continuing basis from beginning to end.

The result will be knowing the cost of the part in different materials and processes; knowing of the manufacturing advantages and disadvantages of different designs; eliminating almost all of the problems before the tool is built; achieving minimum delivery time; understanding the needs and desires of the customer, achieving the ultimate goals of satisfying the customer, and maximizing profits.

* Tables 1 and 2 are modified from Rubin, I. (1972) *Injection Molding Theory & Practice*, John Wiley & Sons, New York, New York

(1) Rubin, I. I., (1990) *Handbook of Plastic Materials and Technology*, 1745 pages, John Wiley & Sons, Inc. New York, New York

APPENDIX IV

Invitation to Participate in the PPA History Project Sent to All PPA Members

The desire to know our origins is universal. It starts when the very young child asks its mother, "Where did I come from?" which is not a biological question. This desire stays with us all our lives. It is reflected in every religion.

We dedicate enormous wealth and human resources for astronomy, paleontology, and archaeology, all directed to this end—our history. A new biography of President John Adams has over nine hundred thousand copies in print. President and Senator Clinton have received over eighteen million dollars in advance for their history. The most popular government data base is the names, dates of entry, and other information of all those who came here through Ellis Island.

Plastics have changed how people live, what they do, their health, their longevity, and the quality of their lives. This change has been greater in the last fifty years than in any other fifty year period in human history.

The history of plastics is sure to be written extensively because of its total immersion in human life. We have a unique opportunity and obligation to provide future historians with information they normally could never get.

In a major undertaking, the Plastic Pioneers have started a program to collect these valuable and rapidly disappearing historical records. In addition to the pioneers, we have included the members of the Plastic Hall of Fame and now invite members of SPE. Our plans include other plastic societies and individuals. We will then send our experiences to our colleagues in Europe, the Middle East, and the Far East and ask them to do the same.

The information will be turned over to the Chemical Heritage Foundation in Philadelphia. They have, as members, twenty-seven major chemical organizations. The PPA joined them several years ago. Being the major chemical history and library group in the US, they are amply endowed and have world class computer facilities. They have agreed to maintain and put our information into a form usable and available to historians, researchers, and the interested public.

The highest award for achievement is the Nobel Prize. Yet when reporters in the middle of the night inform them, they almost universally ask, "For what?" These are people whose achievements are known worldwide and have led to incredible leaps of knowledge which have been used the world over. The reason for the question is that no one knows how other people see them. You have contributed much more than you can ever understand to the plastic industry. To you, running your business is just the normal thing you do all the time. To others and historians your activities (plus those of your contemporaries) are the core of plastic history. Therefore your history is extremely important.

Our families remember us not by the financial gifts we leave, but by their knowledge and memories of our lives. The document that we are urgently asking you to provide will be cherished by your children, grandchildren, and their heirs.

Suggestions for Organizing Your Material:

The more information you give the better. Tell us about how your business started, how it was run, how you got your customers, who they were, what products or services did you perform for them, your reactions, your observations, the plastic organizations and people you related to, and anything else that comes to your mind. When you are finished, the historian should have a clear picture of what you did.

You might want to refresh your memory by consulting old records, address books, and discussing it with current and former associates. Organizing your notes before you start is essential. Experience has shown that this is the most effective way. Below are some suggestions to guide you. The more you write the better.

History is the amalgam of all our information. What is seemingly unimportant alone, is of tremendous value in the aggregate. Remember, maximize the amount of information.

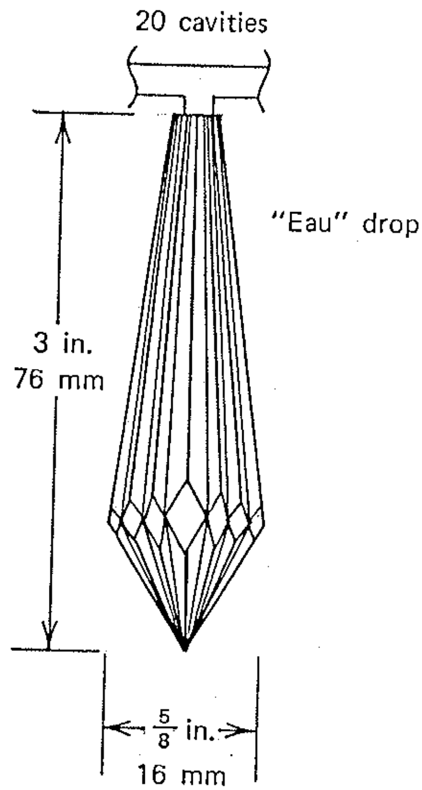
01 Name
   month and year of your recording
   age (optional)
   home address
   home phone, fax and e/mail
   business name
   business address
   business phone, fax and e-mail
02- What is your current business status?
03- What is the name and address of your major plastics business affiliation?
04- Brief chronological history of your plastics affiliations, positions and your responsibilities.
05- How and when did you get your start in the plastic business?
06- What were the steps in reaching your highest position in the plastics industry?
07- Describe in some detail your major plastic activities.
08- Tell us some of the interesting things you did in plastic.
09- If you've made any note worthy contribution(s) to the industry, please tell us.
10- Tell us of your activities in plastics societies and related groups.
11- If you have any awards, citations or the like that you haven't mentioned, please tell us now.
12- Tell us of things that you have done that contributed to the growth of the plastics industry.
13- Do you have any anecdotes about your experiences in plastics to tell us?
14- Can you tell us about some people you have known in your plastic career?

15- Would you urge your children or grandchildren to go plastics? Why?
16- Anything else you have to say is welcome.
17- What were some of your greatest plastics business successes?
18- What were some of your greatest plastics business failures?

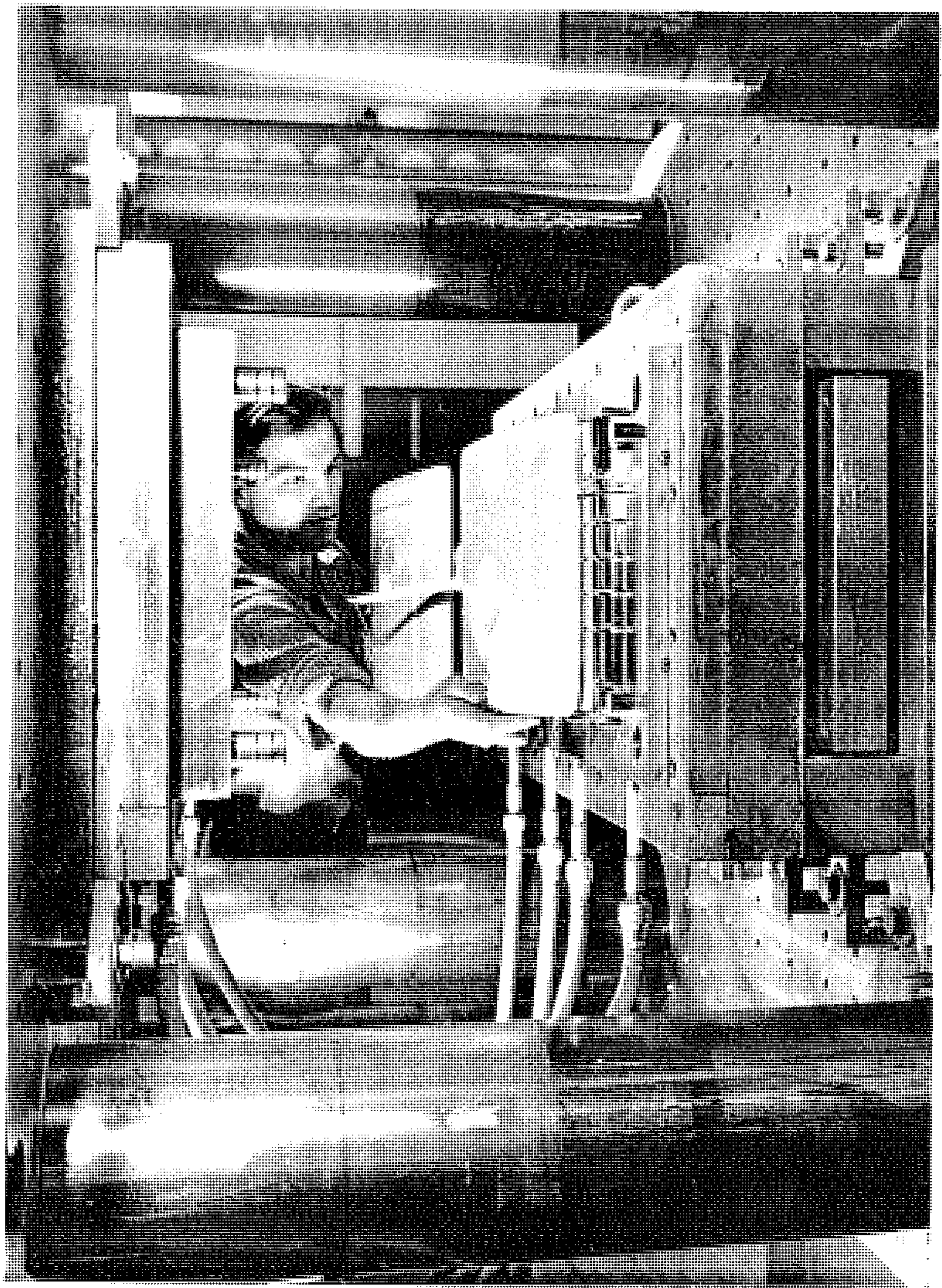
We are also very interested in saving any samples, pictures, documents, awards, patents, or anything of potential historical value. What you have done is part of American history and must not be lost. Please tell us about them. We will get back to you. Thank you.

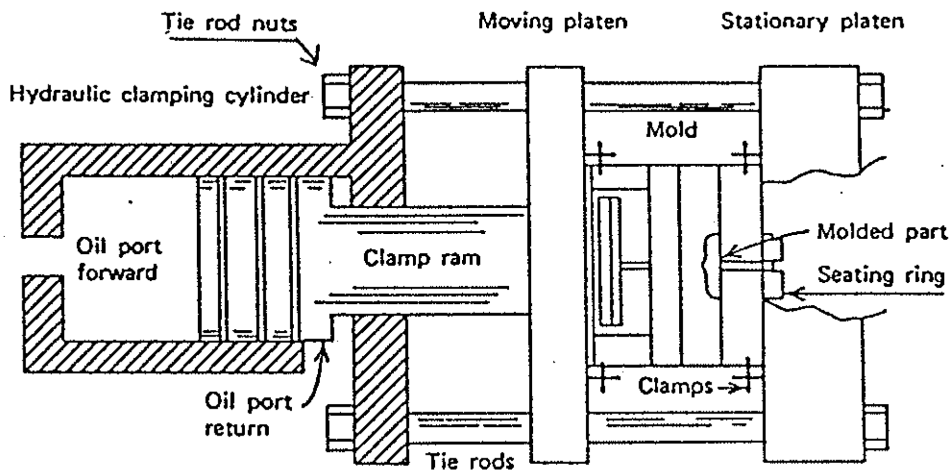
ADDENDA V

Figures 1 through 37



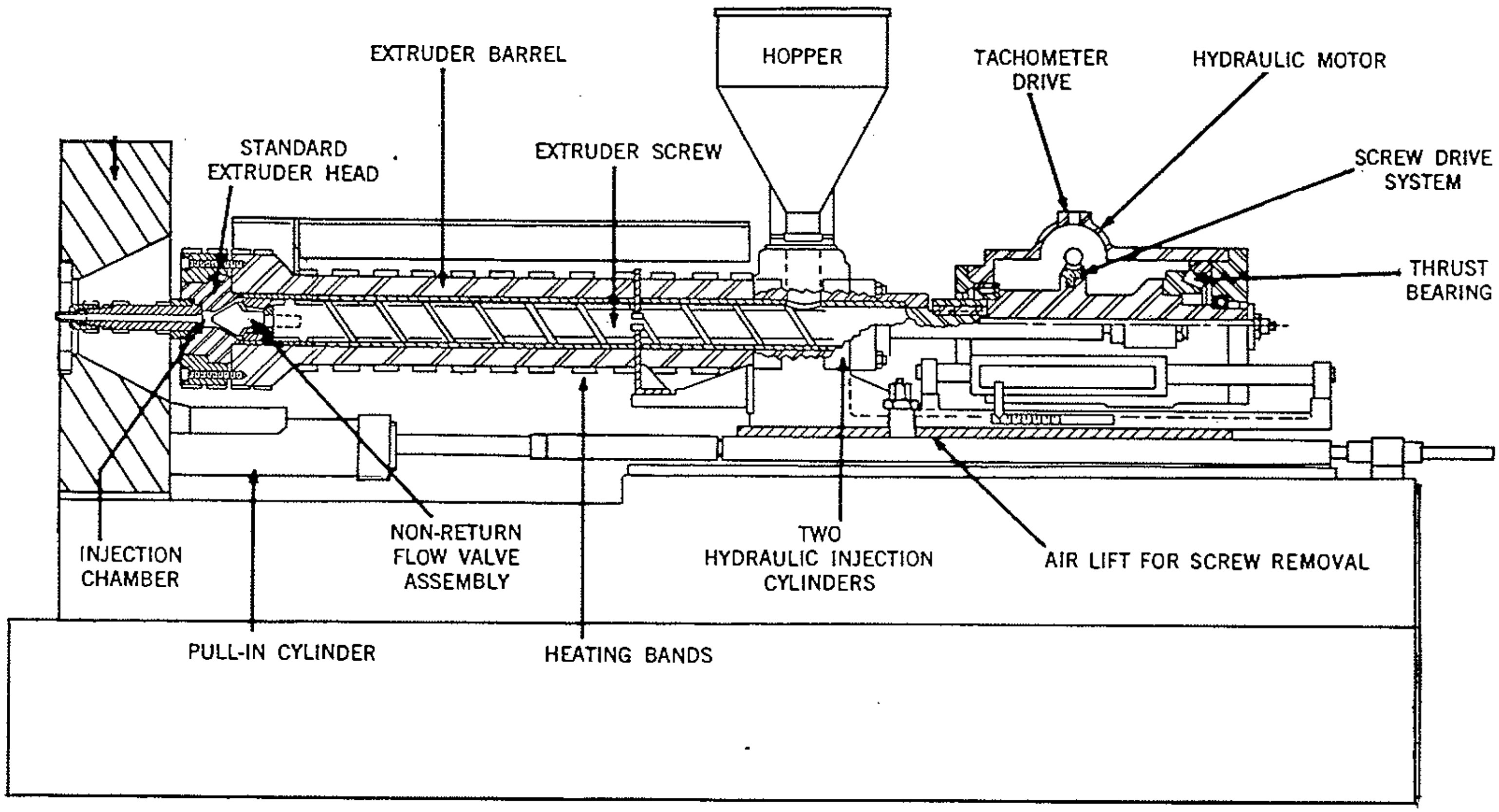
PLASTIC PRISM



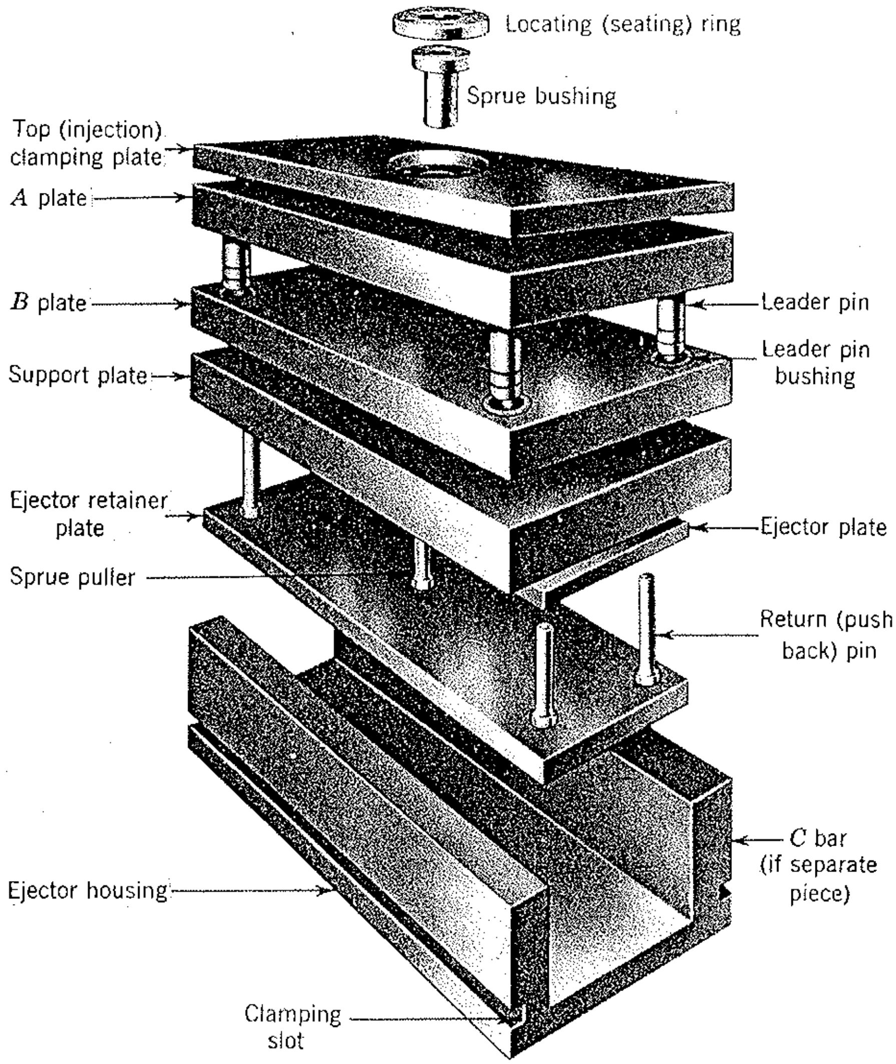


SCHEMATIC DRAWING OF HYDRAULIC

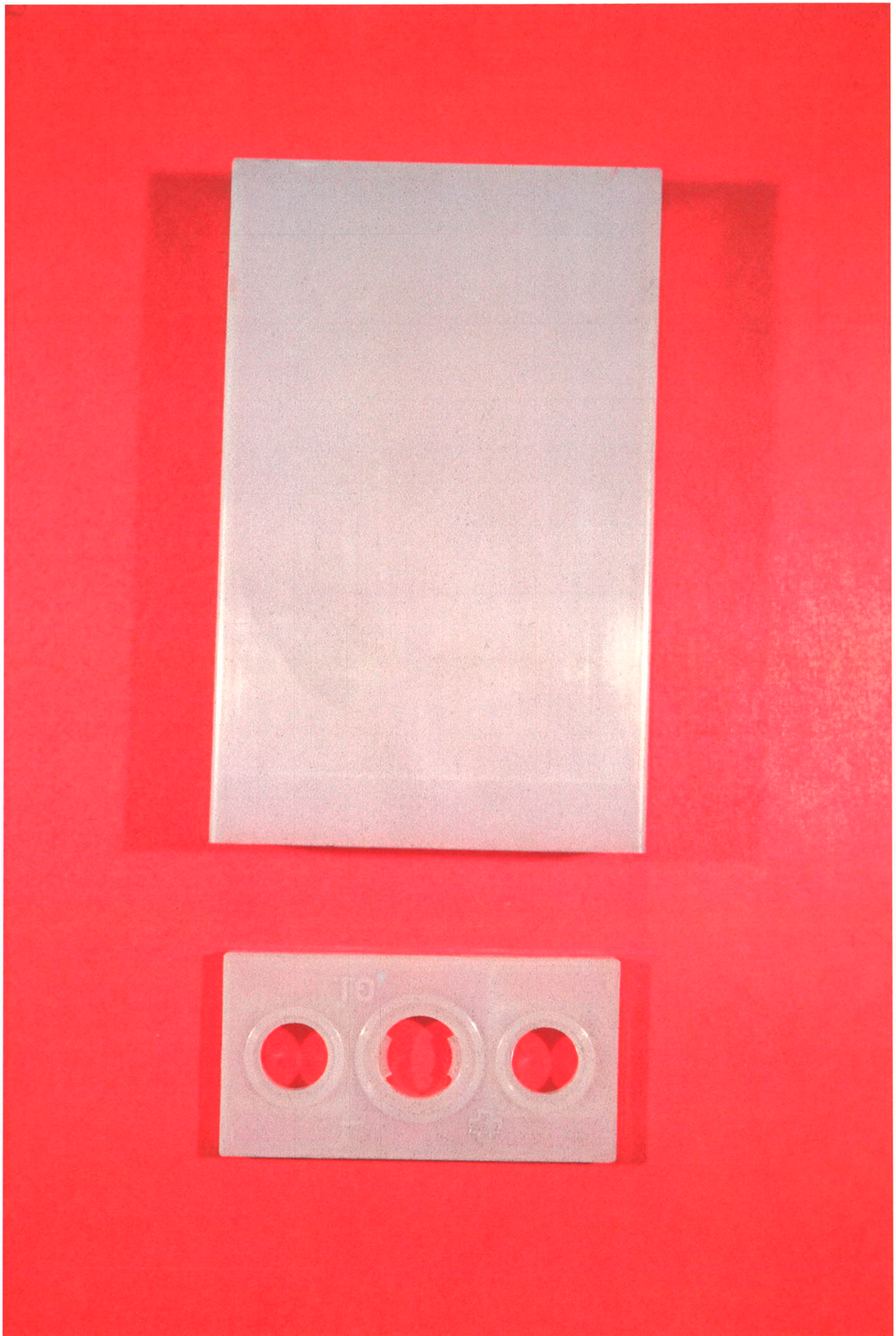
CLAMPING END

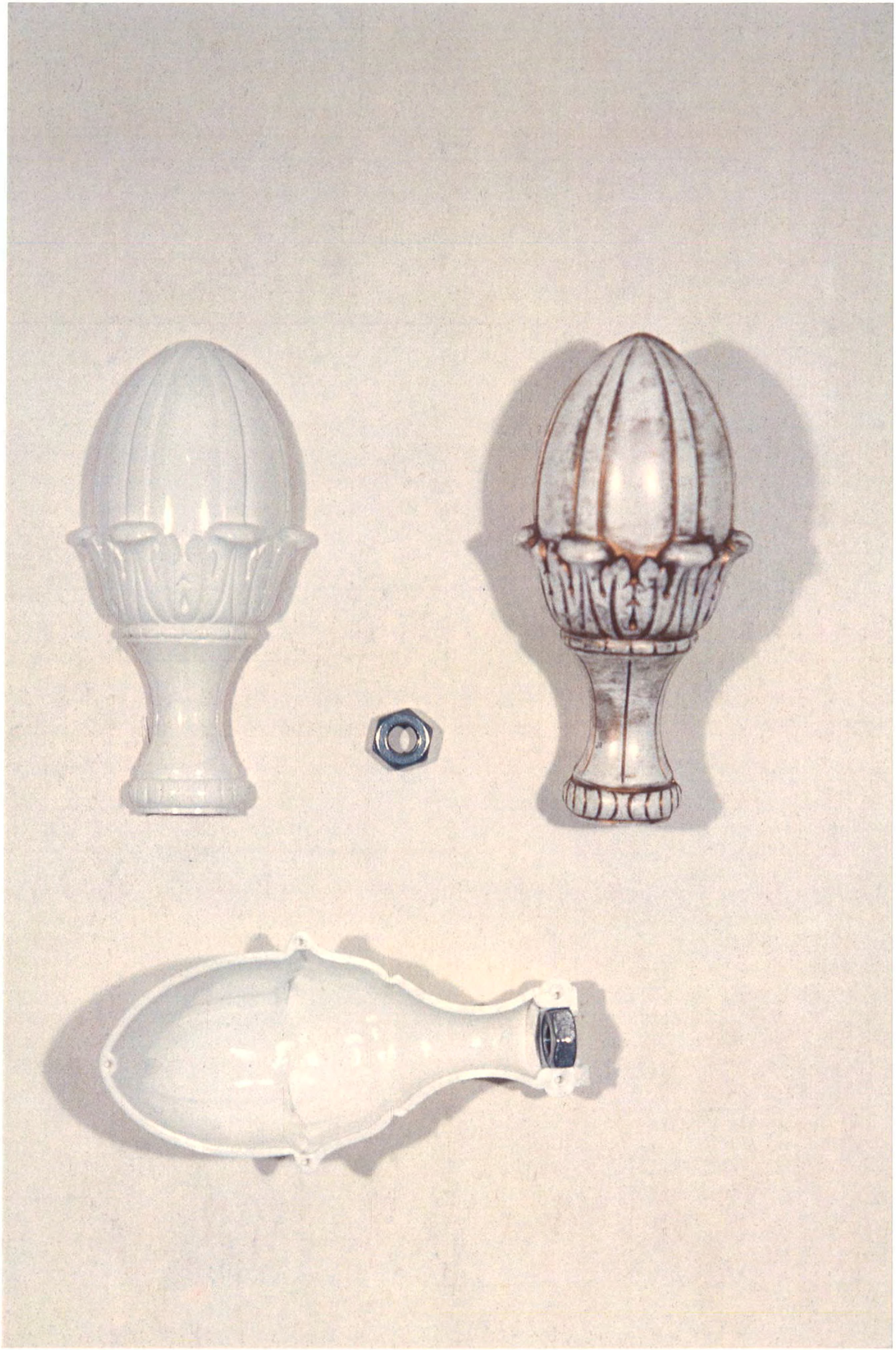


Schematic drawing of injection end of reciprocating-screw machine. Courtesy HPM Division of Koehring Co.



Exploded view of standard mold base (D-M-E Corporation).





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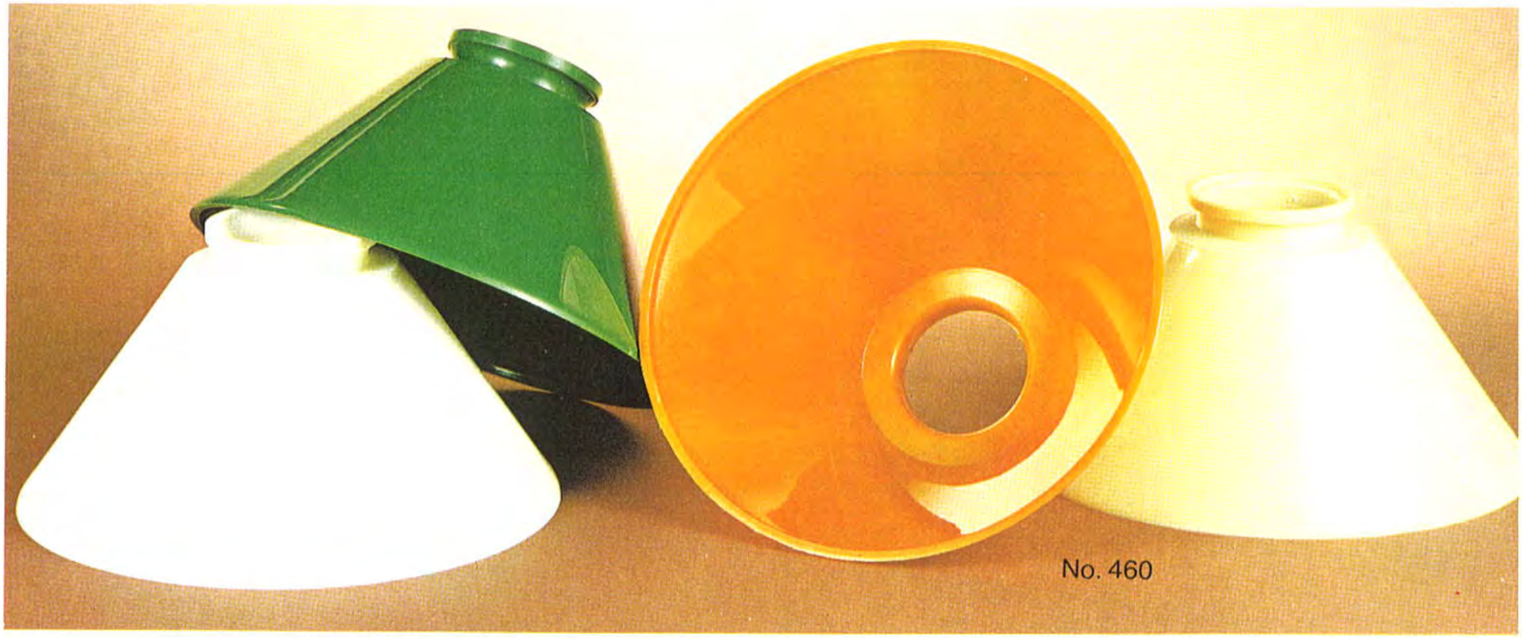

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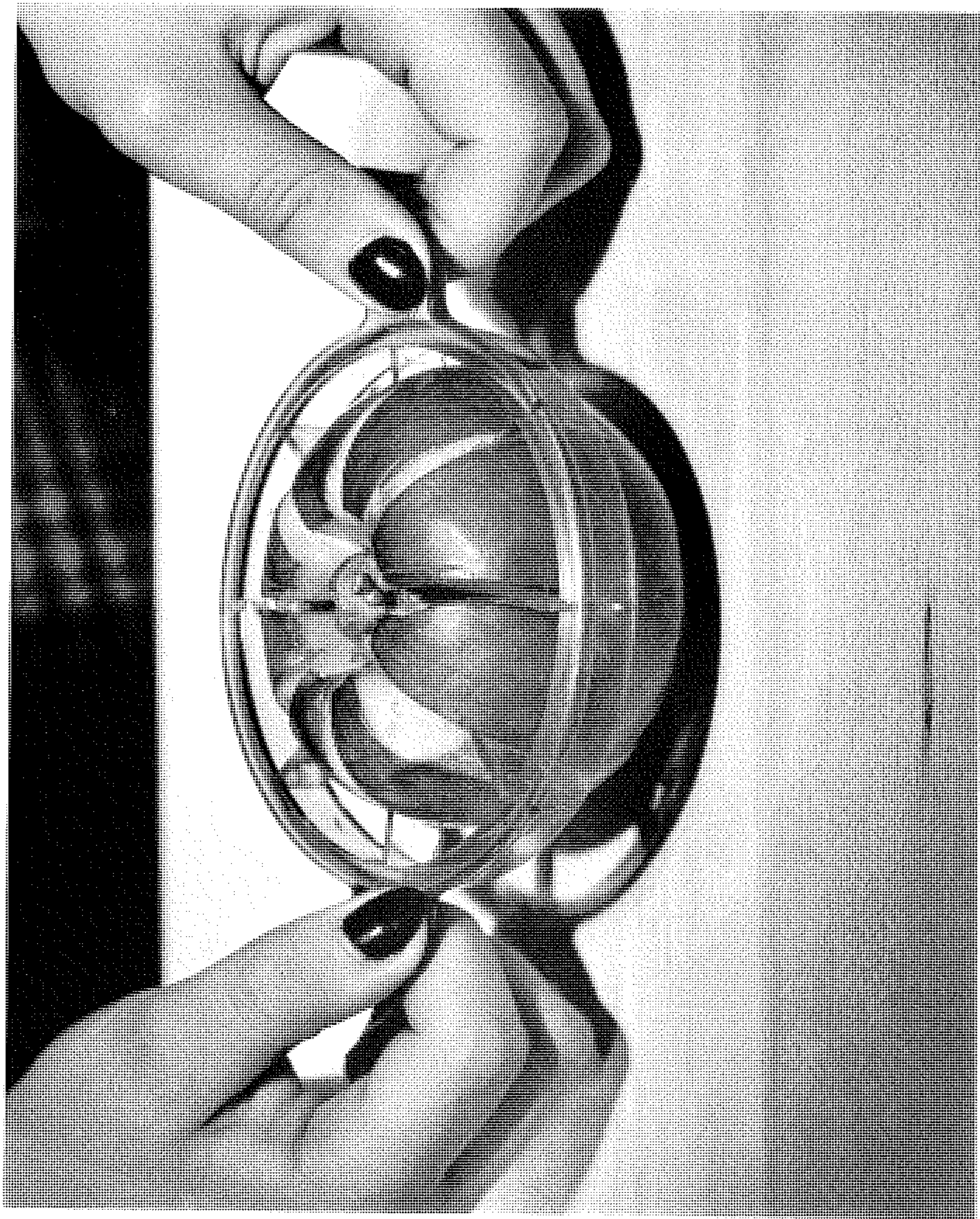

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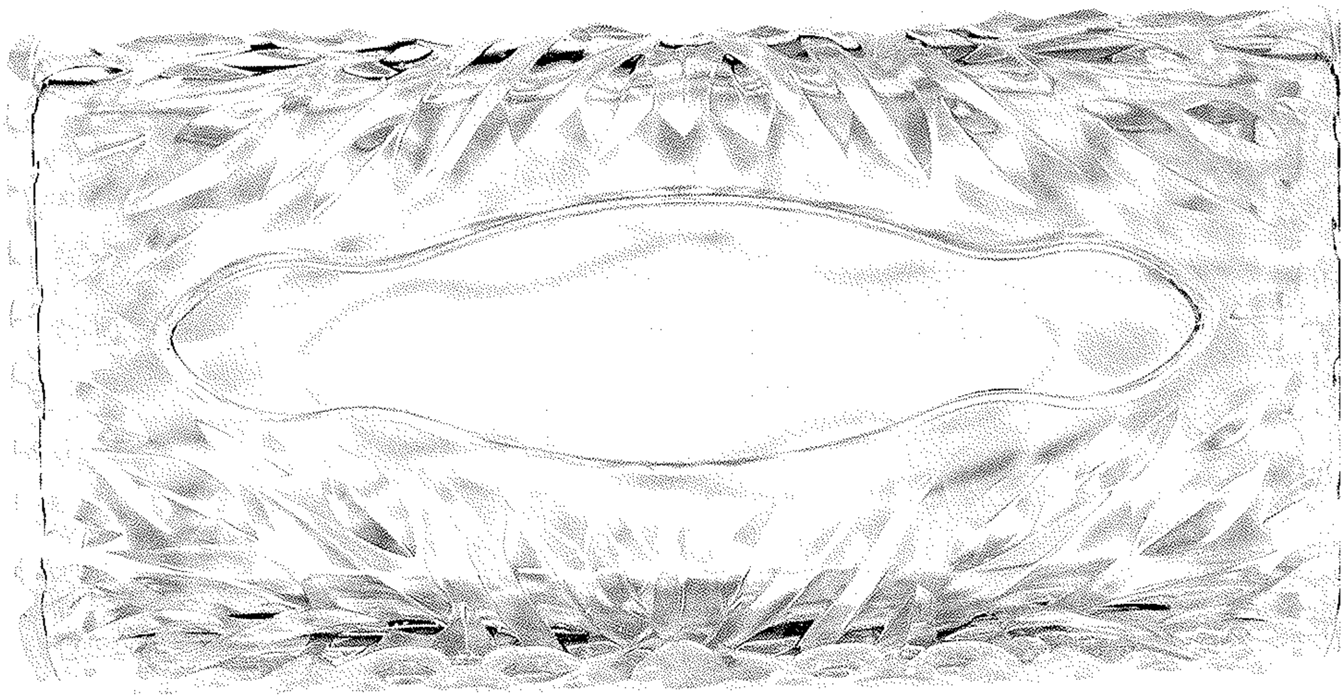

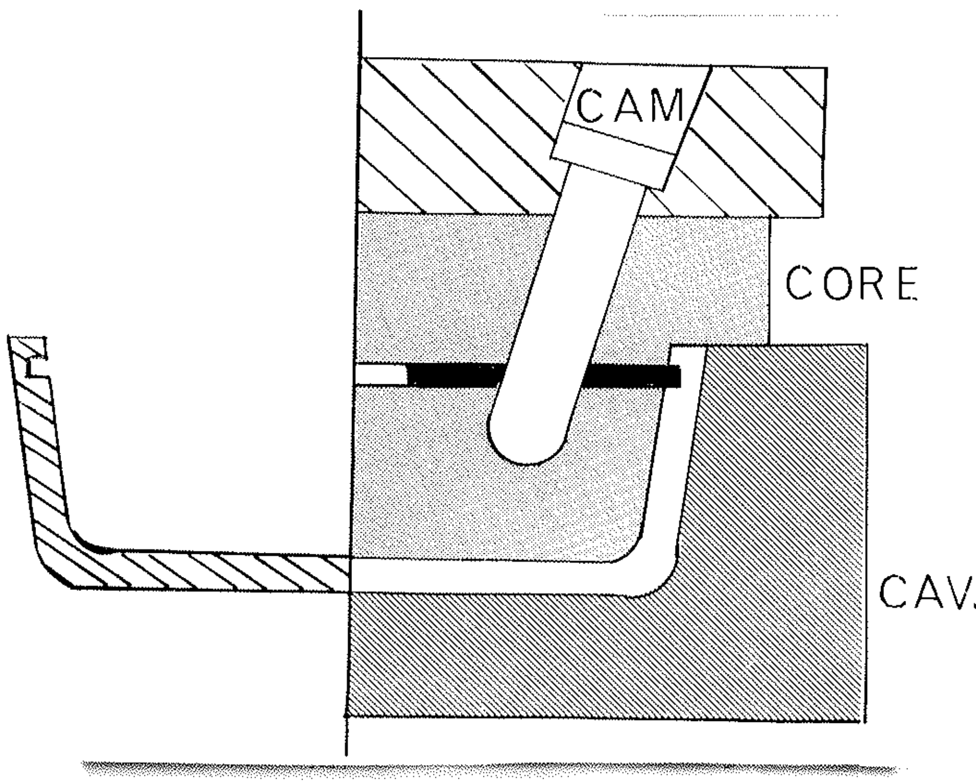
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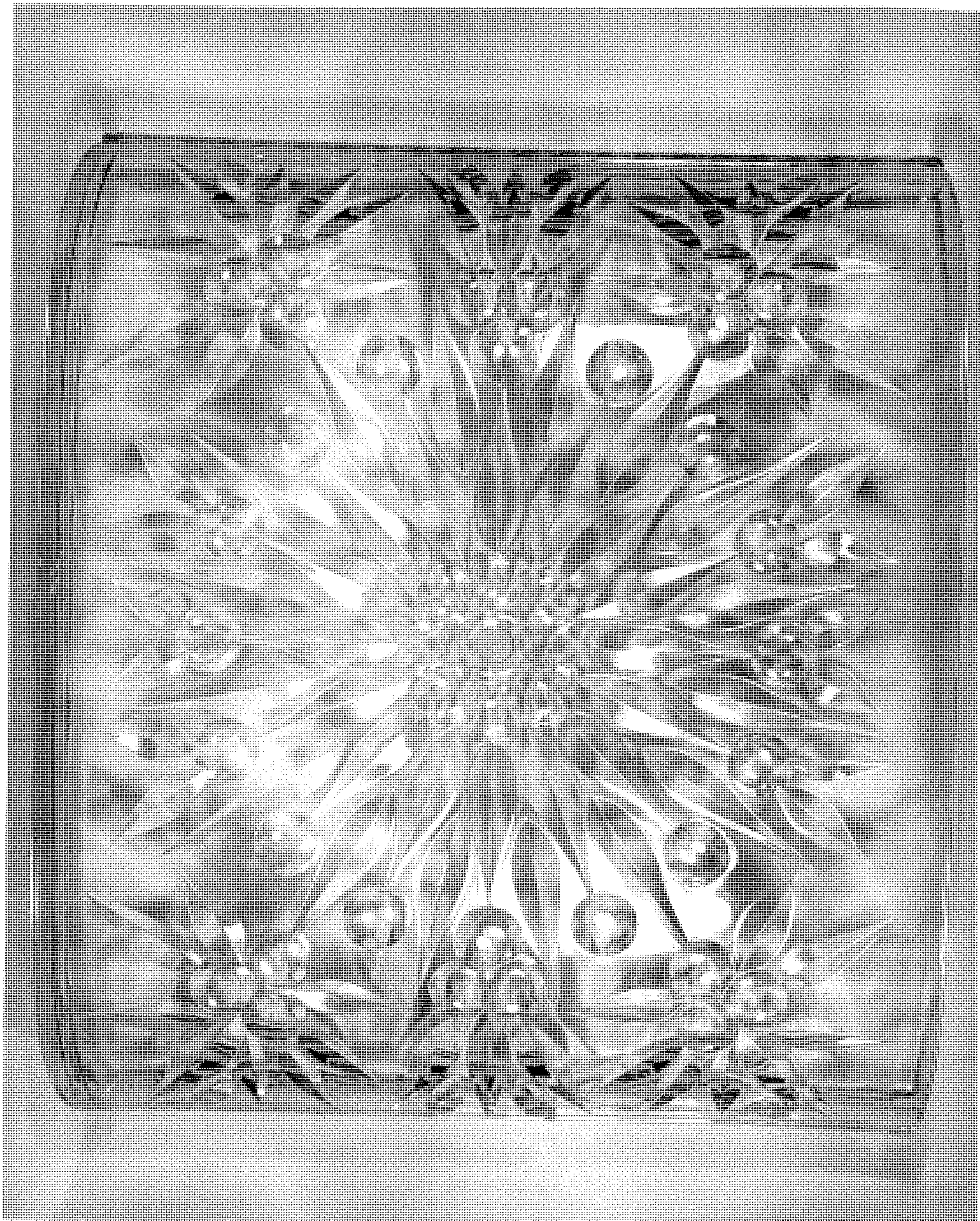

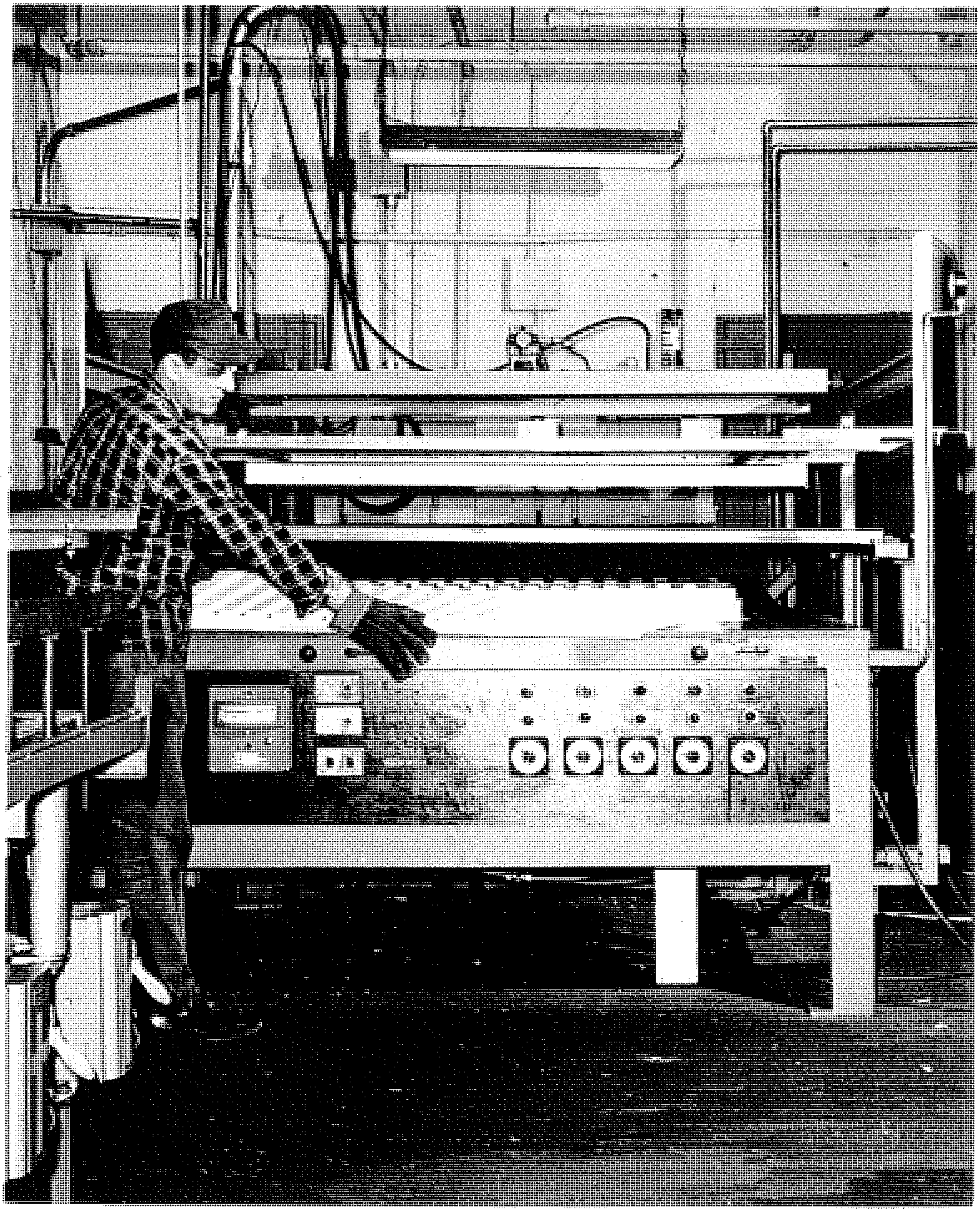

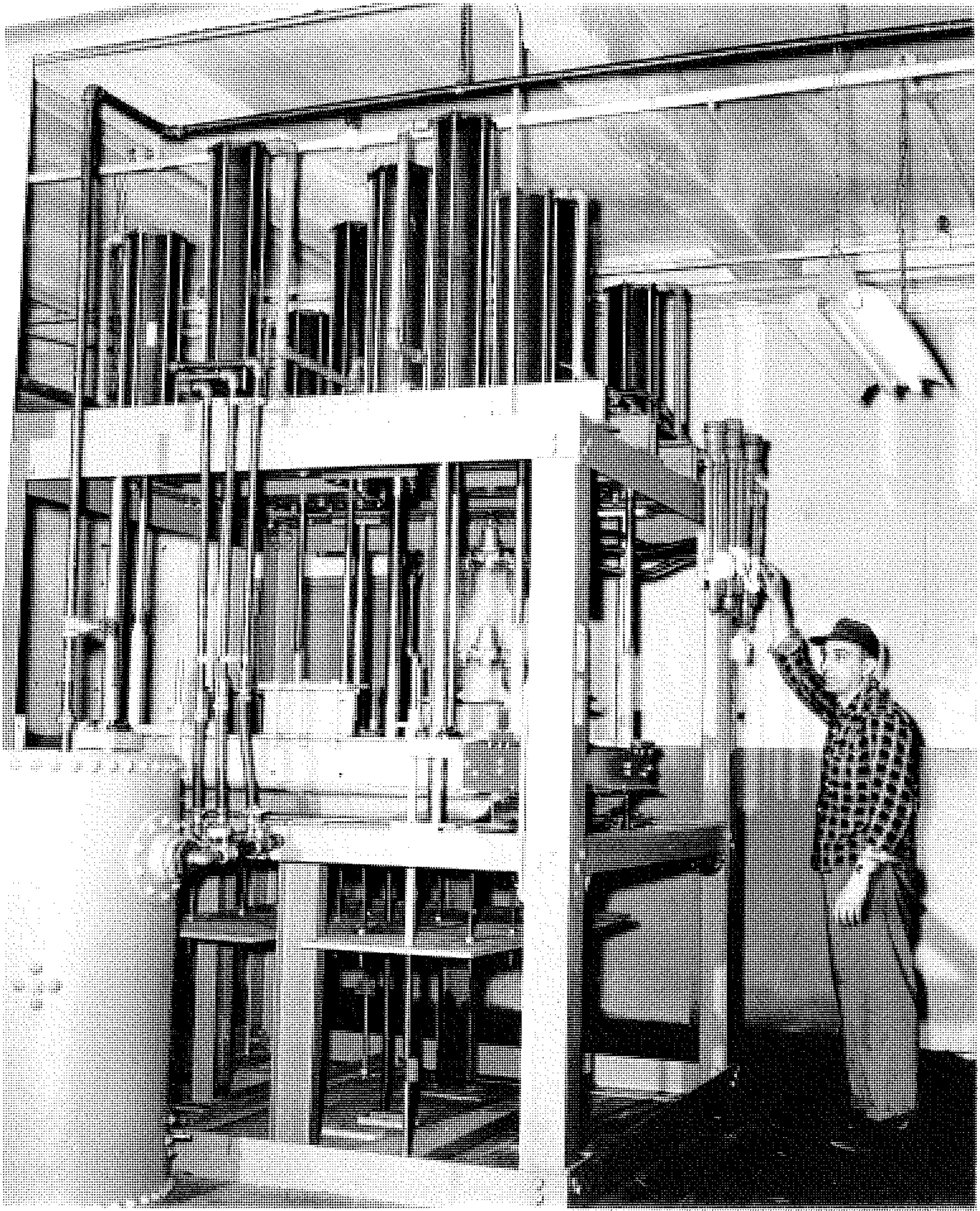


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SOCIETY OF PLASTICS ENGINEERS
NEW YORK SECTION

JOINT MEETING

NEWARK and NEW YORK SECTION

WEDNESDAY, Nov. 12th, 1952

GOTHAM HOTEL
[illegible] WEST [illegible] STREET
[illegible] FIFTH AVENUE
NEW YORK CITY

SPEAKER

JOHN A. SCHWAB
INDUSTRIAL ENGINEER
JOHN A. SCHWAB & ASSOCIATES

SUBJECT

METHODS ENGINEERING
IN THE
PLASTICS INDUSTRY

SPECIAL

SAM SILBERKRAUS
RIVERDALE LABORATORY
DISCUSSES
THE PLASTICS INDUSTRY IN IRAN
AND THE MIDDLE EAST

Dinner Charge
[illegible]

Members and Non-Members
[illegible]

THE PLASTICS SEMINARS

America's Premier Plastics Seminars!

Seymour Lavitt's
- Injection Molding

Irv Rubin's
- Injection Mold Design

Seymour Lavitt's
- Fundamentals of Plastics

- ATLANTA
- BOSTON
- CINCINNATI
- DENVER
- DETROIT
- KANSAS CITY
- LOS ANGELES
- NEW JERSEY
- ORLANDO
- PHILADELPHIA
- SEATTLE

Seymour Lavitt's
INJECTION MOLDING

Seymour E. Lavitt's industry experience includes the Presidency of Sealy Plastics Corporation, Connecticut Industries and The Connecticut Carbon Company. He is now Engineering Coordinator for Plastics Design Associates. He has contributed to plastics research at the University of Connecticut and lectured on plastics at New York University, the University of Chicago and Pratt Institute. Mr. Lavitt has both participated in, and moderated a number of conferences in the plastics field. He has lectured in Brazil, Mexico, Holland and Canada, as well as throughout the United States. At the University of Chicago, Mr. Lavitt trained other instructors in the art and techniques of effective communications and teaching skills. He has provided up-to-date information on critical areas in plastics to over 5,000 participants at his seminars. Mr. Lavitt has been a senior member of the Society of Plastics Engineers since 1957. He was educated at Bowdoin College, University of Hartford, Hillyer College, Howell Cheney Technical Training School and Connecticut State Technical Institute. His greatest strength is his ability to communicate theoretical knowledge and practical experience in intelligible terms.

What you will learn

Like Mr. Lavitt's Fundamentals course this is a five day forty hour program, equal to a full college semester, because the quantity and detail of instruction require this much time. In this seminar a subject of unique complexity is reduced to one almost of simplicity. It concentrates on imparting a thorough understanding of all the factors that affect the injection molding process. In this program you will examine the materials — their properties and behavior in the process, the molds and the factors that differentiate a "good" mold from a bad one; the molding machine itself and its controls. All of this is integrated into a synergistic system for the efficient, economical production of "profitable" injection molded parts.

Who should attend

The program is a sound base for those new to the industry or new to the technology, on the other hand it is designed to provide new insights for the experienced practitioner. While those in manufacturing and engineering will derive the primary benefits, persons in management, product design and marketing will gain knowledge necessary to improve their comprehension of injection molding as a profitable production method.

Call for a detailed description of this program.

ORLANDO — April 8-12, 1991
KANSAS CITY — May 6-10, 1991
BOSTON — June 24-28, 1991
ATLANTA — Nov. 4-9, 1991
LOS ANGELES — Nov. 18-22, 1991

COURSE OUTLINE

I. Introduction
• Characterization of the industry • Markets: past, present and future.

II. Process Fundamentals
• Major variables, temperatures, injection pressures, mold filling speeds, cooling time and rate, cycle time • Effect of variables on shrinkage, crystallinity, molded-in-strains (orientation), mold release agents • Troubleshooting • Product testing • A practical program for quality control.

III. Machines
(Components of a basic injection molding machine and their roll in process performance.) • Material feeding and metering systems • Heating and plasticating (heat chambers, heaters, torpedoes, controls) • Melt delivery systems, single and double stage plungers, screw and plunger combinations, reciprocating screws, non-return valves • Nozzles (plain, pin-point, mixing, valved) • General construction, closing and clamping systems, hydraulic and electrical operating systems and controls.

IV. Molds
• Types (cold, hot, insulated runner and runnerless molds), materials and construction • Special designs (cam and hydraulic side core pulls, thread unscrewing) • Parts ejector systems: runner and gate designs and functions • Temperature controls • Texturing • Evaluation of the state of the art mold • Prototyping.

V. Special Injection Molding Systems
• Insert, index and rotary, multi-color, assembly, flow, stack, injection blow, structural foam, RIM and LIM.

VI. Accessory Equipment and Operations
• Material handling and delivery systems (bulk handling, hopper loaders), color blending (dry pigments and concentrates), scrap processing, material drying, mold temperature control units.

VII. Materials
• Thermoplastic and thermosets; their physical and chemical properties; the effects of those properties on molding operations and resultant products.

VIII. Products
• Study of typical injection molded parts • Relation of part design, function and performance to process requirements and limitations (size, wall thickness, tapers and undercuts, gate location).

IX. Improving Profitability
• Basic cost factors • Typical manufacturing costs • Study of machine capital investment and mold cost versus hourly output • Comparison with competitive processes.

X. Decorating and Secondary Operations
• Printing and painting, hot stamping, vacuum metalizing, electro-plating, assembly and joining methods (adhesive bonding, heat sealing, welding, spin welding, ultra sonic assembly and welding).

Seymour Lavitt's

FUNDAMENTALS OF PLASTICS

What you will learn

Fundamentals of Plastics is recognized as the premier instructional vehicle in the plastics industry. It is a five day, forty hour course — equivalent to a full college semester, because it simply takes that long to communicate this body of information effectively. You will have described in detail every major processing system and many of the less well known, but potentially profitable ones, in addition to assembly/joining and decorating/finishing techniques. It teaches theory only in the applied sense. Each presentation is unique and is as current as this week's technology — it covers microcomputer control and CAD/CAM as effectively as it encompasses rheology and polymer theory.

Who should attend

Fundamentals is an excellent introduction to technology for engineers, managers and designers who are versed in other technologies or other materials, as well as procurement people and sales/marketing personnel who would benefit by a better understanding of plastics. This course provides a review and organization of plastics information that codifies and confirms an expert's knowledge while creating new insights. To the novice it conveys a solid base of information that would take years of experience to grasp, not to mention the costly trial and error. Classes are limited in size, therefore, there is time for individual attention, in effect, the students dictate the content of the program. Because it is tailored to the needs of those who attend, this allows for an in-depth exploration of ***your*** problems. The unique structure makes learning comfortable for both the novice and the expert. No difficult mathematics or chemistry is used — you will be given basic, easily understood concepts that will let you put this information to use in improving your company's profitability.

Call for a detailed description of this program.

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3. You will eliminate travel and housing costs for your group.
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If you think that an in-house program might be for your company, call Len Berringer at (617) 749-1003 to discuss it. Of course, there is no cost or obligation.

LOS ANGELES — April 22-26, 1991
NEW JERSEY — May 20-24, 1991
DENVER — July 15-19, 1991
PHILADELPHIA — Oct. 7-12, 1991
ORLANDO — Dec. 9-13, 1991

COURSE OUTLINE

I. Structure and Development of The Industry
- A. Basic definitions and history
- B. Process and product descriptions

II. Basic Polymer Chemistry
- A. Macro-molecular concepts for the newcomer
- B. Valence, radicals and chain structure
- C. Types of polymerization
- D. Chemistry of thermoplastics, thermosets and cellulosics

III. Production and Processing Methods
(Analysis covers machinery and equipment, products, manufacturers, economics and variables)
- A. Injection molding
- B. Extrusion
- C. Compression/transfer molding
- D. Thermoforming
- E. Blow molding
- F. Calendering
- G. Coating
- H. Casting
- I. Reinforced plastics
- J. Foams
- K. Auxiliary processes — coloring, finishing, sealing decorating and fabricating

IV. Terminology and Properties Analysis
- A. Process and product terminology
- B. Mechanical, electrical, thermal, optical, and chemical properties
- C. Test methods

V. Plastics and Material Study
(Analyzes over twenty materials from thermoplastics, thermosetting, cellulosic, foam and reinforced plastics families)
- A. Volumetric order
- B. Chemistry
- C. Properties
- D. Production and processing
- E. Applications
- F. Manufacturers
- G. Economics

VI. Utilization of Reference Sources
- A. Reference Books
- B. Trade associations
- C. Trade journals, literature, etc.

Call for brochures on Extrusion, Thermoforming, Plastics for Designers and Plastic Piece Part Design.

Irv Rubin's

INJECTION MOLD DESIGN

Irv Rubin, chosen to instruct Injection Mold Design, has, in fact, written the definitive book on the subject — **Injection Molding Theory and Practice.** Mr. Rubin is president of Robinson Plastics and the country's leading consultant on injection molds and molding. During the past thirty years he has held numerous offices in the SPE, as well as other scientific and technical societies. His experience in injection mold design and fabrication is without peer. He established several plastics educational programs in New York City area schools, he was adjunct professor of plastics at New York Institute of Technology. Mr. Rubin was called upon to write the chapters on Injection Molding and Injection Molds in the latest edition of the **SPI Handbook.** His credentials are, in fact, the successes of his life's work. Mr. Rubin's teaching method is one of adaptivity, every class is regarded as a group of individuals each with special informational needs and the program is tailored to serve these needs.

What you will learn

Many companies needlessly spend thousands of dollars on mold rework, changes or repair even after following the "best" recommendations of material suppliers, mold builders and molders. Learn when to question these recommendations and how to evaluate conflicting data. Find out which basic mold designs will most likely produce a part that meets all your quality and price requirements.

You will gain a more complete understanding of the proper function of each element of the mold and learn how each is affected by the injection molding machine and the rheology of the plastic material. By understanding the interrelationship of all elements in the molding process, you can shorten tryout time, minimize rework, lower mold costs, reduce repair and substantially increase the production of quality parts.

Who should attend

Both mold and product designers who need to broaden their expertise in how to design the most cost effective mold, to produce higher quality parts, at the highest rate of productivity. Mold design, despite the introduction of CAD/CAM techniques, still remains a black art — the successful practitioners of which have developed the insight into the most effective techniques. This course is designed to give you that insight, by teaching concepts and the guidance to apply them to specific production problems. If you buy, make or use injection molds, you can't afford not to avail yourself of this opportunity to learn directly from the man who "wrote the book" on injection molding.

Call for a detailed description of this program.

BOSTON — April 22-24, 1991
DETROIT — May 20-22, 1991
PHILADELPHIA — June 4-6, 1991
SEATTLE — Sept. 23-25, 1991
CINCINNATI — Oct. 28-30, 1991
ORLANDO — Nov. 18-20, 1991

COURSE OUTLINE

I. Introduction to Injection Mold Design
- A. Principles and Terminology
- B. The Factors Which Affect Mold Design

II. The Injection Molding Machine
- A. Clamp Types
- B. Tie Bars/Clamp Opening
- C. Plunger Plasticating
- D. Screw Plasticating
- E. Flow — Pressure — Temperature
- F. Pressure Profile in Barrel and Mold

III. Hydraulics
- A. Basic Theory
- B. Valves — Pressure/Flow/Directonal
- C. Pumps — Fixed & Variable Displacement/Servo
- D. Sample Circuits.

IV. Polymer Rheology and Its Relationship to Mold Design
- A. Melt Flow
- B. Hagan-Poiseuille Equation
- C. Reynolds Number
- D. Viscosity/Orientation
- E. Gate/Vent/K-O Location

V. Factors in Mold Design
- A. Mold Bases
- B. Parting Line Effects
- C. Two Plate/Three Plate/Stack Molds
- D. Hot and Insulated Runner Molds
- E. Fixed/Reciprocating Probes
- F. Temperature Control/Cooling
- G. Vents/Gates/Runners/Ejectors
- H. Materials
- I. Hardening/Polishing
- J. Hobbing/Casting/Machining
- K. Cams/Threads
- L. Automation

VI. Correcting Molding Faults

VII. A 73 Point Check List
A custom designed system that could spell the end of molding problems for you.

VIII. Workshop
Bring your problem parts for open class discussion as time permits. One new idea may save your company hours of down time and thousands of dollars.

IMPORTANT: The handbook for this course is Mr. Rubin's Injection Molding — Theory and Practice, the bible of injection molding.

FIVE REASONS WHY YOU SHOULD ATTEND

THE PLASTICS SEMINARS

1. We have the top instructors in the USA
You will participate in a unique learning experience, taught by a member of a consortium of America's foremost plastics instructors — leaders in the plastics industry, the people who have written the books, developed the concepts and systems, have had extensive teaching experience and have collectively been called upon to solve difficult technical dilemmas.

2. We take the time required to be effective
These are multiple day programs, designed to convey information and insight in a time frame consistent with the depth of that information. We don't do one day "quickies" or "freebies" that are thinly veiled sales pitches for someone's products — your time (and ours) is too valuable.

3. You can immediately apply what you learn
You get information that is shirt-sleeve practical, directed to operating engineers and managers who need to gain the essential know-how and insights that can be immediately applied to improving productivity.

4. You can ask questions — and get immediate, expert answers
Our courses are taught live (not videotaped) in an air of professional consultation that enables you to tap the leaders extensive experience and apply it to your specific needs.

5. We guarantee your satisfaction
You are assured that your time will be well spent because in addition to the endorsement of previous students you receive a no ands ifs or buts guarantee — "If your productivity isn't increased as a result of attending, we'll refund your fee". You can't go wrong!

REGISTRATION INFORMATION

Reservations/Registrations
Confirmed registrations may be made by filling in the registration form and sending it to the seminar office with the appropriate fee. Telephone reservations will be confirmed as registrations upon receipt of the fees. All fees are payable in advance — a $25 service fee will be added for open billing to rated companies. Confirmation will be sent directly to the registrant; please check with the Registrar if you do not receive confirmation ten days prior to the meeting.

Cancellations/Substitutions
Substitutions may be made at any time simply by advising the Registrar by phone. Cancellations made less than ten days before the seminar are subject to a $50 service charge; those who fail to attend are liable for the entire fee.

Seminar Hotels — Special Discounts
All seminars are held in convenient hotels. Conteninental breakfasts, lunches and refreshments are included. Lodging and dinners **are not** included in the seminar fee. You will be advised of the hotel name and location when you register for the seminar.

Please make room reservations directly with the hotel where the seminar is being held. Mention that you are attending one of The Plastics Seminars to obtain the group rate where it is available. Busy hotels fill quickly: please make room reservations as early as possible.

Seminar Fees
A 10% discount is offered to the second and all additional registrants from the same company attending the same program.

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RUBIN

INJECTION MOLDING

Wiley-Interscience

INJECTION MOLDING
Theory and Practice

IRVIN I. RUBIN

A volume in the SPE Monograph series

About the Author

IRVIN I. RUBIN is president of the Robinson Plastics Corporation in Jersey City. He is a member of the Society of Plastics Engineers, Inc., the American Chemical Society, the American Association for the Advancement of Science, and president of the Plastics Molders Guild, Inc. Mr. Rubin is especially active in the Society of Plastics Engineers, was president of the New York section, and, at the national level, chairman of the publication committee, the technical volumes committee, and the abstracting task force. He is a member of the Plastics Educational Commission of the Advisory Board for Vocational and Extension Education of the New York Board of Education and was adjunct professor of plastics at the New York Institute of Technology.

INJECTION MOLDING
Theory and Practice

By Irvin I. Rubin
A volume in the SPE Monograph series

Based on more than 30 years of the author's experience in operating an injection molding plant, this volume offers a rigorous theoretical and practical treatment of injection molding. The theoretical exposition is presented in simple conceptual terms which stress the logical reasons for basic processes. Molding machines and their circuits, injection molds and their design and construction, plastic materials, and the correction of molding faults are some of the major topics treated. Examples of molded parts illustrate the practical application of theory and a wealth of useful, general information on operations, maintenance, and management procedure is included.

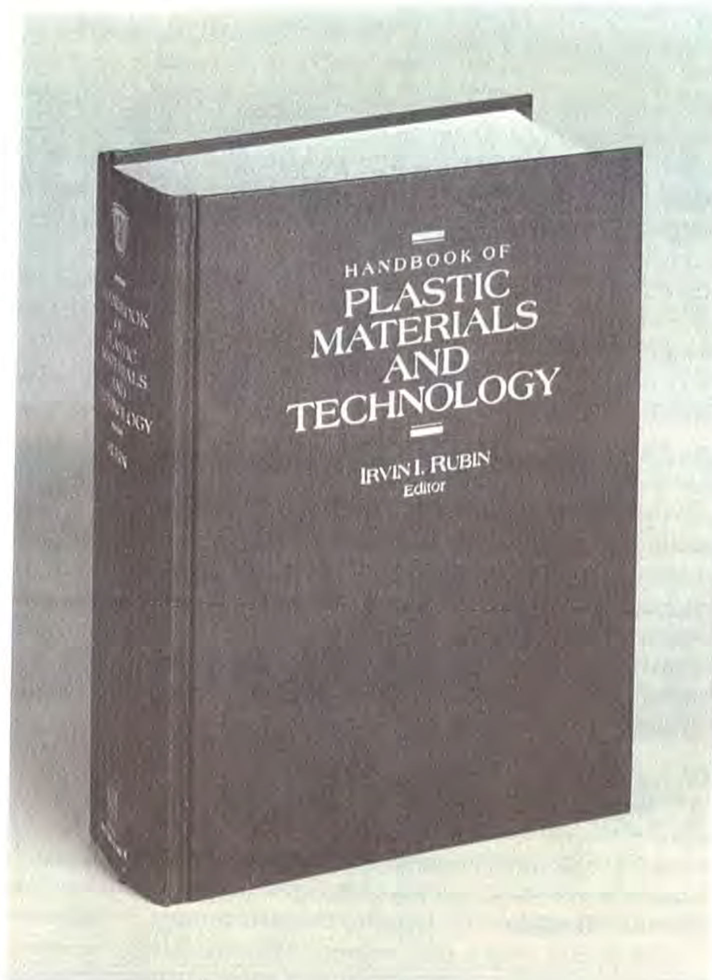
The material in *Injection Molding: Theory and Practice* is presented in eight basic chapters. They cover the injection molding machine, molds, the theory and practice of injection molding, materials and their properties, correcting molding faults, hydraulic mechanisms and circuits, electrical mechanisms and circuits, and examples of molded parts. Practical suggestions, such as a 73 point checklist for mold design, and a complete chapter on why molding faults occur and the ways in which they can be corrected highlight the volume. Especially noteworthy are comprehensive bibliographies at the end of each chapter that review all pertinent English language publications up to the beginning of 1972. The appendix brings together previously scattered, essential information on plastics engineering and operations from a wide variety of sources.

Injection Molding: Theory and Practice will be of special interest to injection molding engineers, operating personnel in injection molding plants, and engineers in the plastics industry and those people who buy and specify injection molded parts. In addition, engineers who require information about plastics properties and processing will welcome this volume. Because of its scope and dual theoretical and practical orientation it can be used as a basic text in technical training programs and college courses.

Major New Plastics Reference Book:

Handbook of Plastics
Materials and Technology

Editor: ***Irvin I. Rubin****, Robinson Plastics Corp., Fellow, Society of Plastics Engineers, Author of* Injection Molding, Theory and Practice



Features:

- Comprehensive, single-volume reference on plastics materials and technology
- More than 100 authoritative articles -- all major plastics, plastics additives, and processes covered
- Hundreds of tables provide current data on plastics properties, formulation, and applications -- hundreds of schematics illustrate processes, equipment and product/component design
- Uniform presentation of each topic; designed for easy reference
- Prepared by more than 100 leading authorities on plastics

This big, new 1745-page reference is the single most comprehensive, up-to-date source of information on plastics materials and technology available today.

It provides clear, concise, detailed information on every major plastic and plastics additive (more than 80) and every major plastics processing method (more than 30) in use today. This encyclopedic compilation of current information was prepared by more than 100 leading authorities on plastics.

The presentation of each topic is uniform and organized for easy reference. Much of the extensive data on each plastic, such as on properties, processability, and applications, is economically presented in tables. The hundreds of schematics and photographs illustrate chemical structure, applications, processes and equipment.

Completely up-to-date, this encyclopedic, new reference will serve the information needs of all management, engineering, scientific and educational personnel involved in the research, development, processing or manufacture of today's plastics. Copies of this big new handbook are now available for prompt delivery.

On the next pages

- Complete table of contents
- Inside a chapter
- List of contributors/affiliations
- Sampling of tables and figures
- From the Editor's Preface
- Offer

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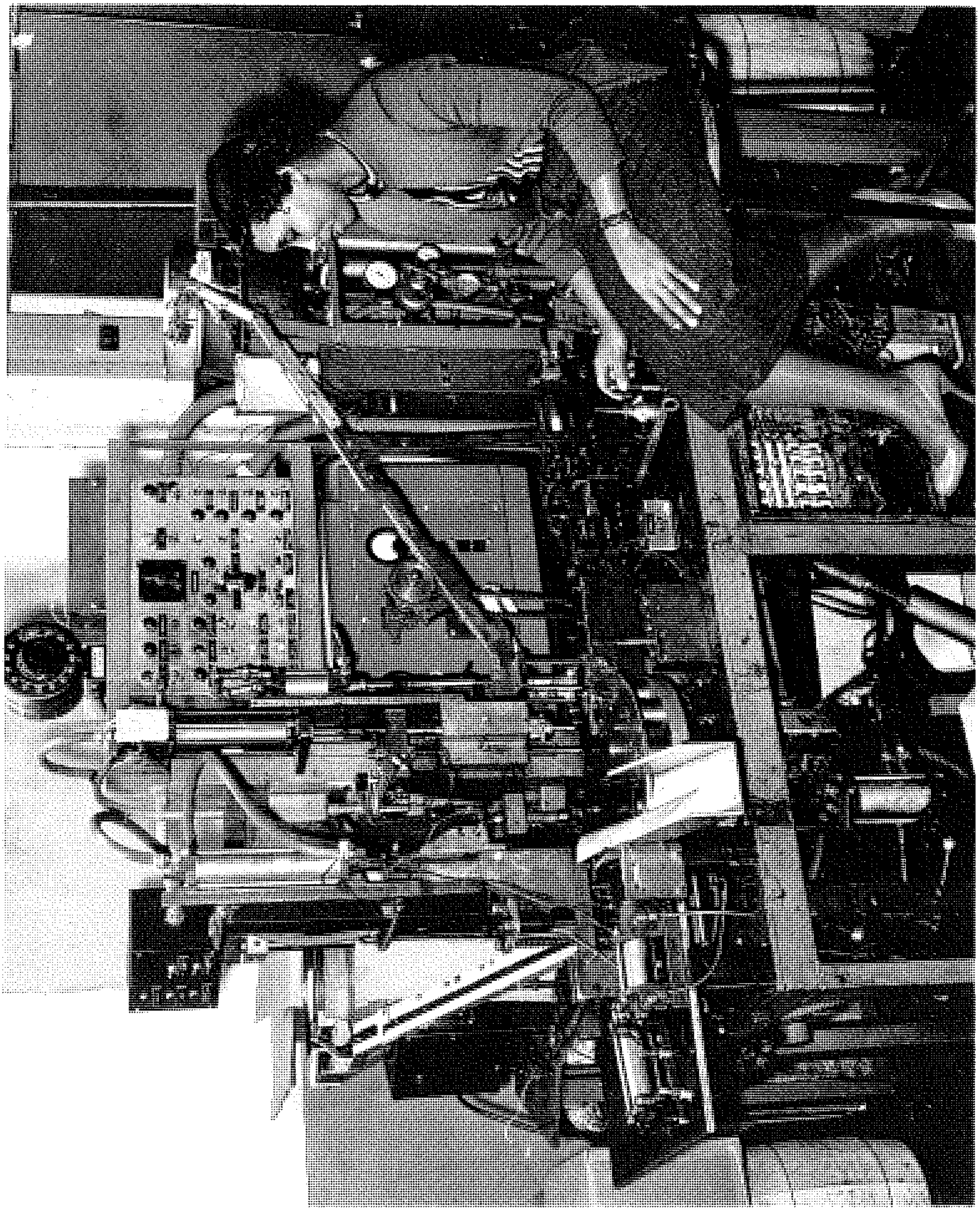

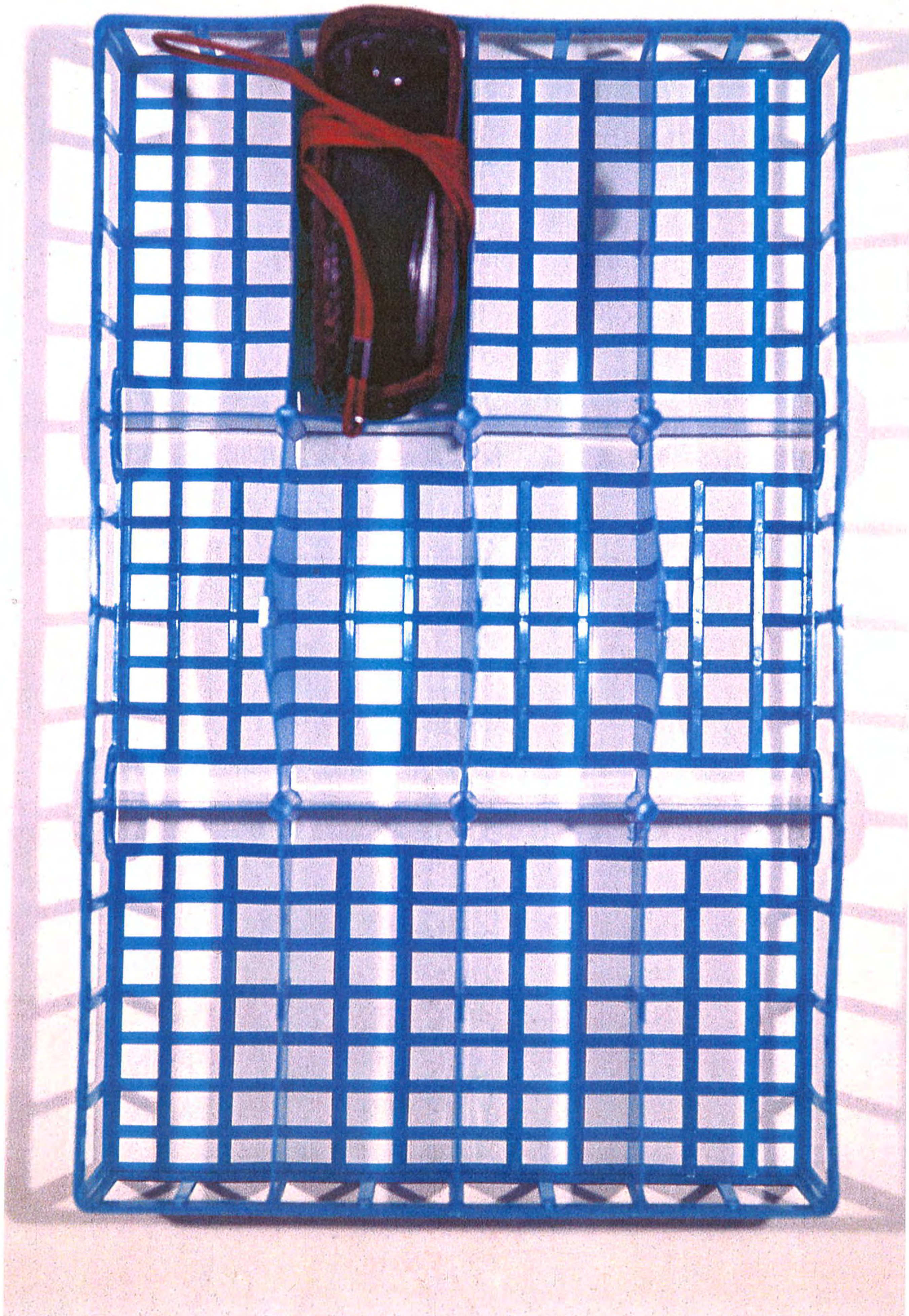

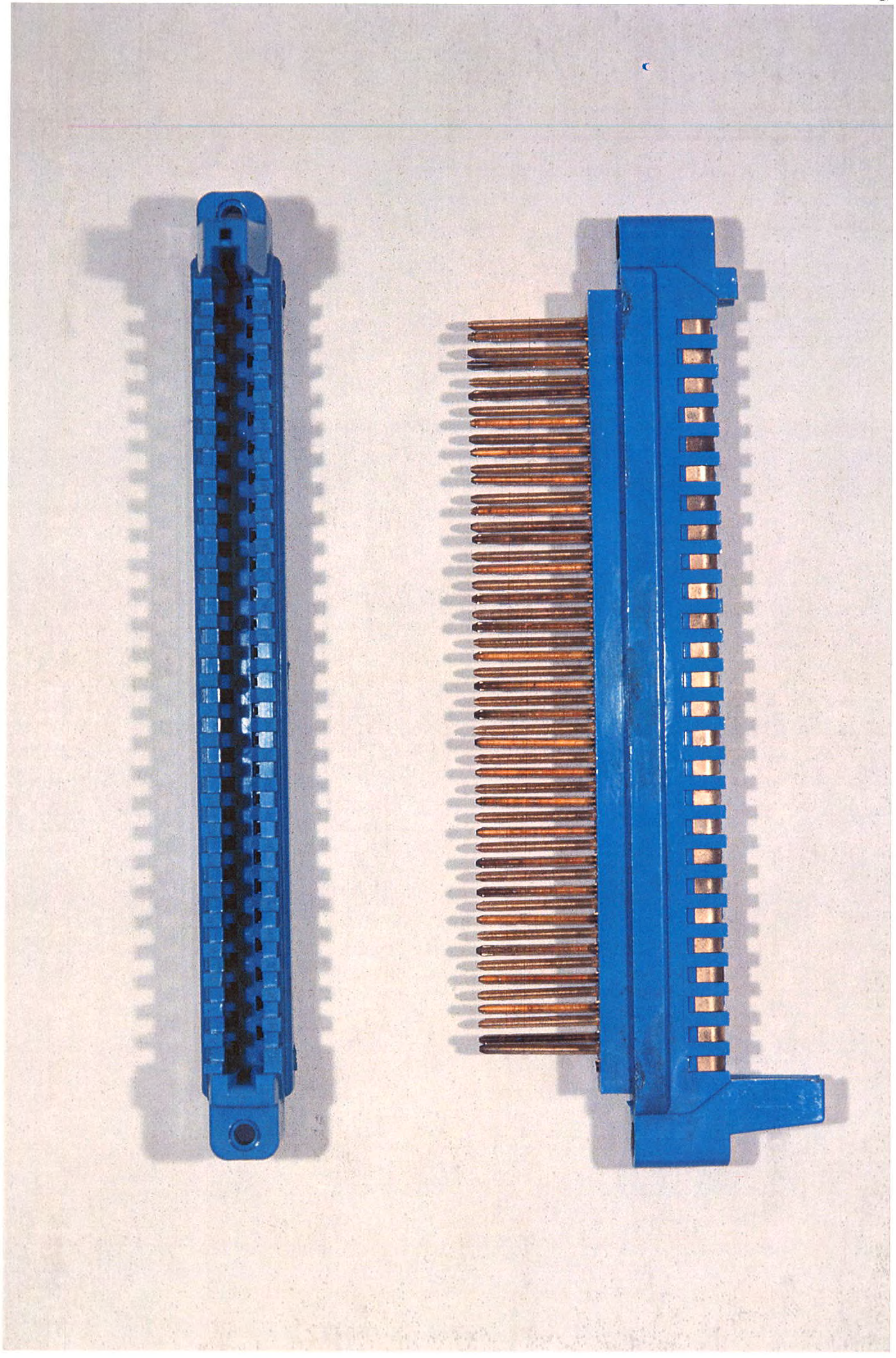

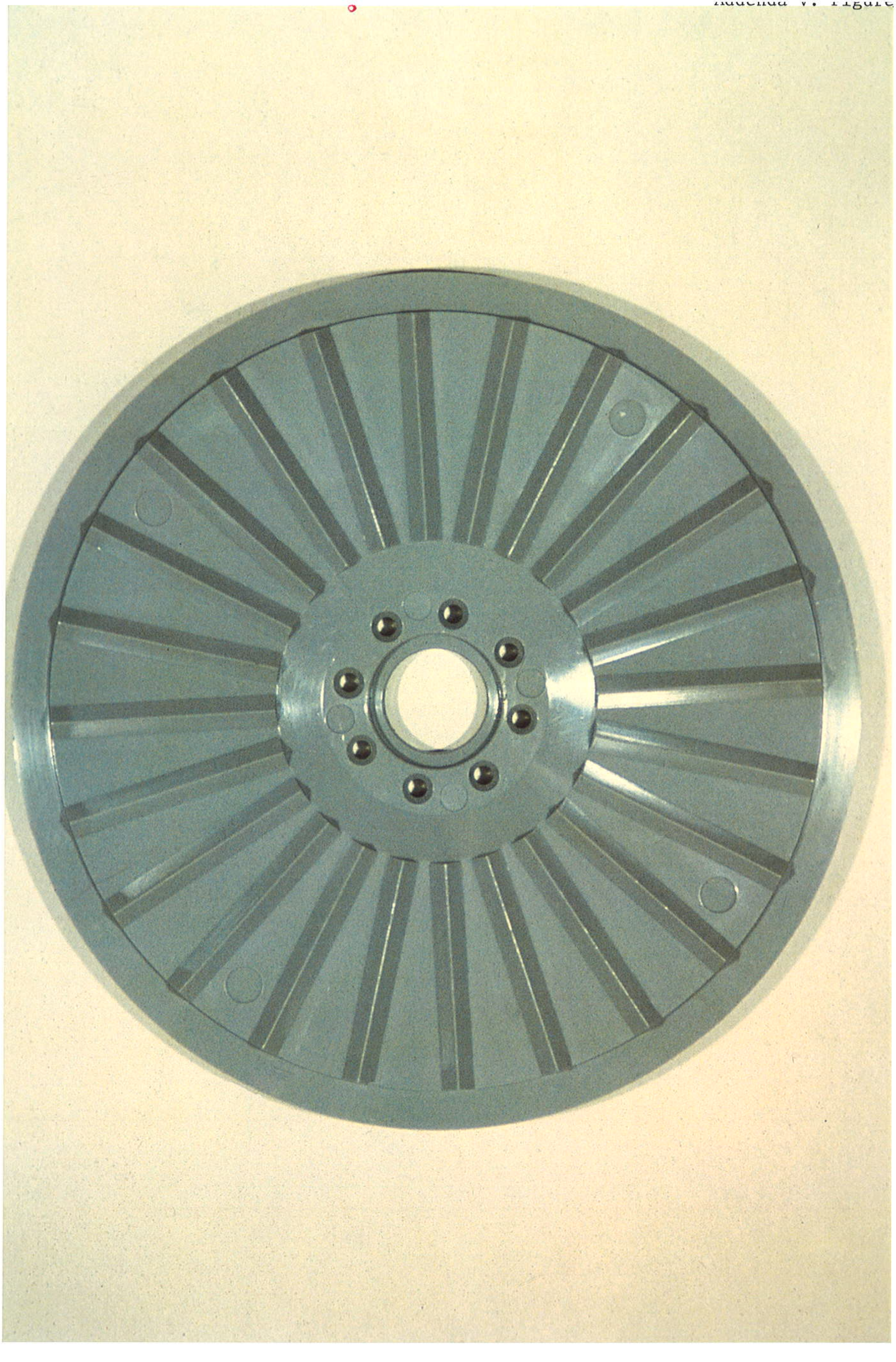

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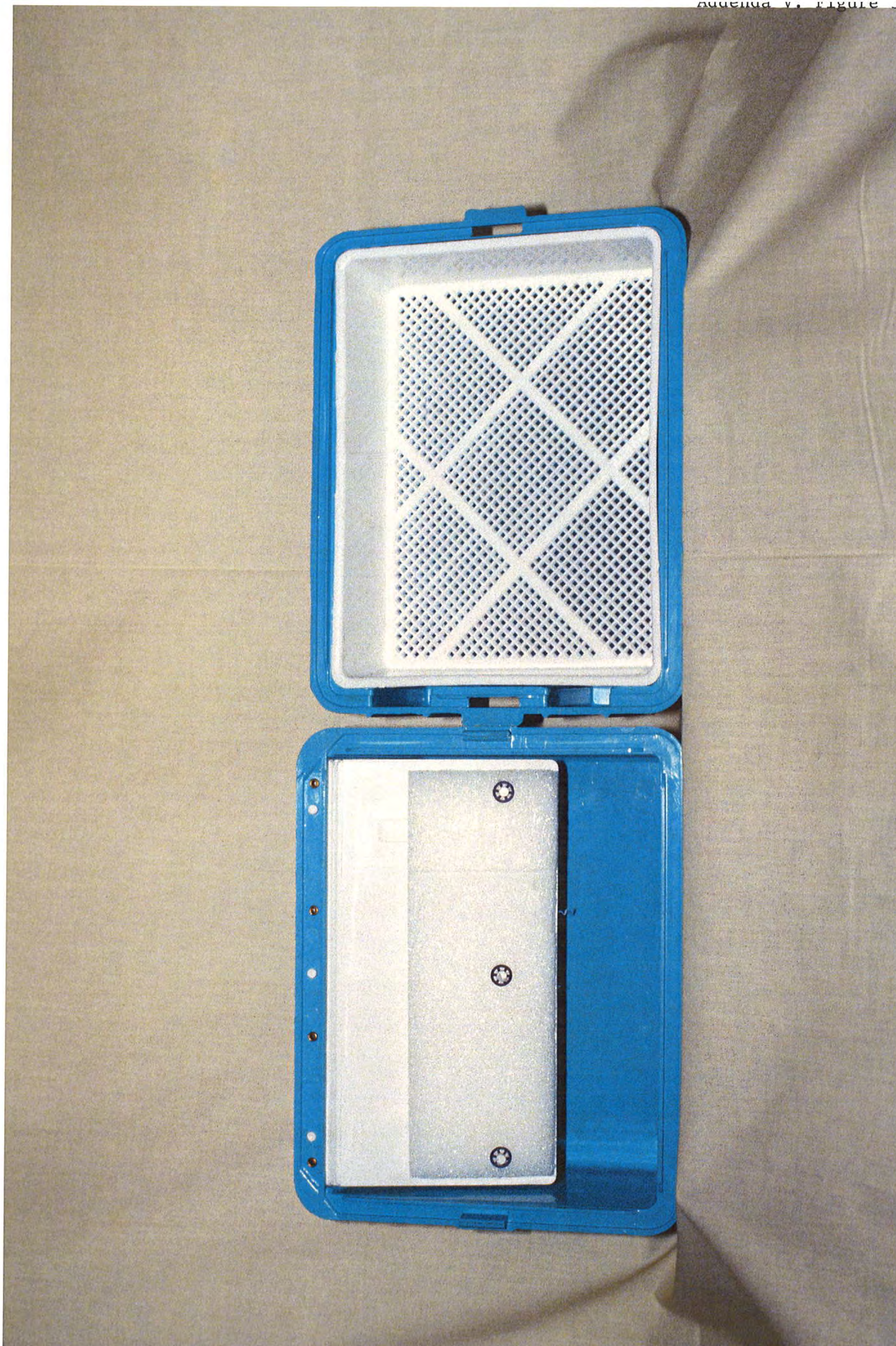

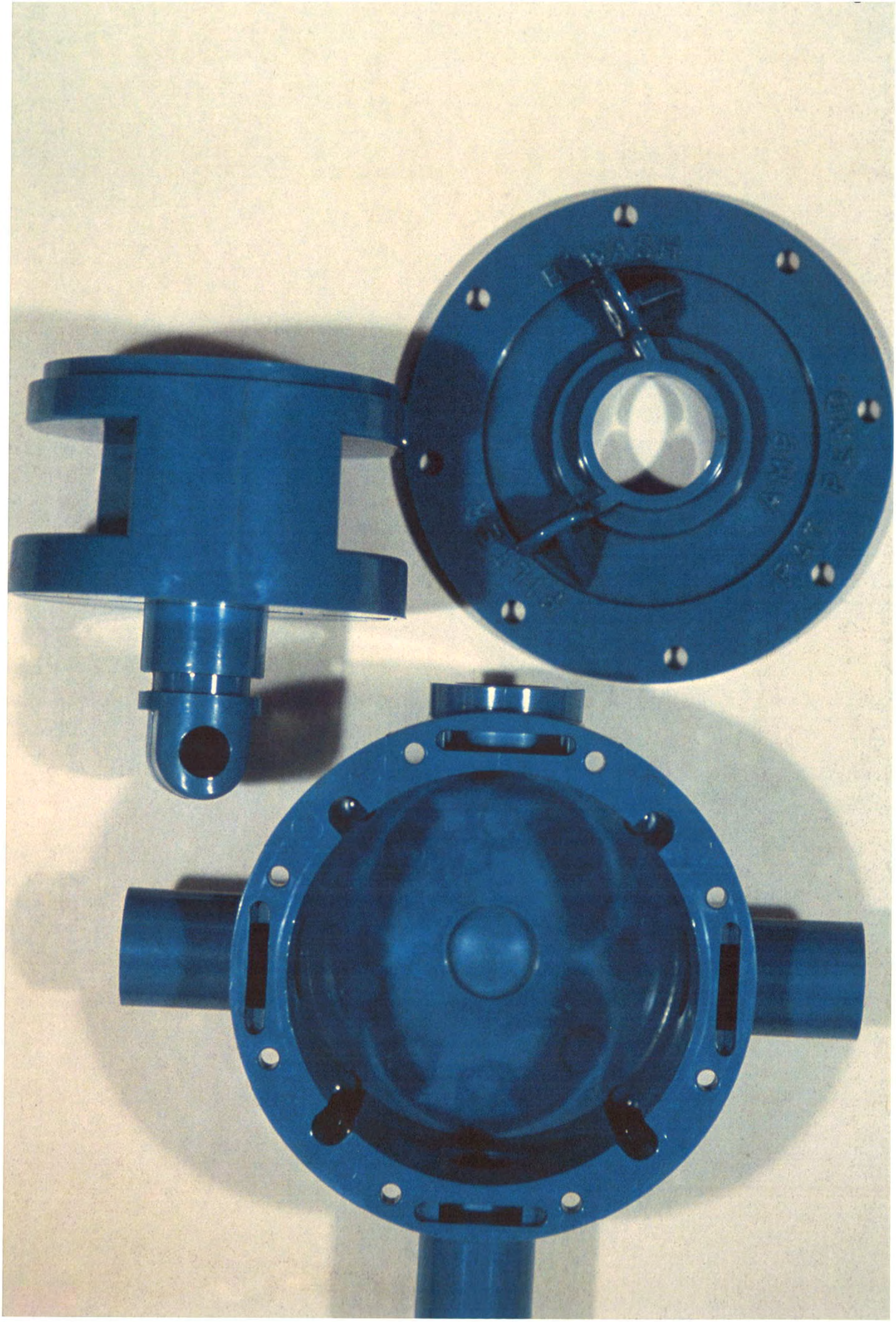

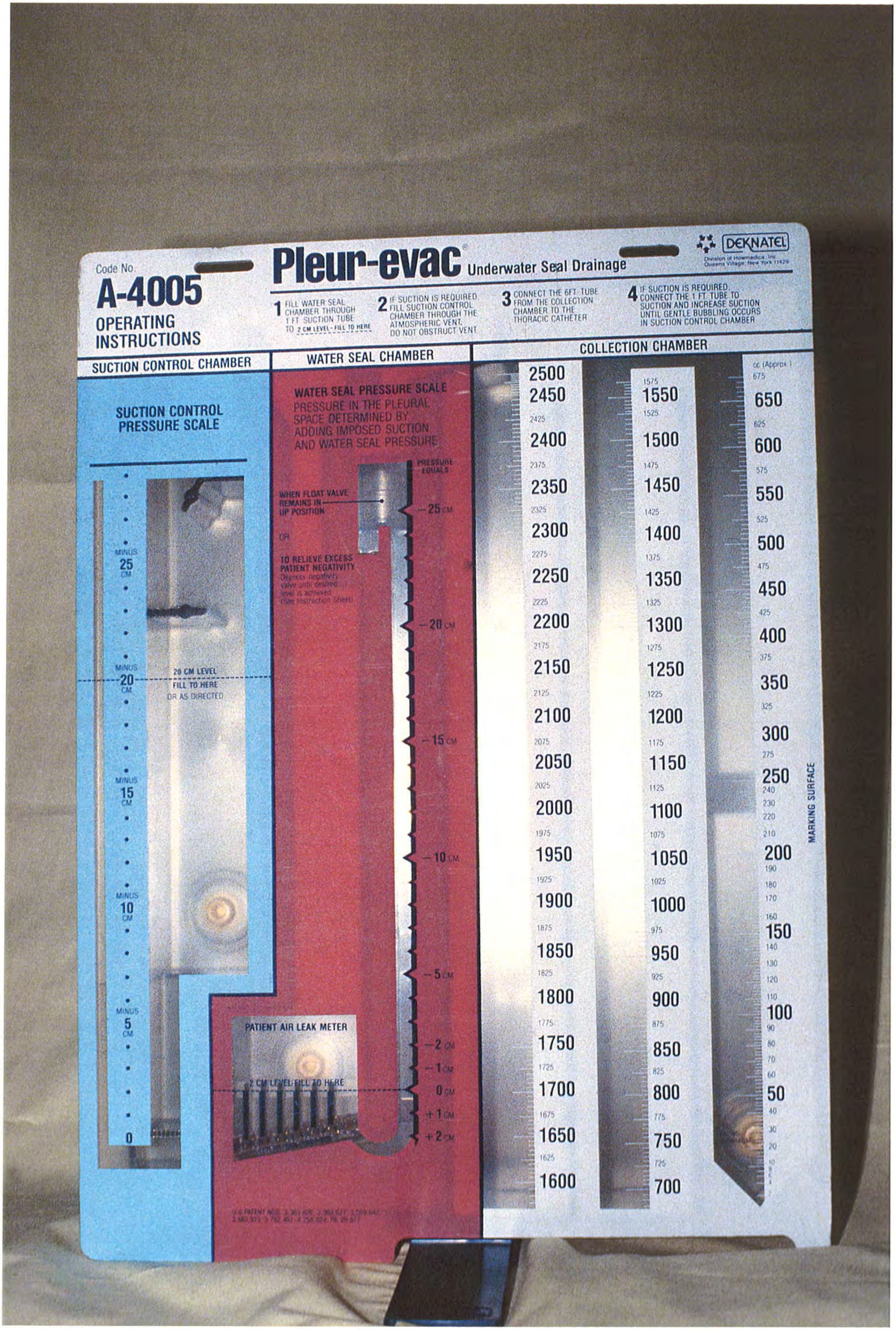

Code No.
A-4005
OPERATING INSTRUCTIONS
Pleur-evac® Underwater Seal Drainage
DEKNATEL
1 FILL WATER SEAL CHAMBER THROUGH 1 FT SUCTION TUBE TO 2 CM LEVEL-FILL TO HERE
2 IF SUCTION IS REQUIRED FILL SUCTION CONTROL CHAMBER THROUGH THE ATMOSPHERIC VENT. DO NOT OBSTRUCT VENT
3 CONNECT THE 6FT. TUBE FROM THE COLLECTION CHAMBER TO THE THORACIC CATHETER
4 IF SUCTION IS REQUIRED, CONNECT THE 1 FT. TUBE TO SUCTION AND INCREASE SUCTION UNTIL GENTLE BUBBLING OCCURS IN SUCTION CONTROL CHAMBER
SUCTION CONTROL CHAMBER
WATER SEAL CHAMBER
COLLECTION CHAMBER
SUCTION CONTROL PRESSURE SCALE
WATER SEAL PRESSURE SCALE
PRESSURE IN THE PLEURAL SPACE DETERMINED BY ADDING IMPOSED SUCTION AND WATER SEAL PRESSURE
PRESSURE EQUALS
WHEN FLOAT VALVE REMAINS IN UP POSITION
OR
TO RELIEVE EXCESS PATIENT NEGATIVITY
20 CM LEVEL FILL TO HERE OR AS DIRECTED
MINUS 25 CM
MINUS 20 CM
MINUS 15 CM
MINUS 10 CM
MINUS 5 CM
0
PATIENT AIR LEAK METER
2 CM LEVEL-FILL TO HERE
MARKING SURFACE
cc (Approx.)

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Another unusual application of injection molding.

Plastic supersedes metal yielding superior product at lower cost.

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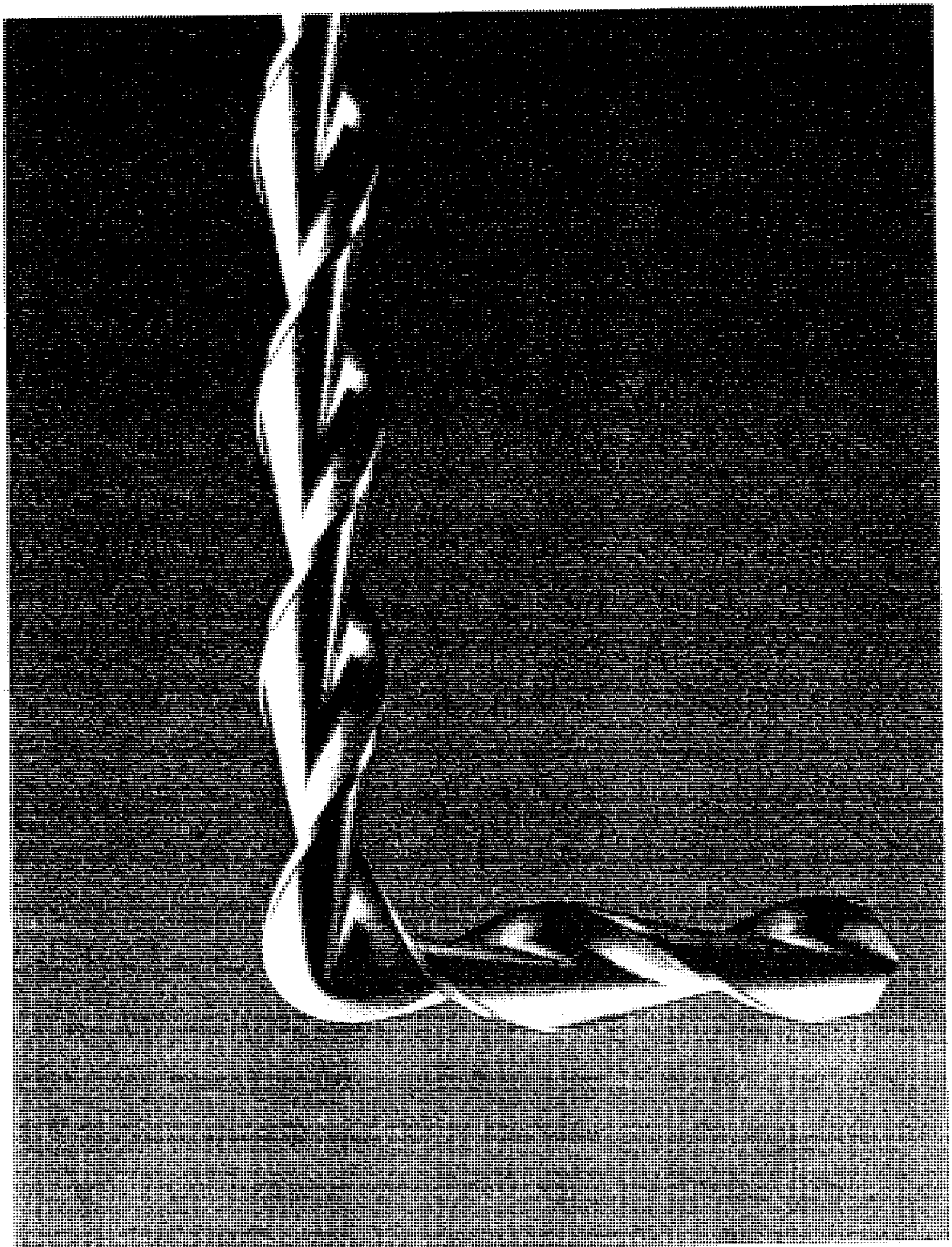

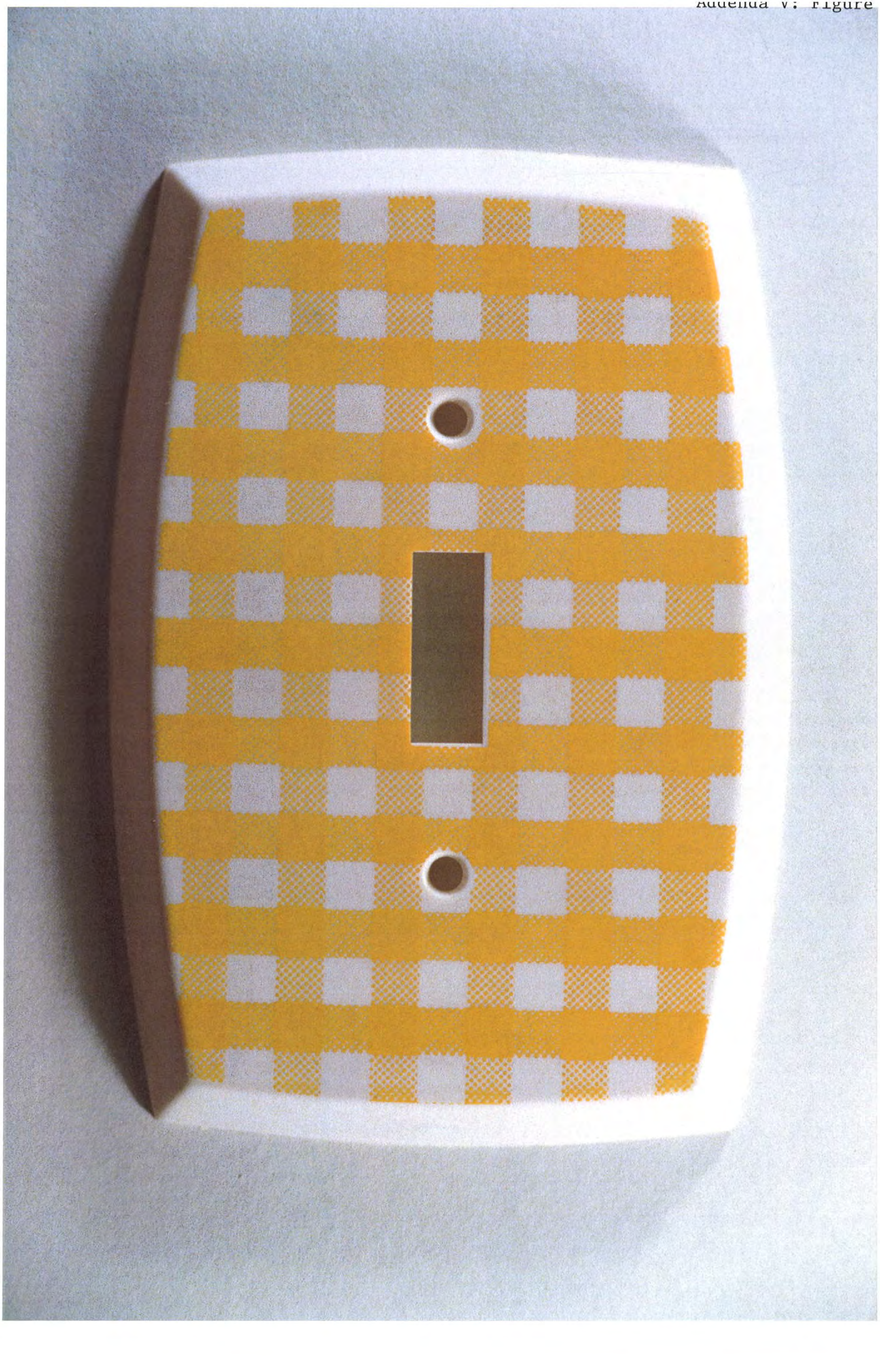

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