



## **Oral History of Tom Malloy, part 1 of 2**

Interviewed by:  
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Recorded November 8, 2018  
Mountain View, CA

CHM Reference number: X8837.2019  
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**Brock:** Thank you very much for agreeing to do this with us. I appreciate it.

**Malloy:** It's an honor.

**Brock:** And I often joke when starting oral history interviews, maybe we can start at the very beginning and ask you when and where you were born?

**Malloy:** I was born in Wilkes-Barre, Pennsylvania, in 1952.

**Brock:** And that is very much-- I guess it was and may still be very much like a coal-defined area. Was it--

**Malloy:** It was. Absolutely. Coal-- It was anthracite coal, which is the most valuable hard coal that was valuable to the steel industry. But the coal really ran out before I was born, for all practical purposes. So, Wilkes-Barre was a boom town, a boom city along with Scranton in the turn of the 20th century. By the middle of the 20th century, it was kind of in decline. And it was still a wonderful place to live for a kid, but still, to the best of my knowledge, it's not an economically very robust area.

**Brock:** Could you tell us a bit about your family or origin, the family you found yourself in?

**Malloy:** Yeah, sure. I grew up in a traditional, Irish-Catholic family, my mom and my dad and four of us siblings. You want to ask a more specific question?

**Brock:** Yeah, just about what were the major activities of your parents? How did they fill their days?

**Malloy:** My dad spent his entire career working for Planters Peanuts, literally started when he graduated from high school in the stock room and retired when he was 65 as a vice president of marketing. And my mom was, in addition to being a mother of this large family, was a dietician, and she worked as a dietician on and off through most of my childhood.

**Brock:** Was her involvement in that-- Was nutrition and knowledge about that a big part of your household?

**Malloy:** No, I wouldn't say so, but it was her profession, and she practiced her profession both in hospital/nursing home kind of environments where she planned meals for patients, and she also had a teaching credential and she taught home economics at least at one point in my childhood.

**Brock:** Oftentimes, people will describe there being a major theme of their household. Sometimes it's religion, sometimes it's politics, business, reading, education. Are there any kind of big themes that stand out for you from your household?

**Malloy:** I wouldn't say so. I would say we were a typical mid-20th century family in the sense that my mom was college educated, my dad went to work out of high school and eventually got an associate degree but did not have a bachelor's or an advanced degree in college. And for that reason, also, I think fairly recent immigrants. In the family, on my mom's side, her mom and dad both immigrated from Ireland. On my dad's side, I think it was one generation before that. But a very typical, strong interest in education, so all of us, the four kids all went to college and we all got master's degrees or the equivalent. My two brothers are lawyers and my sister followed in my mom's footsteps and was a dietician. She just retired. So, education was a big thing, but other than that-- The four kids had different interests and our parents supported that. We had a very-- Outside the six of us, there wasn't a huge extended family, but we had some very close aunts and uncles that we spent a lot of time with, my mom's mom and my great-aunt, while they were still alive. So, it was a pretty close-knit family. We moved to New Jersey when I was in junior high school, and so that kind of changed things somewhat for the family. I didn't notice a big change. I don't think the kids did as much, but it was a big change for my parents because they were born and raised in Northeastern Pennsylvania.

**Brock:** Where did you move to in New Jersey?

**Malloy:** It's a town called Metuchen. It's basically a commuter town for New York City. My dad, as I said, he worked his entire career for Planters Peanuts, but in the early '60s, Planters Peanuts was acquired by the first of a long succession of conglomerates, whatever you want to call it. So, there was a company called Standard Brands, which acquired Planters Peanuts, and subsequently Nabisco acquired Standard Brands, and one of the cigarette companies acquired Nabisco, and then they spun them off, but--

**Brock:** Oh, yeah. R. J. Reynolds bought--

**Malloy:** R. J. Reynolds, that's it. Yeah. But the significance for our family was that when Standard Brands acquired Planters Peanuts, my dad was one of the executives or middle manage-- I think he was probably an executive at that point, but he was one of the five or six people that was invited or offered a job at Standard Brands' corporate headquarters in New York City. And so, there was these five families, basically, or six families, that moved from Wilkes-Barre to various places that they could commute. I think they were mostly in Central and Northern New Jersey, so they could--

**Brock:** Take the train in, yeah.

**Malloy:** Take the train or bus into New York. So, that was pretty traumatic, particularly for my mom and a lesser extent for my dad. The kids, it was just-- I was going from fifth to sixth grade,

and I enjoyed my school and my life in Pennsylvania, but I also enjoyed it in New Jersey. And in fact, I always say that I had the perfect combination because Wilkes-Barre is in a valley in the Pocono Mountains. It's a city, but there's lots of outdoorsy kind of stuff, and not nearly as dense an urban setting, so it was a great place to be a little kid. The street that we lived on was full of Irish-Catholics and Polish-Catholics, and so we used to run in packs, literally, the kids. Every family seemed to have two or three or four or five kids. And that was back in the day when you just had the run of the neighborhood. You could go wherever you wanted as a kid, and nobody was worried that something bad was going to happen. And then, for my teenage years, I was a 35-minute train ride from New York City, and I was in a more urban environment, and it was a great transition for me to get that experience as well. So, it was great for me as a kid.

**Brock:** How would you describe yourself around the time you're getting into high school? What sort of a kid were you? How would you describe yourself?

**Malloy:** Well, I was a pretty typical geek, I think. I was generally acknowledged as being smart, and I liked math. So, I took math and science and all the other things that we took back in those days, and it was a-- I don't know whether it was-- It was probably formally tracked, I don't know. So, I hung out with the smart kids. And I think it was a pretty typical, again, mid-20th century upbringing, at least for middle class white people.

**Brock:** Mm-hmm. Were you able to pursue your interests in things like math and science through the library? Through reading? Or were you doing more hands-on stuff? Were you tinkering or building a radio or anything like that?

**Malloy:** I don't remember any of those. Probably the real turning point for that, other than just classwork and reading, was between-- Must have been between junior and senior year. It was 1969, I know that, because it was the year that we landed on the moon. I was able to go to-- I don't know whether the National Science Foundation still does this, but the National Science Foundation back in those days would sponsor college programs for high school kids during the summer. So, I went on a two-month or ten-week program to learn how to program computers, and that's where I learned how to program computers. I learned how to program Fortran on an IBM 360 at Stevens Institute of Technology, and--

**Brock:** Sure. In Hoboken.

**Malloy:** In Hoboken, that's right. And I lived in a dormitory, and it was great fun. And I remember '69 because of the moon landing, and it happened, literally, and in July while we were there. And so, we stayed up all night and were able to go into the cafeteria where they had set up a TV and watch it happen in real time.

**Brock:** It's interesting, that NSF summer program-- One of my questions was about how, in growing up in the '60s, was the reaction to Sputnik at all relevant? And I imagine those NSF summer programs were in a way--

**Malloy:** They probably were.

**Brock:** -- a national reaction to that.

**Malloy:** Yeah.

**Brock:** You're in high school at a very interesting time in American history, and I was just wondering about how things going on in the broader world were or were not impacting you, in what was going on?

**Malloy:** I would say I was on the periphery of all those things. Our high school did-- this would have been the next year, I think, when we were seniors-- did march after Kent State. We walked out of school, we did what by today's standards would be considered minor acts of protest. But I wasn't one of the driving forces behind that, and so it was all flowing around me for sure. My brother was older. He was in college, and he was worried about the draft, and certainly in a few years I was worried about the draft, too, but that was when I was in college. And rock and roll was happening in a big way, and again, I think I was on the-- I wasn't a huge rock and roll fan at that time, but I did become one, eventually, and I was exposed to it. I didn't get to go to Woodstock, but again, my brother did, I think.

**Brock:** Right. Touching on all these developments.

**Malloy:** Yeah.

**Brock:** What do you think conditioned you to want to go on that summer program to learn how to program computers? How had computers entered your consciousness by that time?

**Malloy:** Well, I think my mom deserves the most credit for all of the nudging and pushing and encouraging of education for not just me but for my siblings as well. I know she encouraged me to do other kinds of projects like that. I remember, I did some crazy science-- It may also have been by the National Science Foundation. I don't remember. But there was some kind of national science project kind of thing, which it was totally screwy, I got to say in hindsight. They-- Oh! It was sponsored by the National Cancer Foundation or Society or something like that, because the project was to go and procure chicken tracheas. And you were supposed to get these chicken tracheas while whatever the things are inside the trachea-- the little--

**Brock:** Yeah, the little fibers or whatever we want to call them? Yeah.

**Malloy:** They wiggle around when the trachea is alive and viable, and we were supposed to get these tracheas, cut them open, and blow smoke on them and see what the effect was--

<laughter>

**Malloy:** -- of cigarette smoke on these chicken tracheas. So, the biggest trick was to get the chicken trachea somewhere before it was totally dead. But that's just another example. My mom somehow made me aware of that, and I went and did that.

She made me aware of the opportunity to do this summer program. And I don't think at that stage in my life I knew that I was going to be a computer scientist by any means. It was just, I was into science and math. I think I had a friend in high school who had an analog computer kit, so I was-- But I could have become something besides a computer scientist very easily. In fact-- We're jumping ahead a little bit, but when I graduated from college, I actually was pursuing two lines for a first job. One was a job in the computer field, but the other was actually to be an actuary, and I took the first set of actuarial exams, and I interviewed in a coat and tie up in San Francisco for Metropolitan Life or something like that. So, fortunately, I chose to be a computer scientist at PARC, but I could have been an actuary at some life insurance company for my whole career, too, and then we wouldn't be having this conversation.

**Brock:** Which was very much a major professional line for people who had done mathematics as undergraduates.

**Malloy:** Absolutely, yeah. It would have been a lot of fun.

**Brock:** My aunt is an actuary, so--

**Malloy:** Is that right?

**Brock:** Yes. Yeah <laughs>, so I know that firsthand from her experience.

**Malloy:** Yeah. Somewhere-- I seem to remember that actuaries have some of the highest job satisfaction in the whole world of all the different jobs you can have, but I don't-- That may or may not be true.

**Brock:** I ask this in every interview because it's so interesting to me, the responses. Was science-fiction part of your reading life?

**Malloy:** Mm-hmm.

**Brock:** Do you see any connection there between-- Was that just part of the culture of people into science?

**Malloy:** It was not the only thing I read, but I definitely read science-fiction. I read the Foundation series, however many there are, and certainly fantasy as well. I certainly read the Tolkien trilogy and *The Hobbit*, which is not exactly science-fiction but it's kind of in the same vein. But I think I read other things as well.

**Brock:** Right.

**Malloy:** I know when I first moved to New Jersey, so that was-- I must have been 11 or 12. I must have read every "Hardy Boy" and "Tom Swift"-- Well, "Tom Swift," so that was not science-fiction, but it's pretty close.

**Brock:** Yeah. And what about work experiences? Was that part of your life during high school? Did you--

**Malloy:** Well, nothing that we would consider much in a professional experience until the summer between my senior year and my first year of college, and that was not even a paying job. But I did have a volunteer job programming for some local government-- It was a federal agency, but it was a local office. I don't even remember which one it was. But they were happy to have somebody do programming for free, and I didn't find a paid job that summer for some reason.

My other jobs were just normal kid jobs. I had a paper route, which was most of the money I made up until my mid-teens. I know that because when I turned 16, I decided I wanted to learn how to fly, and you have to be 16 to start taking lessons. And between 16 and maybe 17-and-a-half, I spent every nickel that I had earned up to the age 16 taking flying lessons, and I got about three-quarters of the way towards being ready to take the license, and I ran out of money, and I've actually never done it since. So, I had a paper route. Wasn't until after I came back after my first year of college that I-- For two years, I worked actually for my town, for the borough of Metuchen, as a garbage man, and a park worker. Again, nothing professional about that.

**Brock:** Well, if we could, let's loop back to that--

**Malloy:** I did work in a-- I was a stock boy in a store somewhere. Anyway, go ahead.

**Brock:** <laughs> Oh, just wanted to loop back to the experience at Stevens with the IBM-360 and FORTRAN. It seems that given that you work in computing, even unpaid, the next summer, it really must have stuck with you, or it must have really made an impression. Can you talk about your experience there, your reaction to learning to program?

**Malloy:** I just remember it was great fun. It was great. I've always enjoyed programming, and in fact even in retirement I still program. But it was also this first big adventure away from home. I was only 30 minutes or less from home, but I really didn't see my folks and my family for most of that two months. I was living in a dorm with a group of kids my age, and we were taking the path over to New York City to do things, and it was just an all-out great experience. And it was my first experience with a university environment because the professors and instructors that taught us pretty much treated us like grownups. We had assignments that pretty much occupied us all day, five days a week, but we also had seminars and we got to drink coffee and eat donuts, and it was just a very grown-up experience.

**Brock:** <laughs> Was the pleasure in programming that you found the satisfaction of puzzle-solving, or building something? To what would you relate the pleasure? What is another thing it's like?

**Malloy:** Well, I would say "Yes" and "Yes" to both of those things. The obvious first pleasure out of programming for me was solving puzzles. So, it's a natural extension of my interest in math. Later in life, I think the latter thing you mentioned, of actually building something, was really important. It's why I ultimately left PARC and went to Apple, for instance, is because I wanted to build something that got into the hands of users. And so, I think those are probably the top two reasons. I can't think of any others off the top of my head.

**Brock:** As high school was coming to a close, what were your hopes and ambitions for yourself? What were you looking at? What was your picture of what you wanted to do?

**Malloy:** I wouldn't say that I had a clear picture. I was not one of those people that knew from a very early age that I wanted to do X, Y, or Z. Frankly, the biggest driving force for me when I was going away to college was I wanted to get far away from home. My dad and I had a falling out when I was a junior in high school, and his response was he had to clamp down on me, bring me in line, and whip me into shape. And so, I had a curfew all the way through senior year, which was kind of annoying. And subsequently, we mended our relationship and had many decades of a happy father-son relationship, but when I was a senior in high school, I just wanted to get away, and so I wasn't thinking about what I was going to do, what I was going to major in in college. I wasn't even-- I applied to some top-notch schools and I got into some of them, and I went to Stanford, which really is, again, why I'm here today. But it wasn't because I knew that Don Knuth was in the Computer Science Department or John McCarthy was in the Computer Science Department and I wanted to work with them. I was not nearly that together or knowledgeable, and literally, I chose Stanford not because it was going to turn out to be such a perfect fit for me but because it was really far away from New Jersey.

**Brock:** But also, obviously, had a high reputation because it's a--

**Malloy:** Oh, yeah. Absolutely. Yeah, absolutely. But my folks really wanted me to go to Cornell, which is where I also got in, because it was much closer. And in fact, when I applied to Stanford-- And I don't even remember why I applied to Stanford to tell you the truth. I wasn't that-- Back in those days, you didn't apply to that many schools. I only applied to four or five schools, and all the ones that I applied to, except for Stanford, were on the East Coast, and then it was, like, the University of Pennsylvania because we were from New Jersey, and Cornell and Yale, I think, Stanford, and there must have been one more-- Oh, Rutgers, of course. Rutgers, because all my siblings went to Rutgers, the State University of New Jersey. So, I don't know why. Somebody told me Stanford was a cool place, and so I applied, and I saw that it was in California which really sounded attractive. But anyway, so, I'm applying to these five schools, and my mom says, "Well, you can apply to that Stanford out in California if you want, but you're not going. Even if you get in, you're not going." So, I applied. We weren't a very talkative family



at that point because I was, as I said, I was kind of pissed off at the way they were treating me. So, I applied, and then I got in, and I said, "Well, I'd really like to go there," and she said, "No. Congratulations, but you're not going." So, really, there was some number of weeks or so when I was going somewhere else. But ultimately, probably because I sulked constantly for however many weeks that was, my mother relented and said that I could go to Stanford.

**Brock:** And so, what was it like when you finally arrived? Had you visited in this process? No?

**Malloy:** Absolutely not. No. I arrived cold. I'd never been on an airplane before.

**Brock:** So, your first airplane ride was out to Stanford?

**Malloy:** Was from Newark to San Francisco, yeah.

**Brock:** <laughs> So, how did you find it?

**Malloy:** Well, again, I really loved my Stanford experience. Some of my best friends to this day are the people that I was in the freshman dorm with at Stanford, which I think is a pretty typical Stanford experience. And although the people that I'm closest to from those days are not really the geeky kind of person that I was and I am, there was so much for a geek like me to do. The first quarter I was there, I took a class in computer architecture. And so, I just took math and computer science and statistics and all that, operations research, all those things, and I just piled on all that great stuff that I still enjoy thinking about or reading about or knowing today. And the flipside of it was, it was the '70s, and as a group of kids we went to a lot of rock concerts in San Francisco, and a few of the kids had cars and we would go to Yosemite and went to Big Sur, and it was just exploring California, for an 18-year-old, is just-- It's a lovely experience.

**Brock:** And your undergraduate years were '70 to '74?

**Malloy:** Yeah.

**Brock:** So, yeah, which is, I guess, continuing to be a very interesting time in American history and especially--

**Malloy:** Well, yeah. Going back to the Vietnam War, they had done away with college deferments by the time I got to college.

**Brock:** Oh, I hadn't realized that.

**Malloy:** And so, I had to go through the lottery either my freshman year or-- the draft lottery-- either in my freshman-- I think it was my freshman year, and I just squeaked by, by the skin of my chinny-chin-chin. I don't remember-- I think they took up to about number 100, and mine was

maybe 120 or something like that. So, I could've been drafted in my-- Or, they could've tried to draft me at the end of my freshman year.

**Brock:** Wow.

**Malloy:** But that didn't happen, fortunately. And there were protests on campus. It was an interesting time, for sure.

**Brock:** And well, could you tell us a little bit about how, in your undergraduate years, how your connection to computers and mathematics developed?

**Malloy:** Well, for the bulk of my undergraduate career, it was really just me working through this program, and I think they still have it at Stanford. It was called Mathematical Sciences back then, but I think it's got a different name now. But it's essentially the same, which is-- Now, you have to remember that in the early '70s, there was a Computer Science Department at Stanford, but there was no computer science undergraduate degree. So, if you were interested in anything of a mathematical, computer science, statistical nature other than being on a track to be a math professor, then you would typically take this math/science undergraduate degree, which was cross-departmental and cross-disciplinary between those four departments, because the math department was the only one that had an undergraduate math degree, and that was for people that wanted to become math professors, get PhDs in math and become math professors.

If you were interested in statistics or operations research or computer science, then you took this math/science program, and you would take classes in all four of those depts, and there was a list of classes and there were electives as well, but it was a pretty hefty list of maybe two, three, four classes in each one of those depts. And so, I was getting a really broad exposure to the mathematical sciences, and it was a fabulous, fabulous program for me because I came to computer science-- Lots of students, I think, now come to computer science from different directions, but I came from the traditional direction of math. I guess physics was the other main direction back in those days, but I came at it from the direction of math. So, I could take what I was learning in linear algebra and apply it to numerical analysis and what I was learning in statistics or operations research and apply it in other areas. So, it was just a great program.

**Brock:** Through your instructors or teaching assistants or just in the course of doing your coursework for these classes, were you getting a glimpse of the kind of computer scene at Stanford in terms of the Computer Science Department, what was going on in the Artificial Intelligence Project? Did you have any insight into that?

**Malloy:** I wouldn't say that I was, again, so clear about my future or driven that I was paying an inordinate amount of attention to that. I took the List Programming: Introduction to AI class from John McCarthy, and I barely knew who John McCarthy was. I took Information Theory from-- What was his name? Covin or Cover?-- Tom Cover [Thomas M. Cover], who's a really famous

information theorist, and I didn't know that. I took an algorithms or a data structure class from some other-- I'd have to look it up-- famous-- So, I was getting exposure to all these famous people, but I didn't know how famous they were and how lucky I was.

So, I think getting to the aha-part of this, maybe, is also kind of an interesting story, and we have to back up a little bit. I wasn't quite sure how much detail you want me to go into, but we're going into lots of detail. So, this is an interesting story, I think. My freshman roommate came from Boston, and his family was friends with a guy by the name of Jerry Elkind. In 1971, I'm pretty sure it was, Jerry was given the job of the head of the Computer Science Lab at PARC and moved from BB&N [Bolt, Beranek and Newman] to PARC. As a result of that, he had a vehicle-- and it was actually a Chevy Suburban, I think-- that needed to get from Boston to Palo Alto. And so, the summer between my freshman and sophomore year, after I was done being a garbageman in Metuchen for the summer, I met up with my college roommate in Boston and we picked up Jerry Elkind's Suburban and drove it to Palo Alto. Again, I had no clue who Jerry Elkind is. I don't think I even met him at the time. But I drove his car to Palo Alto.

Fast-forward two or three years. So, it's my senior year, and my roommate got us, together, a job that we shared, which was an evening clerical job at PARC, which he got undoubtedly because he knew Jerry Elkind. And our job was to come in after working hours-- This was before personal computers, before local area networks, pretty much almost before laser printers. But they had a mainframe computer that they had built from scratch called MAXC, which I'm sure you know about, and they had a laser printer called the XGP which they had wired together through some kind of IO channel and a Data General Nova so that researchers could spool up print jobs during the day, but they wouldn't print out because there was no automatic connection between all these things. So, some clerical person had to come in and basically de-spool all the jobs from MAX up to this Data General computer, and then the Data General Computer was the controller for the XGP printer, and so then get all the jobs printed on the XGP printer which printed out six pages a minute, and then distribute them to the desks of the researchers so they'd be there in the morning.

And this was-- I don't know whether we did it five nights a week or six nights a week, but we split that job. One of us would come in one night, one of us would come in the next night, and it was probably one of the most boring jobs in the world because it basically took about 15 to 30 minutes to get everything set up, and then you had to wait-- six pages a minute-- for all this stuff to print out, and then at the end you had to burst-- It was fanfold. You had to burst it and put it on people's desks. So, that's my next contact with Jerry Elkind and PARC. Chuck Geschke, by the way, was the poor guy who was responsible for us. He had somehow-- They shared administrative jobs amongst the researchers, and so Chuck was our supervisor of this job. And so, I did that during my senior year at Stanford, and it was directly as a result of that that I got my first job at PARC when I graduated. We can talk about that now, or we can talk about it later.

**Brock:** I just wanted to talk about your impressions of PARC during that senior year. You're there at night where presumably most of the people have left, gone home.

**Malloy:** They're gone, yeah. The only people I got to meet were Alvy Ray Smith and Dick Shoup. I think it's because they're graphics/entertainment kind of guys. I think those were just the hours they kept. But they were the only people there, and they also had a TV because of their graphics work, and so-- or, several TVs. And so, I would go into their lab while they're sitting there making history and watch God only knows what on television while I was waiting for the XGP to spit out these pages.

**Brock:** Well, what was your impression of the atmosphere of the lab? Were you impressed by what was going on? Did it--

**Malloy:** I was still clueless. I was still clueless. I am convinced to this day that my roommate got us that job so that I would have an opportunity to go work there eventually, because that's the kind of guy he is. So, he was the kind of guy that was thinking ahead. I wasn't thinking ahead at all. I was, "Well, this is beer money," basically. And so, I did it, but it's through that that I met Charles Simonyi, and-- I don't know. Do you want to go into that part now?

**Brock:** Well, yeah. Well, maybe we could just talk a little bit about the decision between-- You're coming up on graduation, you're going up to San Francisco to interview for the potential actuarial post. Could you just talk a little bit about your invitation to join PARC and why you decided to do that instead of pursuing the actuarial?

**Malloy:** Well, I probably should have taken the actuarial job, from the point of view of comparing the two jobs, because this was not a prestige position I was being offered. In fact, I had no business being at PARC. I don't think they hired-- Other than Ed Taft, I'm not sure they ever hired as a real researcher an undergraduate. So, the reason I got hired-- First of all, I got hired for a summer job. The summer job turned into a temporary job, and the summer job basically lasted for two years. Those were the two years that I was at PARC proper, and it wasn't until Charles and I moved to the Systems Development Division that I actually became a real full-time Xerox employee.

But the reason that this snout-nosed undergraduate was getting offered a job by Charles Simonyi was because Charles's research was around software methodology. He was creating his theory or his system of meta-programmer and technician pairing where a meta-programmer would write pseudocode, essentially, or high-level instructions, for a number of technicians who would then go and write the code and debug the code and make the code work. So, they needed somebody that was 180-degrees opposite from their typical PARC researcher. They needed somebody who was not an esteemed or up-and-coming computer scientist. They just needed somebody who kind of knew how to program and didn't have the deep understanding of computer science that you would if you were pursuing your PhD, as many of the other part-time people or non-permanent people at PARC did, or you were a PhD researcher as most of them were. So, they were looking for somebody who was totally different from the PARC profile, and I fit it.

**Brock:** That was in '74? Or was that--

**Malloy:** Yeah.

**Brock:** Okay. So, your initial summer job, was that offered to you by Charles Simonyi?

**Malloy:** Mm-hmm.

**Brock:** Okay. And it was to-- I've also heard his-- The metaprogramming approach also described-- I forget who used the phrase. It's like "the software factory approach" or something like that.

**Malloy:** Right. That's the idea. The meta-programmer would be able to supervise some number of technicians, and therefore there was this idea that it was a factory-like setting. But he's definitely used that metaphor, for sure.

**Brock:** Would it be akin to an architect and builders? So, in a sense, in the world of physical instructions--

**Malloy:** You mean in the physical world?

**Brock:** Yeah. Is it--

**Malloy:** Yeah. Sure.

**Brock:** For a simple analogy, that would be the same sort of idea, that the meta-programmer would be doing the overall design and specifying how the thing should work, then--

**Malloy:** Yeah. To the first order, I think that's a good approximation. If you delve into it too deeply, it's some combination, probably, of the architect and the general contractor. But we were definitely the subs. Let's put it that way.

**Brock:** <laughs> You were putting in the drywall.

**Malloy:** That's right.

**Brock:** Okay. And was the project that you were to be the sub on--

**Malloy:** Yeah. I was the first technician in the world, in Charles's world of meta-programmers and technicians.

**Brock:** And this was the project that-- This was Bravo?

**Malloy:** Actually, it was Alpha.

**Brock:** Ah. Okay.

**Malloy:** So, Alpha was a short project, but it took us most of the summer, I think. And I don't even remember what it did, to tell you the truth. Charles would remember, if you asked him. So, he had-- For his thesis work, basically, he had mapped out these, actually three projects, I think, Alpha, Bravo, and Charlie, within which he was going to explore this programming methodology. And I honestly don't remember what Alpha was. So, we did Alpha in the summer, then my job got extended, and I think it wasn't probably until the fall that we started Bravo.

**Brock:** Okay. Well, could you talk a little bit about how that project unfolded? What was it like for you? So, this was in part for Charles Simonyi's PhD research at Stanford, but it was also a way to explore these ideas for an editor that Charles Simonyi had been talking about with Butler Lampson?

**Malloy:** That's right.

**Brock:** So, were you an experimental subject to try and follow some sort of protocol that was given to you by Charles about how to--

**Malloy:** At the beginning, yes. Absolutely. But his meta-programming philosophy is not so rigid that the roles have to fit in tight little boxes. As people's interests and skills developed, he basically took that to Microsoft, and it became a very prevalent programming style at Microsoft. So, you could bring in relatively inexperienced people. The meta-programmer would give them relatively detailed instructions, but he wasn't religious about it, and by the time that I could take higher-level instructions he was scribbling things on the white board and I was going off and implementing them. And by the time we were adding people to the team-- We were starting them out at one level, and I was writing metaprograms for other people, but then they were stepping up. And so, I think over time, the lines get blurry in his methodology, and certainly the roles change. I went from being a technician to what you would call a meta-programmer or a technical lead over time.

But yeah, there was this dual activity going on. Both Charles and Butler and I, all of us were much more interested in building Bravo than we were in, in some sense, in the methodology. That might be an exaggeration for Charles because he really wanted his PhD, and he really did believe in his methodology and he took it to Microsoft and it was adopted widely. But the exciting part of it was not, for me, and I don't think for Butler-- was not that, but it was we had this throbbing piece of hardware called the Alto. And we wanted to build cool stuff to run on it and Bravo was the part of that cool stuff that we built.

**Brock:** Right. I have heard, in talking to Charles Simonyi about the Bravo story, he was saying that it was really centered on maybe these two elements that Butler Lampson had surfaced.

One was to have a screen-oriented editor focused to this high-resolution bitmap display, that there was an algorithm for fast display, but then there was also this data structure of the piece tables. So, I just wondered, as you got into the project, how did you learn about those two things? Or if you could just talk about how you got into a project where these two elements seem to be so definitional?

**Malloy:** Mm-hmm. Well, this is where I think the Forrest Gump metaphor really applies, because remember, I'm a technician evolving or growing into somebody that requires less supervision, eventually being somebody who could provide direction to other people. So, I'm getting instructions about what's supposed to happen, and whether it was Charles drawing on the white board or giving me detailed pseudocode, that's how I learned about piece tables. It wasn't like anybody sat down to me and said, "In 40 years, you're going to be sitting in a studio explaining how piece tables are so great." It's just like, "Here's what it's supposed to do, Tom. The data structure is going to do this and this and this and will probably need these kind of inputs, these kind of gozintas, these kind of come-outas. So, go do it, and we want to see some stuff on the screen." And so, I wasn't making the history there. Well, I actually was making it, but I wasn't making it up. I wasn't envisioning it. I was taking very detailed instructions from Butler or from Charles about how this editor was supposed to work. And they really are quite elegant data structures that they came up with for having a system that could both demonstrate the potential of the Alto but also be very usable on a daily basis by hundreds of people, because that was the miracle of Bravo, right? It was a research project that hundreds of people depended on day in and day out.

**Brock:** I was wondering about-- So, there's the conception of this editor and the basic approaches to it that would be definitional for this editor. What I realized I didn't know is as you sit there to try and build the thing, what are you using to-- What sort of environment are you using to--

**Malloy:** We built it all in the Alto, in the language BCPL.

**Brock:** Oh, okay.

**Malloy:** And there was a compiler that ran on the Alto. There was a debugger that Jim Morris wrote called Swat, you may have heard of. And really, we didn't use-- There was an operating system, but it was a very rudimentary operating system which we ended up throwing 99 percent of away because we couldn't afford the space. And we had a very elaborate-- Charles has probably told you about this. We had a very elaborate scheme for swapping code into memory from the disk, almost on a command-by-command basis, because we definitely crammed 20 or 30 pounds of stuff into a 10-pound bag, which was the Alto, and more and more as time went on.

**Brock:** So-- Forgive me if this is naïve and that I should already have an intuition before it, but how were you-- Were you writing the code out on paper and then-- How were you literally writing and manipulating the code that you were using to build Bravo?

**Malloy:** We had a text editor, and it was-- What was it? Well, after we got Bravo up and running, we actually used Bravo as our text editor. But in the early days, we used a line-oriented text editor, like Emacs, but Emacs wasn't available then, I don't think.

**Brock:** Yeah. Something like TECO or those things that were out there?

**Malloy:** Yeah, one of those things. Might have been TECO.

**Brock:** Because that might have been on the MAXC, because if that was supposed to be a PDP-10 replacement--

**Malloy:** Yeah. Right. Probably was, yeah. I don't remember that.

**Brock:** I think that was the editor in TENEX.

**Malloy:** But just as the Smalltalk people bootstrapped themselves into Smalltalk as quickly as they could, we bootstrapped ourselves into Bravo as quickly as we could, and we used it as a programming editor. And I obviously didn't have any of the features that you would associate with a modern editor of understanding the syntax of the language, but it would read, write, and edit plain text files, and we used Bravo for that.

**Brock:** That was something that I have to admit, that I was embarrassed that I hadn't really fully grasp, was-- Just personally, I come to this story having been a Word user since I was an undergraduate, and so when I look at the story, I'm coming to it from that lens. Of course you're using this to make literary things-- But rather, that what I was kicking myself for not really realizing is this is for writing programs, and many of that-- Bravo, that this was a tool through which many of the people at PARC were primarily using it. They could write all sorts of memos and literary productions, but as a tool for writing--

**Malloy:** Because there was nothing else. The Smalltalk people had their own editor, so they could use that. But anybody that was writing in BCPL was probably using Bravo. And then when the Mesa people came along, and when the Mesa environment came along, they had their own editor as well. So, it was very much a transitional kind of thing because it wasn't designed to be a program editor, as I said, but it was the best tool that we had for some number of years.

**Brock:** So, how long did it take to get some sort of working instance of Bravo going, something that could display things on the screen <laughs> and that used this data structure?



**Malloy:** I don't think it took very long, but boy, you'd have to find somebody with records to tell you whether it was three months or six months or what.

**Brock:** Okay. But months?

**Malloy:** Yeah. Less than a year, I would say, for sure.

**Brock:** Right.

**Malloy:** So, there was a crying need for this because when I arrived in the summer of '74, there were maybe six Altos in the world. Chuck Thacker had one in his office because he designed the hardware. Butler had one in his office because he was Butler. I think Charles got one pretty early, but I'm not sure. Bob Metcalfe had two in a lab, or Boggs and Metcalfe had two in the lab, to bring up Ethernet, and in fact those were the ones that I used to program on when they weren't using them, because they were in a lab and they were kind of available for other people. So, that's five, and--

**Brock:** And the Smalltalk Group must have had--

**Malloy:** Smalltalk Group, yeah. They probably had a couple. But there weren't very many Altos in the world, but they were rolling off the assembly line, and by the end of '74 I think almost all the researchers had Altos in their office and they wanted to do things with them. And so, Bravo will-- People were waiting outside our doors or outside my cubicle for releases of Bravo, and that was good and that was bad. We put out some pretty half-baked stuff from time to time. But Charles-- You've interviewed Charles, right? So, I'm sure he's got a timeline somewhere of when all this happened.

**Brock:** Yeah. Although it was very much the same sort of timeline <laughs> as yours around this, I'm sure that can be reconstructed.

**Malloy:** Yeah. I don't think I have any records that would really narrow it down any more than that.

**Brock:** Right.

**Malloy:** Actually, if you had somebody look at the dates on some of the documents that you have in the museum that are Bravo documents-- Like when we did the show, we dug up some document-- Well, some were Bravo documents like the manual that Butler wrote, but also there was some source code and stuff like that. They might have dates or date timestamps on them that could give you some sort of idea. I don't know.

**Brock:** Well, it is just-- So, you were collaborating initially, obviously, very closely with Charles Simonyi in this. When did other-- I guess, as you're working on the project, when do other contributors to Bravo itself come in?

**Malloy:** I don't think it took too long. Probably-- I think Charles and I, with Butler's oversight, probably put out the first release. But it was so well received that we probably got more resources between the first and the second release, would be my guess. I don't really remember.

**Brock:** Okay. So, this was all taking place in the context of the Computer Science Laboratory?

**Malloy:** Yeah. Absolutely.

**Brock:** Okay. And could you-- As you're doing this work on Bravo across 1974, could you just paint a picture of what it was like at PARC at that time, what the environment of the research center was like, what kind of--

**Malloy:** You mean the physical environment?

**Brock:** Yeah, and social environment. What was a day-- As you were working on Bravo at this time, what was a day like for you?

**Malloy:** Well, again, I'm still at this stage in a mildly clueless mode, but it was this wonderfully rich corporate research environment that so many people have written about. A truly astounding group of people, both personally and intellectually. The physical building that's called PARC now was just being built. We started out across the street and moved into that in '74 or '75. Every Tuesday at lunch, there was a "Dealer" where some incredible person would get up and talk about some incredible thing. Physically, it was kind of a mixed-mode office environment with hard-walled offices around the perimeter and cubicles in the middle for those of us that were just sort of peons. And so, in my quad or section or whatever it was, I was in a cubicle and the offices around me were Butler and Charles and Peter Deutsch and Bob Metcalfe and Howard Sturgis and Jim Morris and Jim Mitchell and Chuck-- John was not there at that point-- Chuck Geschke, and John Warnock was not there at that point. Ed Taft. It's just like a who's who of computer science. This is basically my graduate education, right? I ultimately got a master's degree in computer science from Stanford, but this was my graduate education at the feet of the masters. And so, I'm just getting exposed through Dealers to all kinds of stuff. I'm learning about the other activities, the other projects that are going on. I'm being exposed to graphical user interfaces-- What you see is what you get. The first Ethernet is coming online, the first really bona fide laser printer, EARS, is getting installed in a copier room down the hall. So, it was just an-- I didn't know it was extraordinary at the time, but in hindsight, it's obvious how extraordinary it was.

**Brock:** And it's interesting that-- Just this idea of creating this environment, creating the tools of this environment, it must have been fascinating to see all these elements come online and come together and change the way that you and the other people in the center were doing their work.

**Malloy:** Yeah. And socially, I think there were a couple things that bound us all together socially, and I think it was, by today's standards, a pretty tight-knit social group, not just CSL [Computer Science Laboratory] but SSL [Systems Science Laboratory] as well. Less so the physicists down on the first floor. But we played softball together, we had the Dealer every Tuesday. It had a great cafeteria out in the middle of nowhere out there on Coyote Hill, so we ate lunch together every day. And so, we definitely socialized together as well, and it was-- I think in the spirit of an academic environment in that sense, that in academic departments there's a lot of social activity that goes along with the intellectual activities.

**Brock:** Right. One quick question about the piece tables. As you're developing Bravo, how important was that data structure to what Bravo was becoming? Was it--

**Malloy:** It was incredibly important. The piece tables were incredibly important. The incremental display algorithm was incredibly important. I had not remembered it until we did our demo earlier this year, but there was an incredibly important hardware feature in the Alto that you didn't have to allocate a full bitmap; you could allocate bands of bitmap. And that was incredibly important to us, too, because again, we're trying to squeeze 30 pounds of stuff into this 10-pound bag. And so, whereas the Smalltalk folks allocated a full bitmap and had a full graphical user interface and the graphical applications did the same, we actually had an interface where each line of text had its own bitmap, and it was only big enough for however much text was taken up, and the white space in between, we didn't allocate bits for. And so, we were just trying to squeeze-- It's all about optimization for this really quite small machine.

And so the piece tables allowed us to do that by having large documents in edits that were essentially independent of the length of the operands and the edits. The incremental display algorithms were quite elaborate because the processor just didn't have the oomph to recompute whole screens. In fact, we didn't even recompute whole lines if we could get away with it. While the user was typing in, we would figure out where that one character would go, and we'd sort of push a little space out-- If it was simple enough, we'd make a little space in that-- allocate a bigger bitmap, make a little space, and then put that one character down. And we played all those performance tricks that we could think of, and then Chuck and Butler put this feature in the hardware that we used. It was all driven by the fact that we wanted to demonstrate really powerful applications on a machine that just could barely, barely do it.

**Brock:** Right.

END OF THE INTERVIEW