Interviews of the Margaret MacVicar Memorial AMITA Oral History Project, MC 356
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Dr. Aviva Brecher – class of 1968

Interviewed by Madeleine Kline, class of 2020

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MIT Libraries

Margaret MacVicar Memorial AMITA Oral History Project

Aviva Brecher (SB Physics 1968; SM Physics 1968) was interviewed by Madeleine Kline (SB Biology and Chemistry, 2020) at the Boston Marriott Cambridge in Kendall Square on September 9, 2017.

Dr. Brecher transferred to MIT from the Technion [Israel Institute of Technology] in 1965 and graduated in 1968 with both a bachelor's degree and a master's degree in physics. (Professor Benjamin Lax, Director of the MIT National Magnet Lab, was her thesis advisor, and her mentor was the renowned MIT physicist and engineer Mildred Dresselhaus.) After a year of doctoral studies in physics at MIT, Dr. Brecher transferred to the University of California, San Diego, where she completed a Ph.D. in applied physics in 1972. She then returned to MIT as postdoctoral Research Associate in Earth and Planetary Sciences. Dr. Brecher experienced MIT as an undergraduate, graduate student, postdoctoral fellow, member of the research staff and Lecturer in Concourse Physics.

Dr. Brecher chose a career that allowed her to explore many different areas of applied physics without settling in any one specialty. She worked in academia (Assistant Professor of Physics at Wellesley College), technical consulting, and science and technology policy on Capitol Hill. She was also a research scientist and strategic planner at the U.S. Department of Transportation's Volpe Center in Kendall Square for 28 years.

KLINE: Your background, your childhood, is unusual. Can you tell us a bit about it?

BRECHER: I was born in Bucharest, Romania, just as the war [WWII] ended and Russian tanks entered Bucharest. My birthday is July 4, 1945, so I was "doomed" to become an American. My father was a doctor, and we had a relatively affluent life, though as Jews we suffered discrimination under the communist regime. Our family immigrated to Israel while I was in high school.

I studied in Israel during high school, and took classes at the Technion [Israel Institute of Technology]. In Israel, while still in high school, I met Ken Brecher [Kenneth Brecher, SB Physics '65 and Ph.D. Physics '69; Professor of Physics at Boston University until 2015; Director of BU's Science and Education Center], who was a student at MIT in physics. He came to work for the summer with Nathan Rosen, who was Einstein's former assistant, and we started corresponding.

We both were passionately interested in science: I had just won a national math and science competition to work for the summer after my 11th grade at the Hebrew University in Jerusalem, and at the Weizmann Institute of Science, in Rehovot. We corresponded for two years in a long-distance romance while I

finished high school and was admitted to the Technion to study applied physics. It was very competitive to get into the Technion, so I was stressed out after my matriculation. Without my parents knowing, I applied to MIT and Radcliffe while I was a student at the Technion. Since I had advanced placed math and science, MIT accepted me as a sophomore transfer student.

Ken came to work again in Israel at the Technion after he got his MIT SB in physics and was admitted to graduate school. He was also accepted at the Technion as a Ph.D. student, but he didn't know any Hebrew, so we didn't really have the option to study there. I got married to him in Israel right after my freshman year, changed my name from Schwartz to Brecher, and came in on an immigrant visa to MIT.

At McCormick Hall [where most women students at MIT lived at that time] they were very excited, because instead of having three in a room, they were going to have only two, and more storage space in the closet. I became friends with the McCormick women who benefited from my living off campus as a married woman, and they let me use the famous "bibles." You know what bibles are – all problem sets and solutions!

KLINE: They had their own in McCormick Hall? They had their own bibles?

BRECHER: Yes. Then we lived on the corner of Mass Avenue and Ellery Street [in Cambridge] for five years, and we only had a scooter – so I came to classes wearing a helmet. I was very unusual in many respects, because I was a female transfer student from a foreign country, spoke with an accent and was already married. I was also brash enough to ask questions in class, as I had learned in Israel to behave as a *sabra* [native-born Israeli].

All of my husband's friends, when he was in graduate school in physics, were a support system, and they told me what it was like to be an undergraduate. When I came, there were less than 10% women. In a class of 200, I think there were only five or 10 women in my required classes.

When I came from, the Technion, it was a very different system. I had to adjust to relative grading. In Israel, there are absolute grades. Whatever you solve, these are the points you get. There's no class average kind of thing. So they gave me a year and a half for one year of Technion. I passed all kinds of exams when I arrived, advanced placed, and it was very competitive. In fact, Ken said they told the freshmen, "Look to your left, look to your right, one out of three will not be here by the sophomore year." So only the best of the best were left by sophomore year. Everybody else either transferred to easier classes or majors.

What is your major?

KLINE: I study biology and chemistry – premed.

BRECHER: That's very trendy!

KLINE: Yeah.

BRECHER: Well, I did get interested in biophysics and took a lot of biophysics, so after my sophomore year, I worked with a famous neurophysiologist called Pat Wall [Patrick Wall, a British neuroscientist known for developing the gate control theory of pain and a professor at MIT from 1957-1967] and with Jerry Lettvin [Jerome Lettvin ’47, MIT cognitive scientist famous for his paper “What the Frog’s Eye Tells the Frog’s Brain”]. I operated on rats' brains, and we cut possible nervous pathways to the brain for pain. And as a result of this research, Pat Wall held the patent with Melzack [McGill University Pscyhology Professor Ronald Melzack] for what's called TENS, the transcutaneous neural stimulator that blocks pain. People wear it routinely now.

However, because it wasn't predictive, I decided biology was not for me: it was not a real science, since it was mostly heuristics and we just did statistics on how many rats reacted in a certain way. You couldn't predict what would happen. So I decided, "I'm moving to Solid State physics," after taking Millie Dresselhaus's first course she taught at MIT in 1967 – by far the best course I had taken.

[Professor Dresselhaus, a pioneer for women in science and engineering who was also a pioneer in carbon science and carbon nanostructures, was associated with MIT for 57 years. She held professorships in two departments, Electrical Engineering and Physics, and was MIT’s first female Institute Professor. Among numerous other distinctions, she was awarded the Presidential Medal of Freedom in 2014.]

Millie came as a Rockefeller [Abby Rockerfeller Mauze] visiting professor in Electrical Engineering (EE) and was an amazing teacher. She used the Fermi method [Enrico Fermi, the Italian physicist known as the "architect of the nuclear age" who taught her at the University of Chicago] to hand out handwritten lecture notes and told us to just listen and understand and ask questions in class. I organized a petition drive to make her permanent at MIT and gave it to Professor Louis Smullin, then-chair of EE. And in '68, Millie was the first [female] professor in the Electrical Engineering department. Physics did

not give her an appointment until '83, or later. She was a warm, wonderful and caring teacher, and became my informal advisor and lifelong mentor.

I worked very hard to get very good grades in order to make the Dean's List so I would qualify for a tuition scholarship, but just as I succeeded, MIT did away with Dean's List – though I did get a Collamore-Rogers Fellowship! We were very poor and lived on Ken's graduate student's research assistantship, so we took out loans for me to pay my MIT tuition. They were very special loans, called NDEA (National Defense Education Administration) loans: we would only have to pay back half if we taught after graduating. And indeed, we both taught after graduating, so they forgave us half the loan.

As a former Israeli – I became a naturalized U.S. citizen – I was very active in the Israeli Student Association at MIT and served as its secretary during the '67. I gathered money and argued with Arab students about Israel's right to exist and be recognized. In fact, a photo of me arguing with a student sitting at Arab Organization booth in the building 10 lobby appeared for five years on the MIT catalog covers. I was also active in the MIT Hillel, which offered me religious support during holidays away from my family (though we did enjoy Ken's family celebrations in Great Neck, N.Y.) in my student days. So later, remembering this with gratitude, I became a member of the Hillel board for several years.

I also worked at the National Magnet Lab (NML) on research using powerful lasers and very high magnetic fields during the summers, to earn money. During my senior year, I did graduate research toward a master's with Professor Ben Lax [a solid state and plasma physicist, class of '49, who was both NML Director and Associate Director of Lincoln Lab]. While I was an undergraduate, it was very unsafe to work there. I had night runs using very powerful water-cooled magnets that overheated and kept exploding and flooding the room, and they watched us on video, in case we got hurt and needed help. When they asked me to work also with very a strong CO2 laser, and tune it by holding a piece of thermal paper until it caught fire in my hand from the powerful beam, I got worried. So we started all kinds of reforms for the safety of students and general operational safeguards in labs. That was also a year when one of the students in physics had a hydrogen explosion and fire, and was scarred.

So in three years, I had finished with a bachelor's and master's in physics, and was ahead of my class of '68. I had to write a thesis, which I did at the National Magnet Lab, naturally, on a potentially defense-related topic (resonant transitions between Landau levels at microwave and infrared frequencies in p-type semiconductors using very high magnetic fields, which could potentially be applied to infrared night viewing devices).

I was on an Air Force grant research fellowship at NML, and I felt a little uneasy because it was during the Vietnam War. There were a lot of demonstrations by SDS [Students for a Democratic Society], and marches at MIT and Boston-wide. We listened to a lot of lectures on anti-ballistic missiles. Henry (Hank) Kendall [Professor Henry Way Kendall, ’55, won the Nobel Prize in Physics with Jerome Friedman and Richard Taylor in 1990 for discoveries that contributed to the quark model], who was my professor in quantum mechanics, started the Union of Concerned Scientists (UCS), and we all joined. I think I was one of the first members there. I continue to upport UCS to this day.

Ben Lax, who was my SM thesis advisor in '68, asked me to write it up for publication and to move to Lincoln Lab to work on a defense-related research topic for my Ph.D. thesis.

Millie informally advised me that a defense-related Ph.D. thesis could not be published in open physics journals, and I could only get a job in a federal defense lab afterwards. So I said, "I won't be able to publish, Ben. Too risky." Meanwhile, Ken finished his doctorate with Phil Morrison [MIT Physics Professor Philip Morrison, who worked on the Manhattan Project during World War II and became known for his work in quantum physics, nuclear physics and high energy astrophysics] in astrophysics and got a postdoctoral offer at University of California, San Diego (UCSD) in La Jolla, California for three years. We went there in December. The sun was shining, and all the buildings were on the seashore, and the students were having lunchtime swims and long sunset beer hours among colorful lights. So, instead of passing the qualifiers after a year of doctorals, I decided that I would transfer to UCSD for my Ph.D.

The UCSD physics department did not give me credit for a year of doctoral work at MIT and for my master's, so I went into applied physics of the solar system. As an undergraduate at MIT, there was real discrimination, but in California, it was a little more egalitarian, and more open. The professors were very friendly, and there were a lot of famous and Nobel Prize faculty there, offering interesting graduate research opportunities.

My thesis advisor was Professor Gustaf Arrhenius, son of a Swedish Nobel Prize winner, who was married to a daughter of another Nobelist. My Ph.D. thesis committee of five faculty included two Nobel Prize winners: Professor Hannes Alfven [a Swedish electrical engineer and plasma physicist who won the Nobel Prize in Physics in 1970 for his work in magnetohydrodynamics], who funded my Ph.D. research, and in whose course on the formation of the solar system I taught as a Teaching Assistant, and Professor Harold Urey, his competitor with a rival theory of Solar System formation. I applied for and won a California

Dissertation Fellowship and a Zonta International Fellowship, and they allowed me to complete a Ph.D. in three years.

At MIT, only Millie Dresselhaus invited us to her house while we were students. And the only role model for a successful dual family of physicists that we had was Millie and her husband, Gene. Professor Phil Morrison, who was Ken's Ph.D. advisor, did invite us over until Ken, my husband, came back to MIT as an assistant professor in '72. So because he had an appointment in physics and MIT had nepotism rules, I came back as a postdoc in a different department, Earth and Planetary Sciences, based on my doctoral work on solar system formation in California.

KLINE: So you finished your doctoral work in California.

BRECHER: Yes, I finished in 1972 work on planetary science and meteorites, as very primitive probes of planetary formation. In La Jolla, I worked on the origin of the solar system with two Nobel Prize winners, as I mentioned. My formal adviser was Professor Arrhenius, but my Nobel Prize adviser was Hannes Alfven. Half of my thesis work (in two volumes) was how primitive asteroids and meteorites could form in the solar system, taking advantage of magnetic field lines of the sun winding, and by direct condensation from a plasma, as Professor Alfven theorized. So I did both an experimental thesis and some theoretical astrophysics papers on interstellar molecules formation published in *Nature*.

At the University of California, I got an Amelia Earhart Fellowship [awarded to women pursuing doctoral degrees or conducting research in aerospace-related science or engineering], and I was able to write my thesis in two volumes. Since the two Nobelists on my committee didn't agree on the origin of the solar system, I had to refer to both of them, and my thesis defense lasted four hours, although I had five people on my Ph.D. committee.

In California, the grad students enjoyed life on the beach, so it normally took six years to graduate. I only had three years from start to finish. So the other students hated me, because I created the bad precedent of getting a doctorate in only three years. I worked day and night, doing both experimental and theoretical work. I gave a lot of conference papers and published before I came back to MIT as a postdoc in Earth and Planetary Sciences. I was a research associate for five years and lectured on Earth as a Magnet, and co-taught a course on the solar system with Professor Irwin Shapiro. [Shapiro, an astrophysicist, joined MIT's Lincoln Laboratory in 1954 and became a professor there in 1967.]

I remember that Millie came to my first MIT department seminar to critique and help me improve the presentation. She also assisted me and other MIT students and staff to prepare short papers for conferences and to apply for research grants to support and my work on the magnetism of Apollo moon rocks and meteorites in my labs in building 24 and NML. Millie was very supportive and helpful, both as a career mentor and family role model, while I was an MIT student, postdoctoral research staff and lecturer, and continued to encourage me during my long career after MIT.

My years as a Research Associate, 1972-1977, were seminal for me and all female MIT staff and faculty. That's when MIT instituted Affirmative Action and hired Mary Rowe [MIT Professor of Negotiation and Conflict Manager at the MIT Sloan School of Management] as ombudswoman. All of a sudden, I got a big salary boost from DEPS Chair Frank Press, because Mary Rowe audited the department equity record and found that my salary was the lowest of 18 postdocs. I was the only postdoc in Earth and Planetary Sciences who was a woman. And then Tanya Atwater [Professor of Geophysics who specialized in plate tectonics, including the San Andreas Fault] arrived, and she stayed on as faculty.

Frank Press [Professor Frank Press, geophysicist and one-time head of the Department of Earth and Planetary Sciences; lifetime member of the MIT Corporation; president of the National Academy of Sciences from 1981-1993; advisor to Presidents Kennedy and Johnson], who became the president's science adviser, said about my low pay compared to my peers "Yeah, but your husband was a professor in physics. You didn't need the money."

Also, Millie started at MIT a women's faculty and staff support group, including the graduate students. Mary Rowe was there, and Emily Wick [Professor Emily Wick, '51, a women's rights pioneer and the first woman to become a tenured faculty member at MIT, in the Department of Nutrition and Food Science] became a dean. This was such a new and wonderful support system for all of us.

I was lucky, because I was working on the analysis of Apollo moon rocks physical properties and their history, especially on the magnetism of moon rocks and formation of the so-called magcons [magnetic anomalies]. I employed a lot of UROP students in my lab, with support from Professor Margaret (Scotty) MacVicar. [MacVicar, SB Physics '64, ScD Mettalurgy and Materials Science '65, and Dean of Undergraduate Education 1985-1990, established the Undergraduate Research Opportunities Program n 1969. This oral history project was created in MacVicar's honor, following her death in 1991 at age 47.]

Also, Ben Lax, still Director of the National Magnet Lab, let me make measurements there, using very sensitive superconducting helium magnetometers in a field-free room, until I was able to purchase new equipment. I was very active in the Division of Planetary Sciences, and edited the Physical Sciences Proceedings of the annual “Lunar Rock Festival” conferences in Houston. NASA gave me a recognition award after 10 years of serving as a NASA principal Investigator in its Lunar and Planetary Research program.

The period after I came back to MIT was a fantastic time of change. Thanks to affirmative action initiatives, MIT transformed itself into a friendlier place for women and minorities. Dr. Shirley Jackson [currently president of the Rensselaer Polytechnic Institute; SB Physics '68 and Ph.D. Physics '73; first African-American woman to earn a Ph.D. at the Institute; recipient of the National Medal of Science for Physical Science] was the only black woman student in physics in my year and became president of the Black Student Union. We were lab mates and wrote our lab reports together, remaining friendly over the years. All of a sudden, there were more women applicants, better women applicants, more women faculty, more women postdocs – more visible and outspoken. And today, half of MIT students are women, though the faculty has a long way to go before achieving equal opportunity.

MADDY: Didn’t you teach at Wellesley at some point?

BRECHER: There was a lot of pressure to "publish or perish" at MIT. I was getting my own grants as a postdoc and paying more for my lab engineer than for myself. And I had a lot of UROP students, some of whom are professors today, one of them at Columbia. But I had to move on. Wellesley College had a student exchange program with MIT and built a new Science Center. I went to teach physics at Wellesley College as assistant professor from '77 to '80, while keeping my research money and lab at MIT, and employing or transferring the best Wellesley physics students to MIT, Stanford or Harvard, which they didn't like. There was no way to do my research at Wellesley. It was very high-pressure to be an assistant professor with a very low salary. I had to teach two courses and two labs each semester, provide problem sets and exams solutions in the library, as well as videotapes on how to use advanced scientific equipment.

While at Wellesley, I got a Japan Society for the Promotion of Science Fellowship and worked for a summer at the Tokyo Polar Science Institute on the magnetism of rare Antarctic meteorites, and traveled there extensively.

I came to Wellesley with two other MIT physicists: a woman colleague from the Magnet Lab with whom I team-taught some courses, and a man in laser physics. The man was assured to be on a tenure track because he said he would sue Wellesley for discrimination if he didn't get tenure! Since I knew I didn't have any chance of tenure, I came back to MIT to teach physics in the innovative Concourse Program with Jerry Lettvin. That was a wonderful teaching experience, because we used the history of physics, and all history of science, to teach also chemistry, and calculus in a historical context – and everything was coordinated.

KLINE: This was in Concourse Physics, you said?

BRECHER: Yes, Concourse Physics. Does it still exist?

KLINE: Concourse, yes.

BRECHER: OK. It's a special track. We could not give grades to the freshman; we had to give evaluations. It was very exciting, because they learned the history of science while learning the real science. They learned calculus before doing the physics applications of differential equations. It was a fantastic program.
But by that time, my husband and I had two busy careers and we wanted children. In '75 we had our first child, and in ’77 our second. When I went to the Wellesley interview, I was pregnant. I gave birth on August 5th and started teaching two courses and two labs on September 1st. So it was a very high-pressure balancing parenting with our busy research and teaching careers in physics.

Since my research was still at MIT, I had to “publish or perish,” so I published a lot with UROP students, who where my co-authors. It was fantastic that my students learned how to do research and they were so grateful they could get into graduate schools because they had publications.

In 1980, I decided to move to technical consulting and needed some training on how to convert from academia to business. Chris Jansen [Christina Huk Jansen, SB Materials Science & Engineering 1963 (third woman to graduate from the department); SM Materials Science & Engineering 1966; Ph.D. Materials Science & Engineering 1971] and Lita Nelsen [SB Chemical Engineering 1964; SM Chemical Engineering 1965; Sloan Fellow 1979; director of MIT's Technology Licensing Office from 1992-2016] were teaching a helpful IAP seminar called "Guerrilla Guide to the Pinstriped World," based on their industry experience. If you wanted to convert from an academic career to industry, you took that workshop and you applied everything they said.

So I applied to and went as a Senior Technical Consultant to Arthur D. Little Inc., where Liz Drake [Elisabeth Mertz Drake, SB Chemical Engineering '58 and ScD Chemical Engineering '66] was a vice president. I learned how to market, became a risk assessment expert, and worked there for five years on very diverse applied projects. It was a lot of travel, and very high pressure, writing proposals and reports, doing the work as teams. I converted there from MIT research on planetary astrophysics and earth sciences to doing practical things, like nuclear waste isolation in deep repositories, modeling the performance of nuclear waste containers, risk assessment for salt and potash mining, and space power issues and applications. ADL was a fantastic, high-pressure learning environment.

Meanwhile, in 1983 Millie convinced me to apply to the American Physical Society (APS) to be a Congressional Science Fellow, just as she was becoming APS president. Congress had no technical background to deal with major environmental threats and energy needs, like nuclear winter, acid rain and defense needs like Star Wars [missile defense]. I knew that the nuclear waste disposal legislation that was passed was terrible. And she said, "Go and help them." So I got trained with a wonderful group of fellows and worked [1983-1984] for the Senator from Massachusetts [Democrat Paul Tsongas], whose staff director also was an MIT physics major. I was a legislative assistant on technical issues, so I got to write interesting legislation or amendments, some of which were passed. My husband got an NRC Fellowship at NASA, and we moved with our kids to Washington, D.C. for a wonderful and exciting year.

Paul Tsongas took me on the Senate floor to negotiate in real time with other Senate staff when our amendment on anti-satellite weapons was passed. I had to explain to staff Kepler's laws [of planetary motion], and how satellites move in orbit, and how easy it would be to bring down U.S. satellites with anti-satellite weapons. So we blocked Star Wars, basically, for two or three years. Paul Tsongas, called a “new Deal Democrat,” was fantastic and open- minded: I took him to a nuclear reactor for the first time, and we took him and his kids to see the stars at the Naval Observatory. He lived only a block away, but had never used the telescope there to marvel at the night sky.

I was involved in broad science and technology policy on Capitol Hill, and afterwards I became active for years on scientific societies (APS, AAAS, IEEE) committees to share and apply what I learned. When I came back from the Hill and started working for the federal government at the USDOT National Transportation Systems Center (now the Volpe Center), Millie got me to lecture on S&T policy options and their pros and cons in the MIT course she ran with

Kaiser [Frederick M. Kaiser, Congressional Research Service]: Science and Technology for Policymaking. I don't know if that course still exists and is as popular.

KLINE: It does, yes.

BRECHER: Yeah? I gave a couple of lectures there. Millie also urged all her students to work in industry, to learn practical problem solving and learn to work collaboratively in teams. She was on the NIST – the National Institute of Standards and Technology – and was Director of the Office of Science at the Department of Energy. She got her students and mentees so many good jobs in industry, and created such an awareness of the importance of science policy that MIT started an office in Washington. Students can go and work in Congress. I urge you to do that. They'll give you a fellowship. And they have a nice place to live in Washington.

KLINE: What was the next step in your career?

BRECHER: I could not go back to consulting, because I got 'Potomac fever' and wanted to help bring universities researchers together with industry and government. So after one year back at Arthur D. Little, I went to Boston University as Director of Academic Corporate Relations. I tried to get recognition for professors in industry and place graduate students for summer jobs in industry. Meanwhile, The U.S. Department of Transportation (DOT) National Transportation System Center in Kendall Square got a space safety portfolio in commercial space transportation and needed expertise.

So a friend who had heard about it said, "You must go and work there, because you know space." So I got the offer, and my first project was to develop a risk assessment for commercial space launchers. Then I wrote (with colleagues and contractor help) a three-volume report within six months, and that became the bible for the launch safety at the national ranges, not just new commercial spaceports. Some of my risk assessments were entered by DOT in the Congressional Record testimony. At DOT, I worked for almost 30 years on research and technology strategic planning, advanced Maglev [magnetic levitation] and high-speed trains, and many diverse advanced transportation technology, safety, environment and health topics, so I became a National Technical Expert.

It was a very exciting time, but I had to move on and retired in the summer of 2015. While at MIT there was pressure to (over)-specialize on a narrow topic, I learned in my career that you have to be versatile and a quick study to survive in

our rapidly changing technology-driven workplace. Whatever you learned at MIT, you can learn much more on the job and apply it to new areas. So I worked on many advanced transportation technologies and their impacts on safety, health and environment. And the fact that I knew in-depth about magnetism and electromagnetism from MIT helped me work on magnetic levitation technologies, high-speed rail, intelligent transportation systems, and their safety and environmental issues like greenhouse gases.

I also worked with NASA and other federal agencies (DOE, DOD) on security, remote sensing of unmanned aerial vehicle applications for transportation, etc. The DOT Volpe Center career offered a wonderful opportunity to pick my projects and apply for grants, the same kind of thing I did in my youth at MIT. MIT was a wonderful incubator to teach you to work under high pressure and be a self-starter. That's what you will carry over in life from MIT. You can do anything you want to do, move around topics and pick your own projects.

So I became convinced that academia is not such a great career choice if you have to specialize. But if you like diversity and you're interested in the world at large and real problems, you move on to “greener pastures.”

What I also learned from Millie was time management and prioritizing how to be both a mother and a career woman. The first time we visited Millie when I was an undergraduate, she invited us for a Shabbat dinner. She was Jewish, but Gene [Dresselhaus's husband Gene Dresselhaus, physicist at MIT Lincoln Laboratory and Francis Bitter National Magnet Laboratory] was not. Her daughter, Marianne, was baking the bread. The kids were serving at the table. There were four kids. They played a string quartet and Gene was turning the pages. And Millie said, "You can't have one kid or three kids. They are like electrons in atomic orbitals. They have to come in pairs, with spin up and spin down for a stable orbital. Either two or four is the ideal number.”

So we had two kids, one after another, and we had successful and productive dual careers. (My husband, Ken, was Assistant and Associate Professor of Physics at MIT, then Professor of Astronomy and Physics at Boston University, where he is now Emeritus.). It was very high pressure to maintain dual careers to conferences and travel yet assure a smooth home life. Millie was such an inspiration for so many women students, staff and faculty at MIT, and such a career support system for me. She always had good advice and was always open to listen. I would take an Israeli lunch of hummus and pita and stuff to her office, and we would catch up. I will miss her. I will be on the panel [at MIT] on November 26th [2017], for her memorial.

Anyway, in my class, I became friends with the other women in physics. To this day, I'm friendly with Gail Marcus [SB Physics ’68, SM Physics ’68, SCD Nuclear Engineering ‘71], our class secretary. I will have my 50th class reunion next summer, a real milestone. I will buy the red jacket and the gray pants, but luckily, they don't ask the women to wear a tie! (My husband had a barber pole tie.) They will give us some sort of scarf with the MIT insignia.

And here is the best thing: I only wear my MIT ring because on the inside, it has my name. So if I fly somewhere and the plane crashes, they will know whose finger this was. Since I did risk assessments-- It's a great conversation starter.

KLINE: I was going to ask you about it.

BRECHER: Next year, you'll have to get one.

KLINE: I will, this spring.

BRECHER: I think they changed at the design a little bit.

KLINE: Every year, there's a committee.

BRECHER: I don't know what our class gift will be. All I know is I give some money to the Millie Dresselhaus Nanoscience Lab and for the Scotty MacVicar fund. I also give some money for Hillel, which was a fantastic support system for me. At the beginning, I was very involved with the Israeli Student Association here. I was its secretary in '67. And then in the '72 war, as I've mentioned, I became active on behalf of Israel’s right to exist and argued with Arab students about it.

KLINE: I have more questions on things that you've already said, just a little bit more detail, if that's OK. I'd like to hear about your growing up, what your family was like and what kind of encouragement or discouragement you experienced from your family.

BRECHER: Well, all I can say that in Bucharest, they actively discriminated against Jews and intellectuals, considered to have “bad social origin.” My father was a doctor, a gynecologist, who actually delivered me at home. And my mother was also an intellectual trained to teach French and German, but she helped my father in private medical practice. We were very aware that the communists were brainwashing kids in schools, and that you could not speak openly of the fact that my parents wanted to immigrate to Israel.

We suffered a lot after applying to immigrate several times. For instance, my brother was thrown out of architecture and my father was thrown out of his senior job at the Jewish hospital in Bucharest [Caritas], and was made to commute to the provinces, three hours by train each way every day. My brother, who was very talented in architecture and painting, was forced to become a television technician. So I had no chance at all to go to university if we had stayed in Romania. But I made good friends there whom, to this day, still meet in Israel. We were economically well off and enjoyed the Romanian culture and beautiful country, but were second-class citizens.

KLINE: How old were you when you immigrated to Israel?

BRECHER: I was 15 when they let us out. Stalin died in '54, and that's when first we were allowed to apply to emigrate. Ceausescu sold each Jewish family for $5,000. HIAS, a Jewish organization that assisted refugees, helped pay for Jewish families to emigrate, so the tyrant Ceausescu got rich. When we went to Israel, there were 600 doctors sent at the same time to free up jobs and housing for new graduates in medicine.

So let me say that my background in Romania was very useful, because I learned how to cope with discrimination. And I learned very good science with the Russian method. And I knew Russian, so at the Technion, I was able to read Russian math and science books.

It was a very rough beginning in Israel, because I didn't even know the Hebrew letters. I was a very good student in Romania, so I knew a lot of math and science. And when I got to Israel, I tutored my classmates in sciences and they tutored me in Hebrew and Bible and social science and history. So I still have these high school friends from Israel who helped me survive the first year until I learned the language.

I didn't know a word of Hebrew when I went directly to high school, so they put me a year back. And even so, after three months, I was fluent in Hebrew and started raising my hand in class. And what was good in Israel was that there was tracking: there was a biology track, a math and science track, social science, and literature track. Because I was good in sciences, I chose to go to the math and science track. And we learned very advanced physics and chemistry and math: Linus Pauling's quantum chemistry was taught in high school.

So I worked very hard, and I became the valedictorian at my high school. But I had to go an hour by bus each way, plus 20 minutes on foot to Kiriiat Haiim High school from Akko, where we lived. I think that high pressure to succeed in Israel,

in both high school and at the Technion, was also good for me at MIT: I learned how to take exams and stay focused. And when you come to MIT, that's the most useful skill: how to stay cool under pressure.

Growing up, I had to learn French, piano, ballet and how to embroider. I had to read literature, go to museums. In school I learned Russian and English. We were a cultured family, who enjoyed theatre, museums and opera. Our whole family immigrated to Israel, including two doctors. So they wanted me to also become a doctor. My father said, "Physics is useless. In the first economic crisis, they won't need physicists, but people will get sick, and they will always need doctors." Maybe he was right.

Although I have never been unemployed as a versatile applied physicist, it was not so easy to get good jobs in physics. When I finished my doctorate, Harvard offered me a post-doctorate with no money to write my proposals and get my grants. Cornell offered my husband a faculty position and me half a position. Only MIT offered me a full postdoc. It was always pretty rough while thinking where would I fit in best, and how I would fit in and what value added I can bring my job, what edge or advantage I would have over my competitors.

At MIT, I was lucky as a student, because Professor Lax was very paternal. In his physics classes, he gave us open-ended problems for which he didn't know the solutions. We had to figure them out in teams. It was incredibly good training on how to ask the questions that are half the answer and perhaps the solution. And then Millie's advice was priceless, as I told you before. I took most of my physics courses in electrical engineering, rather than the physics department. EE faculty were great teachers and posted problem solutions, while the physics professors were typically poor teachers.

At the beginning, I had a hard time understanding the technical English, you know, and I didn't know how to type. MIT required all term papers to be typed, so my husband had to type them. I loved humanities courses and wrote long papers, and he'd say, "You have verbal diarrhea. Why do you have to have such long papers?" And when I would get A plus, or A minus, it changed his opinion. You know, scientists don't know how to write, so I took a technical writing course here at MIT, a special physics class. And that was the most valuable thing I learned, namely, how to write a technical paper and how to give a seminar and how to organize the material.

And the most useful course I took at MIT as an undergraduate was a psychology seminar on the formation of learning sets, learning how to learn. The professor, Jim Lackner [SB Humanities '66 and Ph.D. Psychology '70] is now at Brandeis,

where he became an expert on space biology and provost. It helped me treat each new learning experience as a scientific problem. It's very useful.

So let me say that there are offerings here at MIT that can help you for life if you are open-minded and you figure out where you are weak and try to think constructively how to shore up your weak points. I became a fast learner, which was very helpful to my career, no doubt.

KLINE: You mentioned a little bit about McCormick Hall and about Hillel. I was wondering if you could speak about McCormick Hall – a little bit about the women there. Also, about Hillel and some of your husband's graduate student friends. I was wondering if you could speak about your communities while you were at MIT and how they have supported you.

BRECHER: McCormick Hall as a dedicated women's dorm was new then, but I only went to McCormick occasionally, to read and use their problem set bibles. The women there seemed very concerned with dating. Because I was married, I didn't like that. And the MIT men were very aggressive to women students in those days, and they made quiet wisecracks about how you looked. It was a very insensitive environment for women, and the social aspect at MIT was so lacking in those days.

Because I married at 20 to an MIT graduate student, I was very unusual. And I had to learn to cook, so I had my own pressures. You know, all my husband's friends would come over. I didn't know how to cook, and I quickly had to learn how. And the food was terrible at MIT in those days. You know, the machines gave you such horrible sandwiches. I got an ulcer from being under pressure of five courses a term while eating machine food.

The only social support system I had was MIT Hillel. Rabbi Herman Pollack [the first full-time Director of MIT Hillel] was there for support and advice. He became a great friend for life to me and my husband. I later was on Hillel Board for eight years here; again, Millie got me to serve on the board. She was on the board. A lot of rich people were on the board. I still go to the Hillel seminars. So you have to create your own support system, I think. It's much better today. There are lots of choices. Are you in a sorority?

KLINE: I am, yeah.

BRECHER: Which one?

KLINE: I'm in Sigma Kappa. I find that to be a very valuable support system of women, so I was curious as to what your experience was like.

BRECHER: They will probably become your friends for life. I mean, that's important as a support system. But it depends on the culture of each sorority, or living group. When I came back as a postdoc, I had very valuable NASA moon rocks that I worked on to measure their magnetic and other physical properties, with overnight security checks: I had a safe in my lab in Building 26, with a cipher. And the students were helping me make measurements also on these very rare meteorites and moon rocks. One day, one of my students took the newly-arrived moon samples from the Green Building to bring them to Building 26 lab, to the safe, and to lock them up – but he lost them on the way and could not remember where they fell out of his pocket. And my whole prestige with NASA was at stake because the fraternity was so permissive.

I was on a NASA Committee, and was a member of consortia studying each important Apollo boulder to figure out its formation and history. I gave talks every year at the Houston Lunar and Planetary Science Conference (called the Lunar Rock Festival). We had the whole consortium make complementary measurements, and all of a sudden, my moon rocks are gone. So I said, "We have to find them! I went to his Back Bay fraternity house, where I found a giant pot room. He was growing pot in the room with UV lights. He was spaced out when he took my samples, and he couldn't remember what he did. I took him to Jerry Lettvin, to hypnotize him and see if he could recall what happened to these moon rocks. Under hypnosis, he said he had to repair his motorcycle and he probably lay down on his back to look under the motorcycle – and they probably fell out of his pocket. And because they looked like any earth gray rock and dust, they were gone for good. So that ended my ability to get moon rocks to make measurements at MIT. He gave me a real heart attack, and I learned about fraternity life from that.

KLINE: I guess so!

BRECHER: The reason I thought I would bring a different perspective [as a foreign student at MIT] is that I did not live in dorms, and I was already married. There were different pressures then. You know, how to earn a living, how to be self-sufficient. I was very serious and very dedicated. I didn't play around like the other students. We both were very busy. Ken was a graduate student working on his Ph.D., and I needed to recoup the loss of time in Israel where they put me back a year, plus there were 12 years of high school. So that's why I finished in three years, with a bachelor's and master's. And that's why I was always

pressured to regain lost time in my youth. I worked a little too hard. Too much work and not enough play while at MIT…

As I mentioned, I made up for it in sunny California, where all of a sudden, [from] the gray of MIT corridors and the seriousness of round-the-clock work, there was color and there was light, and fun. People invited students to their houses. And my advisers were very unusual. They were Swedish Nobel Prize dynasties. Harold Urey [Physical Chemistry Professor who won the Nobel Prize in Chemistry in 1934 for discovering deuterium] who was on my committee was a crotchety old man. There were very famous people at U.C. San Diego.

But also there was feminism and political activists that opened my eyes there. Angela Davis and [Herbert] Marcuse were teaching people to be revolutionary. They had a college called Lumumba Zapata. You know, it was like going to the moon from MIT, you know, the contrast. So I invite you, after MIT, to go somewhere else to find out how people live there. The culture here at MIT was very inbred, very closed, very high pressure and way too serious.

I love California, and we toured colleges there with our son and daughter. Both of our kids live in California now: one in San Diego, one in Los Angeles. And my name is on a UCSD Jacobs School of Engineering pavement stone there, saying that '69 to '72, when I lived there as a grad student, were very good years. Coming back to MIT, I had to adjust again to the pressure-cooker lifestyle. Like a reverse culture shock!

The only thing I can say in hindsight is that “you live and learn” – truly, lifelong learning is the key. So don't think that whatever you learn now for your degree will be your specialty forever. And if you want to have fun, my advice is: don't specialize. I've worked on so many topics in my professional life, and it was fun to diversify. I did work on nuclear waste isolation, risk assessment for nuclear repository mining for potash mines in Canada, magnetic levitation trains, electromagnetic fields and radiation safety, energy efficient and intelligent high-speed transportation options, remote sensing applications, etc. I'm still consulting on a possible Maglev in the Northeast [the public transport technology that uses magnetic levitation to move vehicles without making contact with the ground or an electrical pickup]. And I'm supposed to go to Japan sometime soon to help bring a prototype superconducting Maglev from Baltimore to Washington, D.C.

As part of my work, I've been to Japan four times already, and to China twice. In Germany, I made measurements of electromagnetic fields on a Maglev, and in

France on a high-speed train, to apply to our Northeast Corridor rail improvements. So professional life can become fun if you are open to change. What city do you come from?

KLINE: I'm from here. I'm from Sudbury, Massachusetts.

BRECHER: Really? Wow, locally born and bred.

KLINE: So I need to leave!

BRECHER: You're overdue to move to California!

KLINE: Exactly. That's what I plan, after college.

BRECHER: Absolutely. My daughter went to Stanford and loved it. And my son went to Michigan. They did not want to be at MIT, or at BU, where my husband is a professor – and where they could go for free. Better not to be too close to home. And they did not want to be in science either, because we had already over-exposed them – we dragged them to science museums, and rock collecting. Too much science!

KLINE: So what did they choose to go into?

BRECHER: My daughter studied abnormal psychology in film with Zimbardo [Psychology Professor Philip G. Zimbardo] at Stanford, and then wanted to make movies. But then she started working more on high-tech as a project or product manager, and now has her own consulting company. And my son always wanted to be in start-ups. His first company with UMI friends was called Versity.com – transcribing class note for students who don't come to class and posting them on the Web, and he was involved in other startups. He works now making money as a wealth manager at Morgan Stanley in La Jolla, where he's a senior vice president. He manages half of my retirement money. I told him that if he does well with my money, he'll have some inheritance, and otherwise, he'll have to pay for my nursing home! He’s got a big incentive to do well by me!
So, do you want to be a neurobiologist?

KLINE: I want to go into medicine. I'm going to medical school. I'm interested in immunology and infectious diseases right now.

BRECHER: That is very competitive.

KLINE: Yeah.

BRECHER: Well, more power to you.

KLINE: I wouldn't be here if I didn't like the challenge.

BRECHER: Well, good. So you live at McCormick?

KLINE: No, I live in Maseeh Hall. It's a new dorm. But it's right on the corner of Mass Avenue and Memorial Drive. It's beautiful. I'm very happy there.

BRECHER: That's great. Fantastic.

One other thing: One of the best things at MIT when I was an undergraduate, and then when I came back as a postdoc, was the Cheney Room, because there I met bright women who were in every other field at MIT – humanities and math, architecture, and sciences and engineering. I befriended many women, like Lenore Blum [Mathematics Ph.D. '68; Distinguished Professor of Computer Science at Carnegie Mellon], who became a famous mathematician. And I learned how to be an activist at Cheney. That's where I met Chris Jansen and Lita Nelsen. And it was a great place to sit there in between classes, play the piano, lie down or study quietly. To this day, I think Cheney Room is one of the islands of refuge for women at MIT who are under pressure – and a great place to make friends.

KLINE: I've been there, too. I love it! It's a really great place.

BRECHER: I played the piano there with Millie Dresselhaus, who brought her violin so we could play Tchaikovsky, although I was out of practice. (We could not afford a piano till I came back as a postdoc.) Millie brought the civilizing effect of music, by playing music before every EE seminar. This was unheard of at MIT – to bring culture and refinement to a very rough, down-to-earth place. And when she became head of Materials Science and Engineering, her door was always open for any woman: student, staff, faculty or secretary. She continued to run the support group for many years. I think that she helped reshape the life of women at MIT. Thank God for Millie!

KLINE: Yes!

BRECHER: And thank you again for listening.

KLINE: It's so great to hear your story. Thank you.