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Martin J. Graetz

Transcript of an interview
conducted by

Christopher Weaver

at

National Museum of American History
Washington, D.C., USA

on

30 November 2018

with subsequent additions and corrections

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Abstract

Martin Graetz begins the oral history by discussing his early family life, education, and his personal interests in science fiction and music. He follows with his transition into MIT, meeting members of the Hingham Institute, and learning to program. Martin then discusses development of the Spacewar! concept, its implementation on the PDP-1 at MIT, and his contributions to the project. Finally, he recounts his efforts to record the history of Spacewar! and its development since 1962 along with his other creative endeavors.

About the Interviewer

Christopher Weaver is a Distinguished Research Scholar at the Smithsonian's Lemelson Center for the Study of Invention, Distinguished Professor of Computational Media at Wesleyan University and Director of Interactive Simulation for MIT's AIM Photonics Academy. He has contributed to over twenty-five books and publications and holds patents in telecommunications, software methods, device security, and 3D graphics. The former Director of Technology Forecasting for ABC and Chief Engineer to the Subcommittee on Communications for the US Congress, he also founded the video game company Bethesda Softworks. Weaver is co-director of the Videogame Pioneers Initiative at the National Museum of American History, recording oral histories and developing new applications for interactive media and public education.

About the Editor

Justin S. Barber provided transcript audit-editing, emendations, and supplementary footnotes to this oral history as part of his broader work into video game history and digital museology.

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Weaver: Good morning. For posterity, would you please state your full name, where this interview is being done, and the date?

Graetz: All right. I am Martin J. Graetz, and we are at the National Museum of American History, and it is November 30th, 2018.

Weaver: Thank you. Would you please tell us a little bit about your early childhood, your mother, father, any sisters and brothers, and where you grew up?

Graetz: Well, I was born and spent my childhood in Omaha, Nebraska, and I have two younger sisters, both of whom now live in the Boston area, along with me. My parents were also born in Omaha. Both of them were children of immigrants. I stayed there until I graduated Omaha Central High School and came east to go to MIT. There wasn't really anything all that remarkable about growing up in Omaha. It's not that remarkable a city, really. Although I've since modified that opinion because there are some remarkable things about it. At the time, it was just where we lived.

Weaver: You have a nickname, I believe, and I'd appreciate it if you would tell us how you got it.

Graetz: Yeah, the nickname. I always wanted a nickname when I was a kid, but nobody ever gave me one, except "Pejorative", because I was too much of a nerd. But almost my first week of classes at MIT [Massachusetts Institute of Technology], we were waiting for the class instructor to come in. We were waiting for a *very* long time and, for some reason which I probably will forever regret, I suddenly said, "Does anybody want to hear a shaggy-dog story?" Well, I actually got through one of the versions of the shaggy-dog story before the instructor showed up forty-five minutes late. At the next class session, people started calling me "Shaggy" and then it finally got shortened to "Shag." Since that was the first

nickname I ever had, it stuck. So that's all you're going to get, because the shaggy-dog story is literally too long to tell.

Weaver: Well, go backwards just for a minute. You were talking about how you had gone to high school and basically went to MIT. That's interesting in and of itself, because to get into MIT isn't quite what one might consider easy, I would think. So, it would be appreciated if you would tell us what sparked your interest in science. Where did you evidence any kind of science or engineering abilities? And how did you get into MIT? Why did you get into MIT?

Graetz: [Laughs.] Well, as far as how I got into MIT, that is still not quite clear. As far as getting interested in science goes, I really can't say any particular event or particular time. I was always interested in how things worked. It was also something that was in the air during the early forties, because I was child during World War II. Technology was a very important part of what was going on. I really don't know at what point I decided that I really liked scientific stuff, but by the time I got to high school, I had already been exposed in a limited way to science fiction. I got exposed more permanently in my freshman year. I was at high school, I was at Omaha Central High School, which is still considered one of the best high schools in the country. I spent one day there and the next two weeks in the hospital. Turned out I had a very mild form of polio, and so I was out of high school for a month.

During the time I was in the hospital, a close friend of my mother's—people were sending me magazines and all kinds of stuff—sent me a copy of a pulp science fiction magazine called *Startling Stories.* I thought that was interesting, but I couldn't quite figure out what was going on. A year later, I thought, well, okay, it's an anniversary. Let's have another look at *Startling Stories*, and that pretty much did it. I started buying science fiction magazines. I got mixed up in other kinds of science endeavors in high school in the Science and Math Club, things like that. Science fiction did tend to push that interest, though, because there were all kinds of things going on in science fiction that weren't happening in real life and, in many cases, couldn't. The result of that, actually in my senior year, was that some friends of mine and I founded a Science Fiction Club at MIT.

But while I was in high school, I leaned toward science classes. I took physics in my junior year, didn't do all that well in it, but I found it fascinating. Took chemistry in my senior year, did a little bit better. By that time, I decided I wanted a scientific college education. I applied to a number of schools, Iowa State, Carnegie Tech, as it then was, and to a few other regular liberal arts schools. I applied to Brown, for example, and to MIT. By that time, there were two fellows I knew who were in the class ahead of me who already came to MIT and who were already there. But I really didn't know where I was going to go until late that summer after I graduated. I got an acceptance from MIT, which, of course, we thought was an enormously great accomplishment. It wasn't until later that I discovered that MIT had a habit of taking in huge freshman classes and expecting them to be winnowed down through what I suppose you would

call destructive testing until the senior class was very small. The amusing thing was that on the day I left to go to MIT, I got a rejection letter from Brown.

Weaver: You have read a lot of E.E. Smith. Would you please tell us about that and about his work?

Graetz: Okay. The Smith novels. I encountered those, of course, during the course of, the 1950s, being a stone science fiction— "Capital F"—fan. I got involved in fan activities. I even published a one-shot fanzine. But E.E. Smith was very big in the canon at the time. He was, in fact, still writing. Although he had finished the *Lensman* series, he was actually persuaded, I am sure, by large quantities of money to write a final *Skylark* novel in the late fifties. It's not very good, but it's bad in an interesting way. E.E. Smith just was one of those things you had to read, whether he was a good writer or not, just like you had to read some of A. Merritt. I tried, but I couldn't get through it.

There were a lot of other writers, of course, many who were, at that time, at the height of their powers, like Isaac Asimov and Robert Heinlein. Isaac was then still a professor at BU [Boston University], and he came to the MIT Science Fiction Society meetings quite often, so we all got to know him pretty well. It was common for fans to go down to New York and visit editors in the publishing houses in New York City. That's how I got to know John W. Campbell and a couple of others like Bob Lowndes and Larry Shaw. They were all publishing, some good and a lot of bad stuff, but we took it all in. Somehow we managed to read most of it, what was coming out. And, of course, we collected magazines and books, and I collected the Smith books until eventually I got a full set.

Weaver: When you were at MIT, can you tell us about the clubs that you joined, created, or followed?

Graetz: Well, the first club I joined was the Outing Club. I had gone with my friends to the local woods in Omaha for day hikes and things, but I really wanted to get involved in more activities. So, I joined the Outing Club. I went to their introductory day, which they called "The Circus", and got exposed to things I'd never done before, like canoeing and rock climbing and bicycling, although I had ridden a bike before. And I bought an adult bike for getting around Cambridge and Boston.

The other club that I joined at the time was, of course, the Science Fiction Society, which had regular monthly meetings on East Campus. That's where I got to meet Isaac Asimov and also several other writers in the area, including Harry Stubbs, who wrote under the name of Hal Clement. [He] wrote some very important science fiction novels, like *Needle* and *Mission of Gravity*. There was another couple who wrote science fiction whose name was Boyd, and they wrote together under the name of Boyd Ellanby. I think the husband had died, but Lyle Boyd, she came to meetings several times. So, we had a good connection to the professional world.

Those were pretty much the only clubs I really joined. I did sing in the Glee Club for a year or so.

Weaver: When did you become interested in music?

Graetz: Oh, that was early on. My parents were not musicians, but we always had music. After the war when my father was finally able to get a record player, he bought albums of classical music. These were the old 78s, of course, so you listened to them in five-minute chunks. And also, Walt Disney's *Fantasia* came back, and I got introduced to things like a potted version of Stravinsky's *Rite of Spring*. We had an album of the complete [Stravinsky] ballet. Beethoven's symphonies, Mozart, Brahms. I think Stravinsky may have been the most contemporary, although we did have a copy of Leonard Bernstein's *Jeremiah Symphony*.

Weaver: When you went to MIT, you had mentioned earlier that you hadn't done that well in physics, but you had done better in chemistry. Did you enter MIT in chemistry?

Graetz: Yeah. My major at MIT was chemistry, but mostly because it was the last thing I studied in high school. I didn't really know what kind of science I wanted to study, and I floundered through chemistry until I flunked out. I should have read the writing [on the wall] when I realized that the only course at MIT that I got more than a C in on the first try was music. They had a very good music program that was run by a Viennese musician named Klaus Liepmann. He conducted the Choral Society and the Glee Club, and he played the viola after a fashion. He wasn't a great musician, but he had great musical instincts. He got me interested in doing a little bit more with it.

The other member of the musical faculty was a composer named Ernst Levy. He was Swiss. He spent a number of years at MIT until he retired and went back to Switzerland. He died a couple of decades ago, and people are starting to notice some of his music now again. He was a fine composer.

Weaver: How did you meet Wayne [Wiitanen]?

Graetz: Well, Wayne and I were—actually, we came to MIT in the same class. We both were at Burton House, the dormitory on Memorial Drive. Probably we met in the Outing Club. He was on the third floor at the time. I was on the fourth floor. So, it was easy to get together with him frequently. We were in different courses. He was in mathematics. But I'm pretty sure we met in the Outing Club and went on several Outing Club hikes and rock climbs together, because we were both into rock climbing by that time. And, well, "Slug" came later. Now, Wayne and I got to become good friends during our undergraduate period.

Weaver: You mentioned that you had some problems with courses. Did you ever graduate from MIT?

Graetz: No. I flunked out and decided to try again. [I] passed most of the courses that I failed the first time, but I always ran afoul of differential equations. It wasn't entirely my fault. The first time I took it, we had a small textbook. I got up to a point and then I just couldn't manage certain kinds of integrals, so I failed that course. That contributed to my flunking out the first time. I was able to take it one more time before I flunked out. The second time, they had expanded the course and had a new textbook. I was able to pass everything up to the point at which the new material arrived. That made me flunk the course again. The third time when I came back and took it, they had enlarged it a third time, had a third text, and the same thing happened. I got past everything I knew already and fell down on the last. But I also wasn't a very good chemist, and so I didn't do terribly well. I got into the middle of my senior year and that was it.

Weaver: Can you talk about moving into Old Joe Clark's?

Graetz: Oh, yes. Old Joe Clark was a cooperative housing. It was very common in those days for a group of guys—and, of course, it was always guys—to find an old house that was available for a nominal rent and had enough bedrooms so that everybody could have a bedroom. You had a common kitchen and you shared the rent and all of the utility and phone expenses. It was a nice cheap way for people, single guys, to live in a reasonably decent fashion. Old Joe Clark had come into existence after the Second World War. It was an outgrowth of some college guys who had gone into the military or into the defense sector and came out and roomed together. They eventually rented a house near Harvard Square from a man named Fred Brueger.

At that time, I don't know how they acquired the name. "Old Joe Clark" was the name of a folk song. Most of the fellows living in the house were either folk dancers or were singing folk songs, which were very big at the time. By the time I moved in—and this was through Bob Keppel, who was a member of the Science Fiction Society who lived there—they were in North Cambridge in a big old Victorian house just off of Mass Avenue. When I flunked out and needed a place to live, I was riding around Cambridge and found myself near Old Joe Clark. I walked in and discovered that they were looking for a roommate. I was able to move in, and I stayed at Old Joe's for several years.

Weaver: Did Wayne also stay at Old Joe Clark's?

Graetz: Yeah, he moved in after our Army time. Actually, I think it was just before our Army time. He decided to leave MIT. He was in danger of flunking out, too, and so we left at the same time. I flunked out in January and he left. Through advice of the Selective Service rep, we both enlisted in the Army Reserve. We spent a couple of months in Cambridge going to reserve meetings. Wayne moved into Old Joe's, because at that time, Frank Marr was a roommate with us at the time. And in May when we were called up for our basic training active duty. Frank, who had been in the Army, drove us down to what was then the

Boston Army Base, drove us into the gate. He told the sentry on duty, "Fresh meat!" and took us into where we were taken into the induction center.

We spent the next six months in the Army, came back and moved back to Old Joe Clark, which by that time had moved into a different house in Cambridge on Fayette Street.

Weaver: When you were at Old Joe Clark's, did you do anything that had to do with folk music?

Graetz: Oh, well, that was part of the point. It was Old Joe Clark that got me into folk dancing and folk music when we were at Thomas Park in North Cambridge. Of course, I never did any dancing, but that first Friday, I learned several of the standard rituals at Old Joe's, one of which was a communal supper. A woman named Angie Taylor came and prepared for us, and she was the woman who taught me how to do square dancing and contra. Her brother and sister-in-law taught me how to do international folk dancing. That pretty much set a pattern for a number of years.

Weaver: In addition to the folk group and you learning dancing, did you and Wayne engage in some way of maybe making money or something with the group and take it on the road?

Graetz: No. Actually, Wayne was never a dancer. We used to have songfests. At MIT, the Outing Club had regular weekly songfests, and Wayne got into that. We did a lot of singing. But as far as making money, Wayne had already started working in the computer industry. I was struggling to find jobs as a lab technician at one chemistry lab or another. After we got out of the Army and I was still trying to do that, we decided that fall that we wanted to find an apartment and live like proper grownups. [Laughs.]

So, in the course of the following spring, we found the walkup tenement apartment in Cambridge on Hingham Street, which is where all this stuff that we're talking about now got started. And for several months, I was out of a job. I couldn't find a decent job in chemistry, and Wayne was carrying me for a lot of that time. Then he said, "There's a job opening." He was working at a place at Harvard called the Littauer Statistical Laboratory, which did computer services for various faculty members at Harvard who needed lots of data to be crunched on the IBM 704 that we leased that was right next door. Littauer was in an old house on Prescott Street just off of Harvard Square.

Wayne said that there was a job opening. [He asked if] was I interested, and I said, "Well, sure. Why not." I went down and I talked to Al Beaten, who was the director of the Littauer Lab. They had an opening for what was called the computer operator junior, which tells you all you need to know about the level at which that job existed. It was right at the very bottom. But we discussed it and he decided that I was able to do the job. The kicker was that the entry-level salary

for that job was at least 50 percent more than I was earning as a supposedly highly trained chemistry lab man. It was a no-brainer. I took the job, and I stayed in the industry for the next fifty years.

Weaver: Is Littauer where you learned to program?

Graetz: Yes. In fact, I learned it from Wayne. He taught a course to several of us at Littauer on how to program the assembly language on the 704, which was called SAP [Symbolic Assembly Program], the symbolic assembly language. Also, the basics of Fortran, which was the second-level compiler language that most of the people who used our services wrote their data programs in. So, yes, that was where I learned how to program computers.

Weaver: Why did you leave Old Joe Clark's, and where did you go?

Graetz: Well, as I said, we left Old Joe's because we wanted to have a proper grownup apartment and live like real people, or at least to feel like we had a grownup apartment. We moved to that Hingham Street tenement because that was the one that was available, and the rent was good. It was $75 a month, which we split between the two of us. And a friend of ours, a fellow named Dave Freeman who was a musician and a craftsman, he moved into the apartment downstairs, which was a big one-room apartment.

We had this one entryway. A typical tenement has several adjacent entryways and apartments off that entryway. In this case, there were two apartments off each entry. Ours was at 8 Hingham Street on the river end of the building. It was just a half-a-minute walk to the Charles River, very nice location. It was about a ten-minute walk to Harvard Square, which is where we went to go to the movies.

Weaver: When did Slug [Steve Russell] come into your circle?

Graetz: Okay. Now, that's something I'm not really sure of. I've been talking to Slug over this weekend about that, because he was at Dartmouth. He came down, I think, to start working for John McCarthy in the original Artificial Intelligence Lab. I'm not really sure. I think he moved into Old Joe's. I think that was it. We had a space, and so it wound up that he and Wayne and I and Frank Marr, who were four of the original Buffalo Boys—we can talk about that—were all living at Old Joe Clark's. Wayne and Slug and Frank and I all went up to the mountains to hike a lot. Slug, of course, became a member of the Tech Model Railroad Club, and when I eventually went over to MIT, we were making the ingredients of what became the *Spacewar!* task force.

Weaver: How did the Hingham Institute come into being?

Graetz: Well, that was just a name. I guess it was probably Wayne or I who gave it the name. It came about because we wanted something that sounded vaguely important for the things that we were doing. It may even have predated our work

on *Spacewar!*, but it was very close. "Hingham" because that was the street we lived on. "Institute" because we were all—well, Wayne and I had been at MIT, which we uniformly called "*The* Institute." So that's what we called it.

When the time came to put together the ingredients that became *Spacewar!*, we decided to put it under the rubric of the Hingham Institute Study Force on Intergalactic Warfare, something like that.[1]

Weaver: Why did you leave Littauer, and where did you go?

Graetz: I left Littauer because I wasn't doing much of anything there. Al Beaten thought it was time for me to get out and actually do something. In the summer of 1961, he said he was laying me off, which was a polite term for saying I was fired. Wayne stayed on, of course, because he was doing substantive work. I had to go find a job, and, of course, at that time, I knew Jack Dennis pretty well through the Science Fiction Society and through the Choral Society and Glee Club. So, I went down to MIT, and just on an off chance, I went to visit him in his office. He was the director of the RLE [Research Laboratory of Electronics] Lab that housed the TX-0 [Transistorized Experimental Computer Zero], the hybrid computer that was one of the predecessors of the PDP-1 [Programmed Data Processor One]. I asked him if he had any work and he said that he needed a summer intern, which in those days actually got paid money. I said I'd be interested. He said, "What do you know?" I said I knew SAP; I knew a little bit of Fortran. He said, "Okay. I'll give you a test."

He gave me the instruction set for the TX-0 and he gave me a task to write a small program. It was a utility program. I don't remember what it was, whether it was a tape loader or a diagnostic, but he gave me two hours to figure out the instruction set and what it did and write a program that would do what he asked me to do, and somehow I managed to do it. The TX-0 had an instruction set of eight entire instructions, one of which had a subset of smaller instructions, and so it wasn't that hard to learn. I sat down and I got a program that satisfied him, so he hired me for the summer principally to write a diagnostic program for a brand-new magnetic tape reader that they had connected to the TX-0.

The TX-0 was an experimental machine and they would attach whatever they wanted to the computer to see how they could make it work, and that was one of them. It was an unusual machine. It wasn't like those big standup IBM [International Business Machines] tape drives with the two reels and the vacuum columns and things. It was a little unit that was maybe two feet high, and it used a spring-loaded tension mechanism where the tape when back and forth to the take-up reel. I spent that summer writing a program that would test it and make sure it worked.

[1] Steve Russell's Video Game Pioneer Archive oral history, dated January 8, 2017, notes the official name as the *Hingham Institute Space Warfare Study Group*.

But that job ran out. By that time, I'd gotten to know a man named Harrison "Dit" Morse who worked at the Electronic Systems Lab in another building at MIT. When I finished my job for Jack Dennis, I went and asked him if there was any work where he was working. At that time, a friend of mine named John Ward was one of the directors of that particular laboratory, so I went there, and John said, yeah, they might have a place for me to do something. I interviewed with the director—it was Douglas T. Ross—and he hired me, but I never had a clear idea of what I was supposed to do. And at that time, the CRT, the display unit, arrived for the PDP-1. I wound up mostly writing *Spacewar!* while I was getting paid by Doug Ross, and he seemed to be perfectly happy with it. That was pretty much what I did—I stayed there until I went to DEC.

Weaver: Would you tell us about your interaction with TMRC [Tech Model Railroad Club] hackers?

Graetz: Yeah. Actually, well, I got to know them, of course, when the PDP-1 arrived and everyone started coming over to write programs. Actually, my first encounter with TMRC was when I got to MIT. In fact, it was another club that I joined when I was a freshman because I liked trains and I had a couple of friends who'd had model trains. I joined and I went to a few meetings. I discovered very quickly on that they really only wanted members who had their own equipment and could operate, and I was mostly just a hanger-on. But I met several of the people who later I worked with on *Spacewar!*, and Slug, of course was a member.

Weaver: So, speaking about *Spacewar!*, how did the *Spacewar!* idea take shape?

Graetz: The original idea for *Spacewar!* originally really just grew out of discussions Wayne and Slug and I had. Slug came over quite often when we were living at Hingham Street. Wayne and I were roommates. The PDP-1 had arrived early or sometime during the summer of 1961. We knew that the display was coming. At that time, of course, I was working on the TX-0 and Slug was doing work at TMRC. They were trying to use TX-0 to write a control program for running model trains, which they switched over to the PDP-1. I always thought that was rather strange because it seemed to me that the point of the Tech Model Railroad Club was to get together and run model trains. Here they were trying to find a way to get a computer to run model trains so they wouldn't have to do so much work. But that was something else.

We started talking about what we could do with the PDP-1 and its display. Some of the important things that we wanted to do were to show what the computer could do and show it off doing as much as it possibly could. And the easiest way to do that was to do something that was working on a display. Otherwise, all you saw on a computer was what you saw on every other computer, which was a big machine with lots of blinking lights and maybe a little speaker that made noises.

We thought that one of the best ways to get people involved was to write some kind of game. Slug, of course, was insistent that it not only be entertaining but

that it would help people understand how the computer actually worked. And, of course, being heavily involved in bad science fiction movies and bad science fiction or even good science fiction movies and good science fiction, we figured that it would be nice to have something that looked like a science fiction movie. I don't know how we came around to the idea of spaceships having a battle in space. Originally, I think maybe we thought it was enough just to have something where with the switches on the computer, you could control the motion of a spaceship-looking object on the screen. But we worked on it a little bit and realized that, yes, it would be nice to have a couple of spaceships that were fighting each other and shooting torpedoes or something that you could see. Flying around and having some kind of rocket blast, and it wasn't too long before we came up with the idea. Even the name *Spacewar!* just fell right out.

Then we set about writing the rules for it. *Spacewar!*, the design and the rules all came about with Wayne and Slug and I sitting down and figuring out how this was going to work. We decided it had to be two people [players], had to be some kind of contest. They would use the computer, which was essentially just a big old game board. And they at first would use the switches because that's all we had. We really wanted to have joysticks, but the only joysticks then were military simulators, so we had switches. We would sit on opposite ends of the switch register and use the switches, which, fortunately, had little momentary positions, to control the rotation of the spaceship, whether it was blasting its rockets or not, whether it was firing torpedoes, and how they were maneuvering around in space. I don't know where the idea of hyperspace came in, but we thought it was a cute idea. It'd be nice to have some way of getting away from things if it got too tight. But that was pretty much it. There weren't many rules, really. The game ended when one of the spaceships was destroyed, and then you started it all over again.

That was what we brought down to the PDP-1 when the display finally arrived. I think it was sometime in October in 1961. By that time, of course, I'd gotten to know people like Alan Kotok and Bob Saunders and Steve Piner and Dan Edwards and Peter Samson, who were all involved with various projects around the TX-0. When the time came to actually wanting to write programs for the PDP-1 and, in particular, *Spacewar!*, we had to get permission from Jack Dennis, of course, who ran both computers. He made that famous requirement. He told us, "All right. You can use the PDP-1 to write *Spacewar!* if you write the software to go with it for supporting any programming on the PDP-1." Namely an assembly program so that you could write programs and assemble them into binaries, a debugging program so that you could write your program and then work out the bugs, and an editing program so that you could sit down and actually type in your programs on the computer.

Well, it turns out that the two main programs were the debugger and the assembly program. At the time, I was working somewhere else. I wasn't involved in that effort, but people like Peter [Samson] and [Bob] Saunders, Dan Edwards, Steve Piner, and Alan Kotok were. They spent that weekend taking the TX-0

programs, which weren't all that different, and porting them over to the PDP-1 so that on Monday morning we had the assembler and we had the debugger and we had the beginnings of what became *Expensive Typewriter*. At the time, the only way we had to write program to write the source code was on the Flexowriter, which was an old IBM typewriter that had a tape punch built into it. When you typed, it punched the tape. And they had a version of the tape punch that could be read by the PDP-1. But eventually we had the *Expensive Typewriter* Steve Piner wrote so that we could actually write our code on the PDP-1. We could run it right from the PDP-1 and didn't have to go back and forth.

Weaver: Why the PDP-1 instead of the TX-0?

Graetz: Well, as I said, we already had the programs for the TX-0, but the PDP-1 was brand new. We had to have stuff to help us write things to make the PDP-1 do what it was supposed to do. It also was a research machine. That was what Ken Olsen donated it to MIT to do. And, of course, the first things that happened—the first big program, of course, was *Spacewar!*, but a lot of little things—Marvin Minsky wrote a little program that he called *TriPos*, for "Three Position." It was a little program that started by displaying three dots in an equilateral triangle in the center of the screen, and then he had an algorithm that allowed the three dots to seem to interact with each other. And according to a number, a random number that you entered in the switches, the three dots would interact in various ways. He would take that number and calculate things. They would make various patterns, a lot of patterns that just blew up into random dots, but some of them did things like make Lissajous figures, you know, the kind of things that are traced by a pendulum, and some made orbital patterns. One in particular made a pattern that looked very much like the image of the Bohr atom, you know, with the thing in the middle and elliptical orbits running around, and because it was three, there were three of them. I filed that away for future reference.

There were other programs that were written to display text on the screen. There were a couple of other small demonstration programs, but mostly it was to be used to write serious scientific programs, the first of which, as it happened, was *Spacewar!*.

Weaver: How long a period of time did it take for the initial idea of *Spacewar!* to evolve?

Graetz: Well, the initial idea really didn't take very long. It was all done on the kitchen table at the Hingham Institute. I don't think that took more than a week or two. It took a lot longer because first we had to wait for the CRT to arrive. Then once we presented the idea to the hackers that were there, it took considerable time to actually get to the point where we could write the program. That, of course, was because Slug was the one who was the natural choice to write the control programs and he also was naturally lazy, like me, so nothing happened for a long time. [Laughs.] He kept making excuses.

Then, finally, it was late December that Alan Kotok, who didn't write any direct programming, but he was instrumental in the creation of the program. He was part of the TMRC group, and he got fed up with Steve constantly saying that he didn't know anything about writing mathematical programs or doing sine-cosine routines or heavy numerical analysis, none of which in the end turned out to be necessary. But Alan went off to Digital [Equipment Corporation] in Maynard and came away with a couple of sine-cosine subroutines that could be used for the calculation. He came back and he shoved them under Slug's nose and said, "Okay. Now what's your excuse?"

So, Slug was embarrassed into sitting down and writing code. The first code that he completed in early January was nothing more than a way of controlling a dot moving around the screen, which he very quickly converted into an actual outline of a spaceship. I don't know how long it took to generate two spaceships. But the two spaceships and I think the rocket fuel and probably even the torpedoes came into existence purely on a black screen. It became impossible to tell what you were doing because you didn't know where you were, so Slug wrote a program to put up some random star-looking dots, which helped enormously, and we were able to start playing it fairly soon.

We had all the ingredients: the controls, the rocket fuel, the attitude control, which was nothing more than a gyroscopic control, and the torpedoes, and we started playing. It was fun, but there were things about it that it lacked. That's where what I call the Tom Sawyer and the whitewashed fence came in. Slug had written the control program, and other people were dying to contribute to it, so Slug essentially handed them the paintbrush and said, "Okay. Here's a section of fence."

I don't know which came first because none of these things happened neatly, one after the other. We were all working on different things at the same time. I don't know which came into completion first, but one of the earliest things was Peter Samson, who, as Slug said, was offended by the random stars. He said, "I can do better than that." And, in fact, when it came to programming, Peter could do better than just about anybody.

He took the Ephemeris, which was a star chart, and he took a section of sky that encompassed the entire zodiac for about 44 degrees north and south of the equator. He programmed stars of the first four magnitudes of brightness, which was about all you could handle, really, and programmed them actually in a way that showed them in their relative brightness. So, Sirius, for example, would be the brightest and other stars down to the fourth magnitude or so would be progressively fainter. He managed to do it in such a way that while the star chart itself took up half of memory, the program only took up a small amount. He was even able to program in a motion control so that the stars would gradually process across the screen and you would see [formations]. Early on, Orion would come into view, and then if you stayed at it long enough, the whole band

of stars would be displayed. That came in fairly early and made the whole thing look a lot better.

But the play was still kind of rough around the edges. Dan Edwards came up with this idea of having something that applied a force that you couldn't control, but which you had to do something about. He invented the heavy star, which was the brilliant star in the middle of the screen that actually exerted gravity on the spaceships, which meant that you had to do something at the very beginning. By the way, that beginning, the spaceships in opposite quadrants with the wedge in one quadrant and the needle in the other, that was the very, very earliest way we got started. But when the heavy star came in, you couldn't just stay there, because you would gradually get drawn into the star, so you had to start moving. To move, you had to find a way not to be dragged into the star, and that meant that you had to start orbiting around the star. Since the ships were faced in opposite directions, you wound up rotating around the star, and because you saw your star trail as you rotated because the decay of the phosphors took longer than the motion, you gradually wound up with something that looked very much like an eye, and naturally we gave it the name the "CBS Opening."

But that was really the most reliable way to get started with a game to make it interesting, and you could then get on with it. You could try to outmaneuver your opponent. By the way, you could shoot right through the heavy star. The torpedoes were not affected by any kind of gravity, but they had a limited range. You had to get close enough, otherwise they would spontaneously self-destruct.

If you got into too much of a bind, if you were faced with several torpedoes coming at you and no easy way to get out, you could push the ultimate escape button, which was hyperspace. That was the last thing to go into the computer, because that was the thing I wrote, and it took me that long. You pushed the button, and that's where the Minskytron came in. As I said, I filed away that Bohr atom version and I looked at it. Turned out that three displays were too many. The display is what took up the time, so I had to reduce it to two, which turned out to be just right because the vertical and horizontal components of that display were a perfect metaphor for going into hyperspace.

You pushed the button, you disappeared, the Minskytron appeared, disappeared, and then you had to wait to see where you would come out again. It could be right back in the same place, because while you were in hyperspace, I randomized the coordinates. You could be somewhere way, way, way the hell away from the other ship, or if you were unlucky and there were still a couple of live torpedoes in the sky, you could wind up reappearing right on top of one of those torpedoes. The only thing you couldn't do, because I made sure that wouldn't happen, was you couldn't appear right on top of the other ship.

Weaver: You mentioned that Peter was the best programmer among you.

Graetz: I think he was.

Weaver: Was Steve the main programmer? In other words, why didn't you do it? Why didn't Peter do it?

Graetz: When I say the brightest programmer, Peter was definitely the most sophisticated. He wrote the most interesting programs, but the idea came from me and Slug and Wayne, and it was Slug who promulgated the idea of doing it. Nobody else was really interested in writing the program. Everyone was content. Slug was making all these noises, so everyone was content to have him do it. He had to sit down and write it. We were all pretty competent at writing programs at that point, so it wasn't a matter of relative skill. Any one of us could have done it. It was Slug who was the squeaky wheel, so he was the one who did it. He wrote the control program. We all contributed large chunks to the ultimate program. See, this is just the way we worked. Everybody did everything, and you did what you were most interested in doing.

Weaver: When Russell started coding, were you still working for Jack Dennis?

Graetz: No, I worked for Jack Dennis during the summer because that was all he had the money for. That fall, I went to work for Doug Ross in the Electronic Systems Lab, which is where I met Dit Morse, which is important later on. Dit had programmed the TX-0 and wrote some of the very earliest computer demonstration programs that were ever done. I was working for Doug Ross all the time that *Spacewar!* was in development. After we finished the program and put it out into the world and I was still working for Doug Ross, Dit Morse was hired to go out to Digital to work for Gordon Bell as the first pure software designer. When I say software, I mean program designer, because the word "software" hadn't been invented yet. He went out and he suggested that maybe I ought to go out and see if there was work. I went out and I talked to a couple of people, including Ben Gurley, and they seemed interested, but they didn't hire me.

I went back and had to figure out what I was going to do next, and a couple of weeks later, Dit called me up. He said, "Get yourself out here."

As it turned out, Alan Kotok went out the same day. We both got hired at Digital the same day, but he was hired to be part of the group that developed the PDP-6 and I was hired by Gordon Bell to write diagnostic software for the PDP-4. We were both working on brand-new machines.

Weaver: You mentioned that you created hyperspace. Would you talk, please, about what was the purpose of hyperspace? Why did you conceive of it and implement it, and what was it supposed to accomplish?

Graetz: Well, I thought I'd covered some of this. Hyperspace, I don't really know when the idea came in. I thought maybe we invented it at Hingham Street, the notion of something to give you an escape valve. Because it was science fiction, hyperspace was the obvious answer. It was going to be a part of the program at

some point, but it wasn't integral to it. When the program was being developed, I was doing miscellaneous things for Doug Ross. I was never really clear as to what I was supposed to be doing, so I noodled about with various logic diagrams and things. Then when Slug started to write the program and I got interested and everybody else got interested, we discussed how it was we were going to put hyperspace in, because it wasn't integral to the actual play. The background stars were important because it helped make the display look good. The heavy star was crucial to making the play have some kind of cohesiveness. Well, the explosion, we called it the crock explosion because that's what it was. Slug wrote the original version. Eventually, other people improved the hell out of it.

But all that got going and I started working out how hyperspace should look. They held open a small amount of space for what really you could call the hyperspace module. In March and April, I was working on actually writing the code and debugging it. It was, I think, at the end of March that I finally got something that would work and could be integrated into the program. By the time we were ready to display it to the public, we had it all going. That's pretty much how it got into the game. It was the last piece, and it was really just a plug-in piece that fit into the last available bit of memory.

Weaver: But what was the purpose of hyperspace?

Graetz: Well, the reason for hyperspace, of course, was to give you an escape route. If too many torpedoes were coming at you or you were about to crash into the sun or something, you pushed the hyperspace button. You disappeared, the Minskytron showed up and you were away for a few seconds, and the time you were away was also random, and you came back at some random point on the screen. The trick about hyperspace, though, was it wasn't something you could use with impunity. Like the torpedoes and the rocket fuel, you could run out of hyperspace jumps.

Weaver: Would you consider that hyperspace was your attempt at play-balancing the game, evening up the score between new players and older players?

Graetz: I don't really know if we thought of hyperspace as anything other than just a simple escape route. A lot of what has come out about the way people perceive *Spacewar!* is really after the fact in a lot of ways. We were just trying to develop something that showed off the computer, made it do everything it could do as fast and as intensively as possible, would teach people how you could use the computer, maybe teach you a little something about physics, which, by the way, was important to us. As Slug pointed out, the spaceships had to obey real physics. When the rockets fired, they had to accelerate slowly from a dead stop. They couldn't just suddenly take off. We even programmed in proper inertial rotation so that when you turned the rotation switch clockwise or counterclockwise, it took a while for it to work. It turned out that that—and because it was inertial, when you stopped, it kept on going, just as with the rockets. But because it was inertial, it became very difficult to control. Slug built in a switch that allowed you

to go back to what we called gyroscopic control so that when you flipped the switch, the spaceship would instantly rotate about its axis, which is where the flywheel was, of course. It made it a lot easier to play the game.

Weaver: When and how did you know or decide that it was ready for primetime, to show it for public consumption?

Graetz: Pretty much after we'd played it for a couple weeks. A lot of other people at MIT who had wandered by came and played it. Jack [Dennis] played it and other people who were working on the TX-0 came and played it. I think we came to the point where we realized we had reached the limit of what we could do. We wanted to display it at the MIT open house, which I think was in early May. By the end of April, we declared it to be finished. That's the version, the listing that I brought down, *Spacewar! 2B*. We set the PDP-1 up to display and let people come. By that time, we had the control boxes, so people could come in and sit down and play. We built a little program that would automatically restart the game and allowed any one person to have something like four or five games to play. Then they ran out of time and they had to leave to let somebody else come in and play. I think we wired in a TV monitor so that you could see what was going on with a TV set that was put on top of a cabinet.

Weaver: You said there were control boxes. Who built those control boxes?

Graetz: Well, I didn't really know. I thought it was built by the Model Railroader guys because the switches and stuff all came out of boxes which you accessed by scrambling under the layout. Going under the layout at the Model Railroad Club was the standard term for finding bits and pieces that you needed. I think the switches mostly came from old telephone company equipment, Telco equipment. There was a momentary push button for hyperspace. There was the two-way lever for the rotation control. Wait a minute. I'm sorry. The buttons were for the torpedoes. There was a vertical lever which you pulled back to fire the rockets and pushed forward to go into hyperspace. There were just the three controls, and somebody built a box out of Bakelite and mounted them on the box. They were just little rectangular boxes. We built two of them. Now, yesterday, I think it was Jack Dennis said that he got a couple of his TX-0 engineers to build the boxes. I don't remember that, to be honest with you, but we had the boxes very early on.

Weaver: Do you remember anything about the relationship between *Spacewar!* and Digital Equipment Corporation [DEC]?

Graetz: [Laughs.] Well, I know some things. In the first place, of course, it was running on the PDP-1. Obviously, those of us who went to work at Digital brought copies of the source tape to DEC. We got it onto the PDP-1 that was running there at the time. Ken, of course, didn't approve of running games on the computer, but there were some things that he really didn't have control over. One of the things was *Spacewar!*, which very quickly became a favorite of the PDP-1

manufacturing team. [It became] one of the things they did when they were testing a PDP-1 for final delivery. They had to run all the diagnostics, and, of course, to make sure that all the diagnostics worked properly, they ran and played a few games of *Spacewar!*. If *Spacewar!* worked, again, because it exercised absolutely *everything* that the PDP-1 could do, the PDP-1 worked. So, they left it in core and turned off the machine and packed it up for delivery. Because it was core memory, the program was still there when it was delivered, set up, and turned on, which meant that the first thing the customer saw was the *Spacewar!* opening. [Laughs.]

Weaver: Did you help to spread the game around the larger PDP-1 community, and if so, how did you do that?

Graetz: Well, as far as disseminating the program, we didn't have to do a thing. It was all done by everybody who had PDP-1's, which mostly were universities and a few corporations. But as I said, because *Spacewar!* was in the PDP-1 when it was shipped, everybody got it. There was no way of avoiding it. Very early on, people tried porting it to other computers, but we didn't care, you know. We were happy to see it go all over. But we didn't have to do a thing.

Weaver: Did you present a paper to DECUS [Digital Equipment Corporation Users group]?

Graetz: [Laughs.] Yeah. Oh, that was fun. DECUS was the Digital Equipment Users' group. In 1962, they held their first users' group meeting at Hanscom Field at the Air Force Cambridge Research Lab. They actually owned a very fancy version of the PDP-1. It was two PDP-1's connected to a common display. I think they may have been doing some original primitive timesharing with it. But they hosted the first DECUS meeting, and so we were able to demonstrate—actually, no, we weren't. One of the problems was that the PDP-1's at AFCRL [Air Force Cambridge Research Laboratory] had a hardware multiply-and-divide, which the MIT PDP-1 did not. *Spacewar!* used the subroutines to do multiplication and division, and I spent a lot of time trying to patch *Spacewar!* to use the hardware multiply-and-divide. I never got the timing right, so I didn't get it working. But they asked me to write a paper about the development of *Spacewar!*, and I wrote this little thing that is in the proceedings called the *Real-Time Capabilities of the PDP-1*. I've got the copy of that, is among the stuff that I brought down for the event.

Weaver: Was that paper well received by the user group?

Graetz: Well, I suppose. As I said, it was published in the proceedings. There were several other papers that were presented. People got a kick out of it, I think.

Weaver: Shag, you've been called the historian of the *Spacewar!* group. Why do you think that it's important to be sure the story of *Spacewar!* is preserved?

Graetz: Well, originally, as far as being a historian, that's more or less by default. I was the one who made his living by writing. In 1981, I think it was, when we were coming up to the twentieth anniversary of *Spacewar!*, I thought, it'd be nice to tell this, you know, to write how this came about. There are a lot of people who still remember it and it did start this whole business of interactive games played on computers and arcades and things like that. At the time, there was a very good fan magazine, really, called *Creative Computing* edited by a man named David Ahl, A-h-l, and I wrote to him asking him if he'd be interested in a piece about the origin of *Spacewar!*. He wrote back and said, "Absolutely."

We had a discussion, and this was all done by proper mail, you know. This is 1982. There wasn't even an Internet then. We exchanged a lot of letters and some phone calls. He said, "Yes, please write something that we can publish around the time of the anniversary."

I got settled down and, for once in my life, actually got a project going. I got in touch with everybody who was involved. Most of them were pretty easily reachable. Slug was out on the West Coast, as were Pete Samson and Steve Piner. Alan Kotok was still in the area. Bob Saunders, I think he was also out on the West Coast working for Hewlett-Packard. Dan Edwards was working at the place that is known by the name of "Never Say Anything" here in D.C. It was easy to get in touch with them. I was able to do interviews with Alan and Steve, who, by that time, had come back, I think, to Digital. I was able to talk to a few of the others, but I got basic information about what they did afterwards and where they were, so I had all that information. I was able to talk to Jack Dennis, of course, and to John McKenzie, who had retired, but was still living in Lexington at the time.

I got in touch with everybody who was involved. Wayne had, by then, moved first to Eugene, Oregon, and then to Ann Arbor, Michigan, where he was working for General Motors. Having gotten all of the information from everybody, I set out and started writing and got a first draft together. I ran it by everybody to make sure I'd gotten my facts straight, got some of the still photographs that I took for an article I had wanted to write for John W. Campbell but never did because I was just too scared of him, and we took some pictures of the PDP-1 and the TX-0 for the article.

I sent all that to David, and in the spring of 1982, it was published in *Creative Computing*. It was later reprinted a number of times both in authorized and unauthorized form. David Ahl reprinted it in one of his spinoff publications. The Computer Museum in Boston reprinted it in one of their newsletters and it got picked up by a couple of people who were writing books. I should point out that the original publication, the text got garbled and it was all out of order. I had to tell David to write a correction. But in the Computer Museum version, we got it right.

Weaver: You mentioned that *Spacewar!*, in your mind, started a lot of the computer game industry to follow—obviously, that's in retrospect. At the time that you were doing this, did you have any inkling of what you were doing? Other than the fun, did you have any inkling of what was to follow, what would become of this industry?

Graetz: [Laughs.] We had no idea of what would come after *Spacewar!*. As you say, we were having fun. We were doing something that showed off important aspects of a computer, showed people how to control items on a screen, showed people rudiments of physics, showed them how to use a computer that you sat down with instead of gave information to somebody else to use. What came after that, we didn't really think about that. We were perfectly happy to be what it was. We knew that it was going to get spread around, so it was pretty obvious other people were going to want to do their versions to write for their computers. For example, Peter Samson at Project MAC ported it over to the PDP-10 that they were using at the time. Various other places did it for various other computers.

Other people were doing other things, not necessarily computer based. Nolan Bushnell was writing *Pong*, for example, which was originally an arcade game, but later when Apple, Atari, and Commodore started producing these little game-oriented computers, those games started to take off. But this didn't happen until the seventies. In the sixties, there was just what it was. A few things like *Pong* came into existence, but that was it, far as I know.[2]

Weaver: If you were talking to a young person now, knowing what you know and you wanted to get them interested in the creative side, the inventive side of making something, what would you tell them?

Graetz: I really have no idea what I would tell a kid, because they grow up with this. They already know how to do these things. If somebody wanted to ask me how this got started, I could tell them, but what to do to do something creative, all I can say is work with the tools you have. If you've got an idea, try to make something work. Don't worry about whether it'll work or not, because it won't. But as far as tools, they've got orders of magnitude more things to work with than we did. If they really want to try something brand new, I don't know what they would look at to think outside the box. There must be tools out there that aren't properly exploited. I would say just look for the things that aren't being worked on. Find a place where there's a hole and plug it.

Weaver: I want to ask you a follow-up question a little out of order. You wrote a sci-fi story that was published, didn't you?

Graetz: I was hoping you wouldn't bring that up. [Laughter.] Yes, I wrote a story. I'm not really a fiction writer, but I wrote a short story. It's not so much science fiction as fantasy. It was based on people I knew whom I disguised very thinly and one of whom I disguised not at all. It was a bad story. It got published in the

[2] The original arcade release of Atari's *Pong* was in August 1972.

dying throes of a science fiction magazine called *Original Science Fiction Stories*. I won't tell you what issue. I won't tell you where to find it. I won't point you in *any* way to a direction to find and read that story because it's not very good. Unfortunately, one of the characters in that story was called Harold Copley. It was based on somebody in the Science Fiction Society named Harold Kaplan, and I read in the latest *MIT Technology Review* that he died this summer. He was a grad student at that time, so he was several years older than me.

Weaver: At that time, didn't you also create or work on a board game?

Graetz: That I'm more willing to talk about. How did you find out about Graft? Yeah, games were a big thing with us. While we were still at the Hingham Institute, Wayne and I, and later Slug and I, because Wayne got called up into the Army, and one of our hiking buddies, Bill Miscoe, we had been playing Monopoly a lot. We had gotten so bored with Monopoly, we thought, "Why can't we make our own game?"

We thought of various things on which to base a game. Well, Monopoly is based on areas of Atlantic City, New Jersey, so we thought our game ought to be based in Boston. At first, it was kind of Monopoly-like, and then we looked at each other and said, "We don't have to have a circular board. We can do anything we like. So why don't we base it, at least in part, on the Boston subway system," which at that time was still called the MTA [Massachusetts Transport Authority].

We devised a board which sort of reflected the major subway lines in the Boston subway system, and by the time we got to actually doing this, I think the MBTA [Massachusetts Bay Transport Authority] had come into existence, because we had the Red Line, the Green Line, the Orange Line, and the Blue Line. We wanted to have something like "Go" in Monopoly that you had to go through, and you could pick up some money and go on your separate ways. Now, the four lines in Boston don't actually converge in one place, so we took a little bit of license and made them all converge on Park Street. At Park Street, you picked up your money and then you spun a spinner. That told you which line you were going to go out on. You could go out, stopping at all these squares of various things that were either Boston-related or completely made up, until you got to the terminus of one of the lines, at which time you spun the dial again or else you picked up a token. We had some tokens that also told you what line you were going to travel on, and ones that told you where you were going to go next.

Graft turned out to be a lot of fun. [Laughs.] It was quite different every time. We made cards for all the different properties. We invented things, cards like the "Chance" cards and the "Community Chest" cards. One of them, of course, because it was a game of Boston, and in those days, graft was the game of Boston. You could get a card saying "You are the mayor's cousin. Get $20," or, "You have been caught with your hand in the treasury." And, of course, we had the Charles Street Jail and a few other things. We had Gilmore Gasworks, based on

a very talkative friend of ours. We had actual locations in Boston that you could buy. You could put up houses or not hotels, but high-rises.

Smith[3]: In 1982, you already kind of did an oral history about *Spacewar!*. I'm curious, would you have guessed that thirty-five years later, you'd be talking about this whole story again?

Graetz: Well, I certainly didn't think so many of us would be around. It's now fifty-five years, fifty-six years. Yeah, I tried to get some interest in a fiftieth-anniversary reunion, but everyone was too far-flung, so that didn't happen. I'm glad that you people got going with it.

There's a couple of non-*Spacewar!*-related stories that I don't know if you're interested in, one that has to do with Ken Olsen and the PDP-1 at MIT, which he didn't take too kindly to. But not long after the PDP-1 was pretty well ensconced—I think it was actually around the time when we were doing *Spacewar!* and it had already been in operation, and he was bringing a number of corporate bigwigs and people he wanted to impress to come see the PDP-1.

In those days, one of the big electronics hobbies was putting together your own audio equipment and high-fi equipment. The biggie at that time was Heathkit, which at that time was owned by a company called Daystrom. So, their logo was "Heathkit by Daystrom". As it happened, I recognized that it perfectly fit the identification block on the front of the PDP-1 that said, "Programmed Data Processor-1," which was two levels of rectangular strips. I hand-drew "Heathkit by Daystrom," and hand-drew it on a template. No scanners in those days. I measured that PDP-1 logo, cut it out, rubber-glued it over the "PDP-1," and then I got the hell out of there because I wanted to be sure that it was still there when Ken came in and saw it. I'm told this after the fact. They came in, Ken looked at it and he frowned, said, "What?" [Laughs.] And he ripped it off and tossed it in the drawer on the console. I never told him who did it.

Weaver: Martin, do you have brothers or sisters?

Graetz: I have two younger sisters.

Weaver: What do they do?

Graetz: The older of the two lives in Lexington. She's a musician and a singer. She teaches voice. She used to have a small musical group called La Duvanet and later had different names that sang Balkan and other traditional music. More

[3] Alexander Smith is a librarian and video game industry historian who regularly explores video game history as co-host of the podcast They Create Worlds. He earned a B.A. in History at the Ohio Wesleyan University, a JD in Law at Ohio State University, and a MLIS at Kent State University. He is the author of They Create Worlds: The People and Companies That Shaped the Video Game Industry.

recently, she's had a singing partner that do tours under the name of The Proper Ladies. They research and sing nineteenth-century traditional and musical songs.

My younger sister is Linda. She lives in Waltham. She's an artist and a photographer, and she is program developer at Mass Audubon at Drumlin Hill. Her husband, Jim Eng, is also an artist. He recently retired from the faculty at Framingham State University, and he has been doing a lot of really fine outdoor pen-and-ink sketches and oil paintings.

So, we've got a lot of arts in our background. I, myself, am a Morris dancer. Go figure.

Weaver: Do you have children?

Graetz: I do not. I never married and I never had any children that I know of. I only had one long-term relationship, a girlfriend that moved in with me in the seventies. She was able to stay in my apartment while I went to England for a year.

Weaver: Excellent. Thank you so much.

Graetz: All right. Well, you're more than welcome.

[End of interview]