

IBM "WOMEN IN TECHNOLOGY" ARCHIVE

ORAL HISTORY INTERVIEW

**DR. JOAN L. MITCHELL**

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LASEWICZ: What schooling and/or education have you had in your background, and what courses interested you the most and why?

MITCHELL: Okay. I obviously started in kindergarten and went to Stanford University for my under graduate, I was a physics major there. I went then to the University of Illinois for a Masters and a Ph.D. also in physics.

I got an experimental solid state physics degree; my thesis was in experimental solid state physics. I did both theory and experiments, and I like that combination.

I might say that I think what got me into math and science, I'm what...I call myself a Sputnik baby. Basically Sputnik went off when I was in elementary school, and by the time I hit junior high they'd started to have those advanced courses. And the one group just one year ahead of me, they had the first teachers who taught the stuff. And so they started pushing us in the math area in junior high. When I hit high school I went through in the honors classes. My sister, two years older than I am, completely missed the classes. [For] my brother and sister,

who are six years younger, [the classes] didn't exist any more. So I went through [school] in a very, very narrow window in which it was okay to be smart.

Now, I thought I was going to be a math major. I loved and tutored math. I always had someone that needed help, that I would help out. I actually only had one semester of physics in high school because I left high school, graduated a semester early and went overseas for six months. I lived in Germany with a family there. And it was a good education. I went to school in Germany but I didn't...I had already graduated from high school and I was already admitted to Stanford University, so I didn't have to worry about grades.

When I got to Stanford University I discovered basically on my first day of calculus I had everything in the review and the next was brand new. So I had no accelerated classes that gave me AP placement. They didn't exist in the school when I was going through.

I really liked the calculus class, and for the math majors you had to take physics for the physics majors, which they started winter quarter. And I'm someone who likes to leave

as much freedom in the future as I can, so I decided I'd take the physics for physics and math majors as a freshman, and that meant that when I got to my junior year, which is

when most of the math majors took it, I'd have some free time.

It was just so much more fun than the math. I fortunately got into an honors math class because I made a decision to go overseas in my sophomore year, to England, so I didn't need any of the language requirements. I basically went to the physics department and said, I'm going overseas, can I still be a physics major? This was the first quarter of my sophomore year. And one of the professors there, his reaction was, sure, anything's possible.

I'd gotten two As, and that was a fluke. I mean, I didn't have the material ever before, because I had missed that part of it when I was in high school, so it was hard work but it was kind of the hardest thing that I could do. There were some things that were harder that I couldn't do, like some of the English.

I was terrified that I wouldn't be able to do the chemistry class, because I just don't think I have a very good memory.

Taking the physics and then getting an A when it was hard, it was all new but great fun, and challenging. And so I then took what he gave me, and he basically had me skip most of my sophomore year classes. And I went to the math department and said okay, here's what I'm taking for physics.

When's the last possible second I can switch back to math? It turned out it was the middle of winter quarter my senior year. There were only three classes that were different and I could pick them up then.

I said, okay, I'm going to come back, I went overseas and I missed math and physics. There was no math and physics for a fantastic two quarters at Stanford in England. I traveled all summer with a friend of mine, so we went to Greece and up to Scandinavia.

When I got home, I was hungry for equations. So I started to do the physics. And I came home that Thanksgiving and I basically told mother and dad, I'm going to flunk everything.

Now, I was almost a straight A at that point, and so I wasn't going to be kicked out of school, I knew that. I knew I could take the risk. And their reaction was, okay, was it

worth it? I said, yeah. I said, well, I don't have to flunk everything.

So I went systematically, I took my easiest class, which was the math, so that when I finished it at the end of the year I'd had what I needed for the hardest class, which I always

try to take simultaneously, which was quantum mechanics for physics.

And so I sort of one by one got the classes under my belt, felt comfortable and started the next one. I had already taken some of my finals, when I went to see the quantum mechanics professor. This is the last class I thought I'd figured out.

Well, I had it all wrong. He about flipped out, because here I had had a whole quarter of his class and I had it completely wrong. But I could say, I don't know the [math], I haven't had it yet. It turned out I'd learned the physics; I just couldn't do the math.

So he helped me. It was kind of fun because there were eight problems, and it was a two- or three-hour final, I forget

exactly. And I was able to correctly set up every problem. I could write the equation out; I just couldn't work it.

I did none of the equations. I finished none of them. But I got them correctly set up. He gave me a B minus in the class, but I'd already promised I'd drop it and pick it up a year later. So I kept trying to see if I could do it.

Now, after I declared my major as physics at Stanford University I found out my grandmother was an applied physics major at Stanford University before World War I. She and her roommate wanted the applied math and they couldn't get it, sort of a theoretical math orientation. And so they went and took the physics together. Somehow, that made it easy not to quit. It was kind of the feeling, if she can do it, I can do it. And so I was determined, and I ended up actually graduating with honors from Stanford, even though I thought in the middle I might flunk all the classes.

So I graduated in physics, class of 30, honors is top 10 percent. It was the top three out of 30. Going on to graduate school was something that was triggered by a comment a high school guidance counselor made to my parents and me.

Back in high school at sophomore year we had what was called sophomore goals, and you took all this battery of exams, the aptitude classes--they were kind of fun to take. And then in front of your parents, the guidance counselor interpreted the results and made some career suggestions. And this one counselor made the comment, he said Joan shouldn't stop until she gets a Ph.D.

And I heard this. I mean, I was never...I was the first person in my family to get a Ph.D. And so I went back and

I'll never forget it, because I went to my English teacher and said what does it take to get a Ph.D.? And she told me, three years after you're done with college.

And my reaction was, no way. Four years of college, that's enough. I'm not going to be interested. Now, it turned out that at the University of Illinois, which is where I eventually got my Ph.D., the average at the time [for physics] was six years, and it took me only five. But by the time I got there I was able to work my way through school and I was kind of being paid to do what I wanted to do most, so I considered a low paying job doing my heart's desire.

So [before graduating from Stanford University], I took the graduate record exam and the general one I aced. But when I got to the physics, most of the easy questions I'd never had. I mean, I didn't recognize them at all. I could do all the hard problems--I'd had that advanced work, but I had missed the easy stuff. So I did not do well, and [there was] a period of time in which I didn't think I could get into graduate school in physics.

You know, I looked into all the alternatives, I took the exam over again, I did better, but I still didn't do what Stanford students normally do on that. And then I got this

letter from one of the universities, the only one in my home state that I could have gone to without being financed by the school. And the letter said, Dear Mr. Mitchell: having carefully looked at your credentials we've decided there's not a match. Somehow it never got in the...I figure they didn't look very carefully.

But I looked into going to law school, I looked into getting a Masters in math...

In the end I went to my parents and I said, I really want to do physics. Can I come home, and I'll study and I'll ace that exam?

Because one of the things I'd had to make up was optics. The secretary from the physics department called me in, this is winter quarter of my senior year, and said, Joan, you've never had optics. I said, no, I was told I didn't have to. And she said, well, it's a requirement. You can't graduate from Stanford in physics without optics. The problem was, I had two days a week solid state physics, and since I had just decided that was going to be my career, I wanted to take it. But this coincided with two out of the three optics classes. So I went to the chairman of the department, it happened to be Arthur Shallow--he received a Nobel Prize

for lasers. And I had known him sort of casually, because I had had him as my freshman physics professor. Stanford University really liked teaching, and so they had their top name professors teach the beginning classes. And then they'd have their graduate students and newer professors teach the more advanced classes.

They felt it was important for the best teaching to be done, and they valued teaching. So I knew him from several years before. And I went to him and said, I've got this problem. I want to take solid state physics, could I come to your class one day a week and take this other class the other two days, and I'll read the book and will that count.

And he said, well, what do you want to do with your life? And I said, well, I want to go to physics graduate school but I'm not going to get in. And he said, why? And I said, well, I didn't do very well in the GRE, and Berkeley's rejected me and I haven't heard from the other two schools, but I'm not going to get in. I mean, I'm just, you know, probably not going to make it.

He let me talk almost an hour, and I told him what I wanted to do and what I liked and what I didn't like. And he made the most amazing suggestion. He said, Joan, we'll wait

until June. And when you're graduated we will pick not the top 10 but one of the next 10 schools, and I will write you a recommendation that will get you in.

So that was kind of exciting. About three days later I got the acceptance from the University of Illinois. I was accepted in their first class. And after I had been there several years I asked my thesis advisor, how come Berkeley just rejected me? And you guys took me on your first round? And he said, because we haven't found any correlation with the physics GREs and ultimate success. If we know your school, because we've had experience, if we know your recommenders and we trust them, we don't even look at the GRE scores.

Now, if we don't know the school at all, then we'll use that as giving you an opportunity to come and try. You know, if you do really well we'll let you in. But if we know we don't even look.

And I thought, wow, that was neat, because something very important happened during that period of not thinking I could make it. I had looked into law, this was during the Vietnam War, and I took the law boards and aced them. I

hadn't known that they had five exams, one of which was practice. Well, they gave me three math and two English.

And fortunately I had gone through the book, because I'm someone that can't understand instructions. I can think of so many different interpretations to the question that I have trouble answering questions. I mean, I actually had trouble with first grade word problems, because I could think of too many possible...what do they want? You know, I've learned over time to give them the easy answer, that's probably what they wanted. And by having taken one of these thick books and read through it and done practice exams, I found out what they meant. And one of the things I had learned was, my first gut instinct was right.

And so I had aced the law boards. I talked to Stanford University about applying to law school, and their reaction was, if you show up two weeks before, you're accepted-- because we want people in science to come. And we're not sure if we have a class. So that gave me this feeling, okay, somebody wants me. But I thought about it, and I really don't like writing, at least not back then. And I thought, I don't really want to have to write all those law briefs. And then when I got into physics, by then I knew that's what I really wanted most. And it helped a lot, because your first year in graduate school could be pretty scary.

A lot of people spend an awful lot of energy worrying, well, am I in the right place? One of the tricks I found that made a huge difference in not wasting energy [was to ask], if I've made the wrong decision, when do I have to change my mind?

It's like when I went to the math department and said, okay, what's the last second I can switch back? All right? So up until then I don't have to...you know, I've still got an escape hatch.

So I wrote down in my calendar when I would have to apply for other graduate schools if I didn't think I was going to stay at Illinois or if I wanted to switch fields. And I just said, I'm not going to question. I'm just not going to spend one second worrying about it. I'm going to do my best, I'm going to try. The worst that happens is I flunk out, okay, I don't have a choice. But I'm not going to question, I'm just going to go try.

And for example my first mid term in graduate school was scary. It was scary to begin with because I never had one, but I walked in, and in the first 10 minutes I realized I

didn't have the faintest idea how to do two thirds of the exam. There were three problems, and you were supposed to do it in two hours. I could do one, I knew that. But I had no idea. And I had studied hard, I thought I was totally prepared, and I was feeling really good, I'd been able to do the homework, et cetera. And so one of the things I've learned is, let me show the professor what I do know. Let me give him an opportunity to give me all the points I can. Let me show what I do know and not worry about what I don't. So I took the one problem and I worked it. But when I got down to the last five minutes I realized that my minus sign, I had an exponential, it had to be wrong. I knew it was wrong. I mean, things just don't...real life doesn't go with exploding things exponentially; they decay down to zero. And so I just took another color, a red pen, and I circled this, I said, I know this sign is wrong but I don't have time to find out where I went wrong. And I had to turn it in.

So I walked out of there knowing my first physics mid term in graduate school, I earned somewhere from zero to maybe a third, which, you know, by standards in undergraduate, that's a flunk.

Now, I heard a few other people complaining so I knew I wasn't the only one. And they were saying this was useless,

why did we bother, we shouldn't have studied, you know. And they were saying they were going to give up, quit trying to study.

And I thought, because of the decision I had made when I took things out of order I could learn it after the test as well as before the test. I just had to master it so it would be a solid foundation I could keep going on. I didn't have to get it right. I didn't have to impress anybody. You know, grades are things that are trying to give you some calibration back, and I used to say, if I was self employed, would I care what the grade was on this exam? Nope. I'd care if I knew how to use it.

So I had to know either before or after. I could get it from the answer sheets. But I needed to master the material. It didn't matter when. I went ahead and studied for the rest of my exams, and the others were a little bit easier. They didn't have quite that trauma.

Well, it turned out I was one of the top three scores out of a class of 100. Basically the top score was under 40, and I got one or two extra credit points. They took one point off for that wrong sign.

And that just set me up. You know, once you've had that kind of experience it kind of moves you to the top of the class. And so I really, really enjoyed graduate school.

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LASEWICZ: I just wanted to ask you a follow up question. You had mentioned that narrow window as a Sputnik baby. And I was wondering if you had seen that reflected as you've progressed with your career both through your education and through the professional ranks.

MITCHELL: What was different about it is that I went through high school, I'd missed the drug culture, okay? My particular class, it was okay to be smart. After all, we were going to save the world from the Russians.

And my two younger sisters were both valedictorians of their class, this is high school, and at least when I was going through the graduating class was over 600. And it was not okay for them to be smart. They had to work hard and cause trouble just to not be the teacher's pet.

Whereas for me it was okay. I don't really know, because, you know, by the time I hit college that was the sit-ins,

the riots. In graduate school they, you know, canceled finals because Kent State had happened. And so it all kind of got mixed in together with Vietnam.

But I do know that I went through in a fairly narrow window in which it was actually okay to be smart. And I think that helped a lot because you weren't being torn to be something that didn't feel natural. You didn't have to pretend.

And [they had] honors classes, I had a group of about 30, and they were about half female, and you know, we went through most of them, English, honors English, honors math, honors history...

And honors classes are actually easier in my opinion because the teachers assume you know the material and you kind of have to indicate it. But the assumptions are in your favor. The one time I took a regular class when there was an honors class, my first B in high school. Fortunately it was the mid term report and therefore it didn't actually show up on my transcript that way. But you had to prove you knew it. And proving is a lot harder.

Also, they worked you a lot harder. And you had a lot of busy work. I don't know about you, but I don't get a lot of

fun out of busy work. And so there's just a lot of extra work that didn't necessarily help you learn it if you had learned it the first time.

LASEWICZ: Okay, so it's 1974, you're graduating with a Ph.D. out of University of Illinois. And IBM is your first position?

MITCHELL: Yes.

LASEWICZ: Okay. Can you talk a little bit about your work history? Why IBM? What did you do in those early years at IBM?

MITCHELL: I'd love to. By the way, if I could mention one of the neat things that happened in job interviewing is that the person that came to Illinois to interview happened to be one of the students of my thesis advisor in the field that I did my thesis. Talk about a fun job interview! [LAUGHTER] You know, we just hit it off. I mean, I was wondering why I knew how to spell his name, and he asked, how's Dave? And I'm saying, how do we know anybody in common? And I realized, he's...oh, you're that name on those log books that I see around.

So we had just a great time for the job interview. And then I got invited to come for the plant visit, and this was my second plant visit. The first visit, I had gone to a very prestigious well-known place and the next day a good friend of mine was coming who was a theorist working for a Nobel Prize winner, James Bardine. One of the things you don't want to do in a job interview is ask the person about your competition [LAUGHTER].

And I didn't find anyone that had been there less than 15 years. When I got to IBM for the job interview, the first thing I noticed was everybody shook my hand. The second thing I noticed was that they all had switched fields, because I was deliberately asking, how long have you been, did you make your decision.... Because at the previous place everyone had stayed in exactly the job they'd been hired into. And one thing I knew about me was, I wasn't going to make rest of my life decisions. I wanted to change occasionally. I like, you know, moving on.

And so everybody at IBM, they said, you know, they called it I've Been Moved. Well, I was looking forward to getting moved. [LAUGHTER] In fact, going to Boulder is my first IBM move in almost 30 years.

I just really liked the people during the actual interview themselves. They had a wide variety of backgrounds, but one particular job stood out. And I think it may have been the challenge.

Keith Peddington who later became my manager, was the person that hired me with the company. He made almost an offhanded comment, something along the lines of, you know, this is a job that most people can't handle. Your assignment is to invent new ways to leave marks on paper.

It was the advanced...the exploratory printing technologies group. And he said, if after 18 months you haven't really done something then we'll get worried. But you know, it takes a while because it's very different from graduate school.

And I remember thinking, I think I can do something in less than 18 months. I really wanted that particular assignment, that job. I mean, I went back to my thesis advisor and said, can I write him a letter saying, I want that job. He said, no, no. You let them make the next move.

Well, within six weeks I had been given the offer and I'd accepted, it was exactly the job I wanted. I was thrilled. I found out later that there was a hiring freeze before I

came for the plant visit and they shut down very soon after, so that I came in a very narrow window that I actually was hired into IBM.

So I started work in October in that exploratory and printing technologies group. The second day on the job I had an opportunity to do my first invention. And that was really fun.

Basically I was in a group in which several people were optical physicists. Okay? They had done optics. Well, remember, I was kind of lacking in optics. I actually read the book and I read a Scientific American that gave me...that passed that requirement.

But I didn't have a lot of background. My thesis advisor had given a sort of physics for poets type course, it was the course for the non majors, required for, like, the premeds, and as a teaching assistant, I was too busy to go to most of the classes.

But when he had it on waves, I went, and he did an hour of probably a hundred demonstrations of longitude roll. Think of a slinky that goes back and forth and transfers, where you're waving it sideways.

And he just did all kinds of waves, either longitude or transfers. Well, in optics you only have one kind that transfers. And so this guy is saying, we really wish we could use ultra sonics for printing, but we have this problem in accuracy.

And I'm sitting there thinking about the long railroad ties that, remember the Indians, you see them in the movies, they used to lean their ears against the [rails]...to figure out when the trains are coming? Those are very long wavelengths. They're longitudinal waves that go in very narrow guides relative to their actual wavelength.

Transverse, however, your guide has to be at least the width of a half a wave or so. And I couldn't understand why he was telling me it was hard. I'm sitting there saying, what do you mean? Finally I said, well, longitudinal waves. And his eyes lit up, because they had just never thought about the two kinds. And so my first patent in fact that I applied for was in ultrasonic printing.

Meanwhile, I'd ordered equipment, and it hadn't arrived. It turned out that I didn't understand the budget process that happens, because you know, I had ordered it in November, and it finally got approved months later and, et cetera. So I

was waiting for this equipment, and in the meantime, a manager came in one day, this was at Easter time, and he said, you know, I've got this idea. And what it was, was to try and use the electro erosion type printing where you have styluses and you pulse them electronically and it basically blows the cover off of paper, plain regular paper.

He had the idea that maybe we could put something in between, which was called, ultimately, resistive ribbon thermal transfer printing. And I don't know if you have been around long enough to remember the Quietwriter printer; it was one of the Selectric line. But it was quiet, it didn't have a ball that banged. Well, that's what we co-invented together. And that's the only time I've consciously used my thesis.

My thesis was on diffusion in sodium into sodium chloride -- in other words, salt crystals. Well, the heat equation is the same equation. So I knew how to solve special boundary conditions.

And I learned a lot from my manager because he didn't have the skill to do that particular problem, but I'd get stuck and he would make suggestions. And guess what? They worked.

I was able to solve the one-dimensional special boundary conditions to model what would be going on. And because you heated up the ribbon and you could leave it behind, you could do things on electronic scales, which are microseconds, instead of thermal scales, which are milliseconds. So the thing could go a lot faster.

And so that was invented during Easter, after I had come in October. When we worked on that, we made sure that we got San Jose involved. They actually made the ribbons, and then I tried to figure out how to measure the ribbons. It was a lot of fun.

LASEWICZ: Was that early success important to your enjoyment of the job?

MITCHELL: Well, actually, I was told that I wasn't very successful. Not my manager, okay? He didn't know that there were people in his management chain that thought I would work

harder if I thought I was in danger of losing my job. This was when nobody got fired at IBM, but I didn't know enough to know that.

I'd been in IBM about 18 months and I was not happy. Because nobody in the world was doing ultrasonic printing, and nobody was doing resistive ribbon thermal transfer printing, I got to working alone in the lab. And I am not a person to thrive in working alone. I was going home at night feeling...what I'd describe as very hollow. Not satisfied. And I actually wrote down my ideal job description thinking about leaving. And I said, you know, this is interesting, because I have this ideal job--if I would act differently. In other words, the job I have exactly matches this ideal description: the flexible hours, working on stuff I think is important, stuff that's going to matter. Okay? But I have to act differently.

And the same manager I described, he had always said, you can invent your way out of a trap. So I decided to consciously see if I could invent my way out of the trap. Working alone in the lab was the trap--nobody to talk to. And I had

believed that no one would be interested. You know, nobody was doing ultra sonic printing, so no one was interested.

And then I went to this seminar that was in the auditorium, just a fluke, I didn't even know it was happening. I was walking one way, I think it was probably after lunch; and my

colleagues were going the other way and they said, why don't you come? So I turned around and went to the talk. It was on data compression. I walked out of that talk saying, I think I know the solution to that guy's problem. And it bugged me. It bugged me for the next three months.

Finally, I got the courage to tell my manager, I really don't want to do what I've been telling you I wanted to do. And he said, why? And I said, well, I think it's a stupid thing for me to do. And he said, I agree with you, but isn't it your idea? And I said, nope, it's your manager's idea, and I don't agree with him but I never said that before. And he said, oh. The problem was, it used everything that wasn't my skills, it was a lot of mechanical things, and I'd have to wait at least six months before I could do the part that I had some skill in. And it just made no sense to me.

And I said, okay, I want to take a week. I've got this idea, it's been bugging me. I'll learn to use FORTRAN on the computer, the host, I'd done that for my thesis. And I want to try this idea out. And he said, fine. I mean, it was only me who was censoring myself. I'd always had the freedom to do what I needed to do. And at the end of that week, I had switched unintentionally into data compression. And I never was unhappy in the same way again.

Basically, what I did in the next few weeks was, I went and talked to people, I probably talked to 50 people, and found out half of them had ultra sonics in their background. They would have been very interested if I'd ever gone and told them what I was doing, but I hadn't, because I'd assumed that they weren't interested. Nobody cared because nobody was doing this stuff.

So I just acted differently. I just made a conscious choice I was going to act like I did in graduate school, and that included, I'd dance in the halls if I felt like it, because that was me, I got enthusiastic. Somehow, I had picked up this idea that going into business you had to be kind of

narrow straight jacket, and I just said I'd forget that, it's not worth it. I'm not happy that way.

It was in the summer, in July, when I started asking people about data compression. In September I was already visiting Boulder to share my results. And three years later Boulder was the one that sponsored me to propose the international standard, the fax standard. I went in '78 to the international committee, and there are lots of stories about how we got that proposal through successfully, and then went back in '79 and ended up having to do the negotiation.

And one thing I'm really proud of IBM is that I knew enough to know that being female might not be that easy. At least the first time the meeting was in Geneva, Switzerland, that is, my first experience in standards. And so I brought my colleague along that I had done this work with and he had the appropriate white hair and was male -- because I wasn't going to let the standard be sabotaged on that basis.

But in fact we made a tremendous team. You really can't negotiate technically if you don't have someone that can be thinking while the other person is talking. In my opinion you can't negotiate, think, talk and listen all simultaneously. It takes a pair of you: one can talk and the other can be watching and observing.

So we managed to get a compromise that made the particular standard good in software. That's one of the contributions [cited] when I became an IEEE Fellow, you had to write down what you thought you'd done. I claimed that I, with my IBM colleagues, were the only people in the world that thought that standard should be done in software.

Their goal was 4,800 bit per second hardware. I couldn't tell them until 20 years later; but I was worried about 25 megabit per second hardware. To me, their goal fit the

handheld calculator that existed back then, real simple software.

But we got a standard in which there were almost no hardware chips because everybody did it in software from the very beginning. Later when I got into data compression to do JPEG, we again set that same goal: good in hardware, good in software, and the best.

We originally said, "we win," but we had to change it later to "everybody wins," because they thought we meant our technology only. But what we meant is that IBM is a company. If you had that property, good in hardware, good in software and the best, IBM would be able to use it and therefore we would win.

But that was everybody wins. And so again, having had that experience that when you do stuff that you can do in software, it's very low entry to get started. People can try it out. You don't have to wait until you have a big market to get started. And later when the markets happen then you can get into hardware. So did that answer your question?

LASEWICZ: Sure, it's certainly a start. So was it a natural progression from the fax standard into JPEG standard, or was there an interim period?

MITCHELL: Well, the fax standard finished as the team I was on that was doing the exploratory printing, when we ended up trying to do facsimile, right, which had the printing and the data compression.

And the next project we chose was IBM's internal teleconferencing system. And I don't know if you remember the Series 1 [grenell] system, they had up to 100 rooms worldwide. I was told that they were able to launch the PC because [of this system]...this was during the gas crunch back in '80, '81 timeframe. And the drivers...the dealers could drive to the nearest IBM teleconferencing center, and therefore, they could tell them about the PC and launch it properly.

When we finished the original [fax] standard, in 1980 I thought, okay, I'm done, standard's technically finished. And I didn't go anymore.

But they had headings called gray scale and color. And they were, you know, to be further studied. And after we had done the internal teleconferencing system, we actually told my management we were interested in participating when the CCITT for the [fax] standard extended into color and gray scale.

And so I'm watching the literature on the...I get these reports from friends that I had made while I was part of the standards process, and there's no word of it. Well, in 1987 I got this phone call from an IBMer in standards and he was trying to tell me that there's this ISO committee called JPEG, and that they were in the process of standardizing gray scale and color. And would I come to a meeting the next day? Well, I had a lab visit by the president of the Research center the next day, it had already been postponed four times, so I wasn't going to change it again for any reason. And I told him, I can't do it.

And so he sent me two inches of documents. And the guy was really smart, because basically it went, technical/administrative. It was about a 50/50 split. And we looked at the technical and it was state of the art. They had us hooked.

Well, I've had occasion to read back through it fairly recently, and it was always in there, telling me that this joint committee was CCITT [fax] and ISO. But we didn't pick that up for some reason—I had thought the "joint" was was a new organization, the ISO side had just become a joint technical committee.

The people that standardized the firmware, the connections between computers, were joining with the people doing the

computer software programs. ISO did that part in this joint area, so where the things overlapped because there was a blurring between hardware and software, well then...

And so we just assumed that was the joint. We didn't understand that this one guy--when he talked everybody listened--it was because he was the other half of the committee giving...feeding them the fax standards. They're very, very different cultures.

I had to get, like, 60 signatures to get that [fax] proposal through IBM. ISO is voluntary, and so we got permission to make an international standard on two phone calls after we were at the committee meeting, because on the plane we read that other inch and discovered we were going to the registration deadline meeting.

We had a cleared talk on an area in which we'd done invention. And we had brought some results thinking we'd share it and then we'd come back to the next meeting in three months.

Well, we were going to miss the deadline. We wouldn't be allowed to make a proposal. And so [Charlie Touchnee] was in standards, he called IBM standards headquarters and they said, you know, if.... They knew me from the [fax] and so they gave him a few questions to ask, and so he came back in

with a big grin and said basically, my management says it's okay if your management says it's okay.

So I went and placed a phone call from Germany, interrupted my director. I knew my manager was out of town, interrupted the director to say, I've got this question. And he asked me two questions: one is, are the patents filed? I said, yep. And is it okay with corporate standards? Yep. He said, okay.

And I said, do I have to call the vice president? He said, no, it's okay. Now, later when I look back, I mean, we told him three years before we wanted to participate, they let us go to this meeting, we were going to propose it, you know, six, three months later or so, so it's not surprising. But I never questioned, I had learned by then, hang up. When you get the right answer, quit talking.

So we got to write our JPEG standards proposal during the presentation of the other proposals. And we actually had one of the better proposals in my opinion. Three months later we had sort of the first shoot out and we were in the top three.

And then they kind of blurred company lines and country lines and formed teams, and all of the three teams that were formed, six months later their proposals were better than any of the original set. I mean, there was just a

tremendous amount of progress made. And fairly soon after that Bill and I became editors of JPEG. Did that answer your question?

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LASEWICZ: What I'd like to do with the next question is to cover what's happened since then.

MITCHELL: Okay.

LASEWICZ: You mentioned the MPEG book and subsequent work.

MITCHELL: As I said, it was almost a year later we found out that that J was CCITT, and I'm thinking, oh! [LAUGHTER]

LASEWICZ: CCITT stands for?

MITCHELL: Consultive Committee for International Telegraph and Telephone. It's now called ITU which is International

Telecommunications Union, dash T for terminals, I think, dash R is for the radio. They used to be CCIR and CCITT.

LASEWICZ: So to follow on from the JPEG work, you have been..

MITCHELL: Well, actually I was in the committee for seven years. We joined in '87 and '94 is when I resigned. And during that time we got to write the agreements down and write the standard and rewrite the standard and write it over as we got agreements and got it changed.

In '92 a significant amount of time was spent writing the JPEG book. And part of the goal behind that was for people to get it right the first time. When you write a standard all you're allowed to put in the standard is basically what, not why, not watch out, not, you know, this is wrong.

And we were wanting to put some stuff in that we felt would be helpful to people. And I will admit the standard was already 200 pages. So maybe you couldn't put any extra pages in.

And they translated it into several other languages so it's a lot of work. But Bill and I went home from one of our editing sessions saying, we're going to write a book and we're going to put all the stuff we think needs to be in it. And that's what we ended up doing for most of 1992.

And then I was involved in trying to...by the way, I might mention that while I was doing JPEG, in '89 to '91 I went into marketing. I was in White Plains, I didn't have to physically move.

But it was a lot of fun being in marketing. And they were thrilled to get the latest information. I don't know if you know Image Plus? Okay, it's an IBM system. They did it jointly with the USAA which is an insurance company.

And basically USAA successfully went to the paperless office back in the 1990 timeframe. And it was, the work that we had done on the fax, on software I had provided some code that went out through most of IBM products. I can tell you the two products it didn't go into.

And we had an AT, a PC AT, in software, able to out-perform a host in a demo in New York City. And so these marketing people had kind of noticed us because of that. I mean, they love it when the competition demands you pull off the covers of this PC and they're looking for corrections and changes and they recognize the boards and there are no yellow wires. It's absolutely standard software. Because it's actually running faster than a vendor's board.

And so one of the things because of the teleconferencing, which is what this had grown out of, we had to make a Series

1 and they'd only had eight 16-bit registers. So, you know-- and it was the same CPU cycles as the XTs were when they came out.

And we were able to keep up with the phone lines and do our data compression. We'd learned to write kind of craft algorithms in very, very fast code. And so they had come to visit us, the Image Plus people, and the particular group that succeeded in making Image Plus happen, they had also sent some technical people to interact with us.

And they were basically off a factor of two in throughput, and they were trying to figure out how to make it go twice as fast. And I said, well, it's been designed to be split-table. If you do half in your card, what if you do the other half just in your PC? And sure enough, that was the missing factor of two.

So I had some interaction with these marketing people. And I was aware that basically trying to do technology transfer is really a sales job. And you don't learn a lot of good sales techniques in research. There are not a lot of people that are involved in that.

And so I was looking for a change to be honest because I'd had 14 years. I'd moved my office three times in 14 years, and remember, I'm the one that joined IBM because I've Been

Moved -- that's what I was looking for? And so I ended up going into marketing then for almost...it was originally a one- or two-year temporary assignment and I stayed almost three.

So when I came back from that...and by the way, I loved it. Marketing people know how to team, they're very social, they're very.... It was a lot of fun because what I did then was basically image education and the standards. So I taught them to understand what they were talking about.

But in the end, I found it just...I was often the only person in the world that believed something was possible. And if I didn't go do it, it wasn't going to happen. And so I went back, and I was involved in getting a team together to provide the JPEG code to the company and things like that.

In '94, that's when I took the unpaid leave. I was working on the MPEG book and I used that at the time to sort of stop and think, you know, for the first time in my life I had weekends truly free. I wrote five days a week and that's all I could stand. I was generally over at my friend's house, the co-author, at about 10 in the morning and I'd leave maybe at 10 at night.

His wife was a really good cook, and she was willing to cook and put a lunch and dinner together for both of us. But on weekends I didn't go. I didn't do any writing. And after

about a year we had the book mostly done but it wasn't ready for publication. And so I went and I taught at the University of Illinois for six months, and I traveled with my parents for like a whole month in the Canadian Rockies.

But when I got back to IBM I was ready to work again. I started interacting with Boulder then. They had real problems--one of them was, the JPEG code wasn't fast enough.

Well, I had done some prototype code during that first year that I was back with Raleigh, and so I took that code to Boulder, and it went six times faster so that you ended this debate of whether they could tell on a full color printer, this is the high speed printer, whether they could have a two by four or a four by six JPEG on it. And the answer was full page, stop fighting about it.

And so they ended up inviting me if I'd come out there on a temporary assignment again. I've been out there for the last four years, and I've now permanently transferred to Boulder.

But in the time that I've been in Boulder I've gone from my...I basically filed 48 patent applications in the last four years. Does that answer your question, what I've done since then?

LASEWICZ: Yes, and that ain't hay.

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MITCHELL: Well, what I'm really trying to do now which is really fun, you know, between the time you file a patent until it issues there's what I call the float? Well, that can be two to seven years. And think of the value of these latest ideas, you know, if no one's using them.

And so I'm trying to figure out how to make money in that time period, consult on IP, find people that want to license it. And they'll have to license ultimately from corporate because when it does issue, if it issues, then obviously they need to be protected already.

But that's been challenging, particularly in these down times. That's one of the things I'm trying to figure out how to do, is find users and outlets to take advantage of before [the patent] issues. Once it's filed you're protected, if, again, ultimately and hopefully it will issue.

LASEWICZ: Can you talk about the professional associations you belong to and what you see as the benefits of those, of belonging to one of those organizations?

MITCHELL: Okay. Well, I'm a member of IEEE, and it was almost a fluke. I can remember I was attending some conference and a friend of mine...it was an IEEE conference, saying, you really ought to join this organization. And I didn't consider myself an engineer. Remember, I was a physicist.

I joined in fact as a life member of the American Physical Society. I did that back when I was an under graduate and then carried it all the way through. One of the things about being a life member is you can't resign, so I still get the American Physical Society Physics Today, and what I've ended up doing by the way with the magazines is I donate it to the local library. And for a while I donated it to a local school. So I'm glad to get them and they're not being wasted.

I was probably two or three years into IBM when somebody said, you really ought to join IEEE. And I did. And it's often been the IEEE conferences that I've attended.

I give a talk called Lessons Learned Along the Way to IBM Fellows and another talk called The Importance of Giving Back and Reaching Back. And I tell people, you really have to give back to your professional society. Pick one, and maybe if you're in math it will be ACM or maybe it's computer science.

I remember the communications society of IEEE, because that's where most of the data compression gets published. But really it's important that you give back to the organization.

One of the things I discovered is that when I looked back after I became a Fellow, I see a very high correlation between people I met through the volunteer work. Remember I told you there was a time I was unhappy, and one of the decisions I made is I realized I was trying to hard to succeed. I was doing no volunteer work.

And so I made a conscious choice from that point I was going to do 10 percent volunteer work. I was a member of Sigma Xi, which is an honor society that's across all disciplines. And so I joined the local chapter and volunteered to be the secretary. Now, I didn't ask, but I kind of knew there was no competition for these jobs, so you were secretary, vice chairman and chairman. It's a three-year sequence.

And I met people because I was up there introducing and going to the...we usually had about eight speakers a year. IBM gave us the use of the auditorium, a discount on dinner so people could come and buy dinner, bring their families and go to an hour talk in the auditorium.

The general public was allowed in. And something happened in that interaction. I met people that later became key in my career, but you have just a different interaction if you've met them during volunteer work.

So I tell people, you've got to join a professional society. You've got to give back to your profession. And that's one of the best ways to do it. Does that answer your question?

LASEWICZ: Yes, that's perfect.

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LASEWICZ: Is eight minutes enough to talk about your mentors over the course of your career?

MITCHELL: Yes, probably.

LASEWICZ: Okay, why don't we do that. Have you had a mentor during the course of your years and if you have had one, how has that affected your career, and are you serving as a mentor yourself?

MITCHELL: Okay. My first manager was very definitely a mentor. Back then we didn't use those words, but we would join him for lunch maybe three or four times a week. And he

did a lot of sort of philosophical discussions about how do you make things happen in research, what kind of management environment do you want to create as a manager, how can you bring the best out of people.

When I went over into marketing my manager there was [Dave Liddell], and he was definitely a mentor. But when I came back to research that original manager left fairly quickly after I came back, and I was not aware of having a mentor. I didn't know enough to know you should ask people, and you may not want to ask them, will you be a mentor, but would you be willing to have lunch with me? I've got some questions.

And then if it clicks and it hits off, then you might formally ask them later. I went and consciously got a mentor in the ethical hacker team, because I was going to go transfer into that when I was done with what I was doing in Boulder in the image area. And that guy3(going)y3(goi0)-9 2h-602

She's mentored me ever since. Since then I've known enough to ask several people. For example, Helene Armitage, I consider her one of my mentors. What I tell people when I give talks is, you should have someone in your professional organization outside the company, somebody that's a peer, hopefully your manager, someone in the next job you're looking to get to, in other words, if you're like a senior engineer and you want to become an STSM, you should have an STSM as one of your mentors.

And I happen to love mentoring. I am consciously...I don't know how many people I'm officially mentoring; I don't keep track because if I did it might scare me. But I probably have at least a conscious mentoring session at least one lunch a week and probably two or three other sessions.

During the time I'm here, I'm having one when I'm done here; I'll be mentoring someone I'm officially mentoring. Another guy that I've been mentoring for about four years, I was supposed to be in this morning but I wasn't there after lunch as I thought I was going to be. And so I do a lot of the mentoring. I'm cons--...I made an offer to all the DEs and some of the STSMs on site that I would be willing to be their mentor if they aspire to get to the next level, and help them get there because there's not a lot of...I'm the only Fellow at the Boulder site.

One of my goals which I've written down is that I want to look back on my IBM career and be able to say I helped at least five people make it to IBM Fellow. Does that answer the question?

LASEWICZ: Oh, yes.

@@ [TAPE CHANGE]

LASEWICZ: I want to know what you'd tell somebody who's coming up just out of school.

MITCHELL: I've had a very good experience at IBM. One of my current mentors is Barbara McLain, she actually schedules regular one-on-ones with me, which is the first time I've ever had that happen, where somebody actually scheduled them regularly.

And it's very helpful, because I always have a full hour's worth of stuff to talk to her about. We schedule them every month and meet about every three, because our schedules are, you know, I'm out of town, she's out of town, something happens.

But what she said once in a panel discussion with other women, I was on the panel, she...someone asked, what do you do if you hit discrimination because you're a woman. And

you know what her answer was? She says, I don't spend one second thinking about it. She said, I just do my top notch job and I don't worry about it. I'm not going to spend one minute thinking about it.

And that's some of the best advice I'd actually heard, because you can kind of...if you expect it, it comes at you. You're very sensitized. Let me give you one illustration. I had not had any trouble in IBM. It never occurred to me I would, and I had grown up in physics, right, physics three percent women at the time, I was one out of three when I was an under graduate and I was three out of a hundred as a graduate student.

And so I got to IBM and I didn't see any trouble. As I said, they all shook my hands, I was impressed with the fact that they'd all switched fields at least once so I wouldn't make my career decision forever.

And like when I did the CCITT stuff, I was aware there could be a problem, but what I found interesting is when I got back from Japan, no one had suggested I shouldn't go to Japan and do the negotiations on the standard.

I got back and I had 15 phone calls of people dying of curiosity to know whether it had mattered if I was female or

not. But no one had even suggested the possibility before I left.

And so they, you know, they assumed I could do it. And I did. And that kind of support made a difference. But I had two friends of mine who were in an academic, one person had sued the New York State University and won a discrimination suit. They came down and visited me simultaneously for a weekend; we went to Boston together.

And you know what? Within the next week I hit trouble in IBM. And I decided, I found out that some other women were having trouble, basically they were going to the model shop and the men didn't know what to do with us. And I found it objectionable that when I took off my lab coat, which I used to keep my clothes clean, and they found out I was a Ph.D.-- their behavior changed.

I don't think there should be any difference, okay? And so I decided I was going to complain. So I told my manager there was a problem. And it just blew up so big, everybody was so worried about it. They were thinking that it was "dirty old men;" well, it wasn't. It was people that didn't know how to deal with young professional women. They didn't know what to do.

And so they would hover and they would, you know, make you feel uncomfortable just by.... And it turned out what had triggered my complaining is the guy had tried to put his arm around me. And I didn't think...I got mad about it, and I went in and told my manager I didn't think it was appropriate.

And so I went to see the model shop manager with my manager, I said, yes, I'm willing to go and explain it. Well, if you've ever had someone say, Joan, Joan, Joanie, talk to you at half speed in one syllable words, I didn't know how to deal with it, because that was the problem. He didn't know how to deal with me. But he talked to my manager, you know, normal.

And I went back to my office and, what am I going to do? He doesn't understand. And my manager stuck his face in a few minutes later and said, did you notice something? And I burst out laughing -- he had noticed. And I was very pleased the problem disappeared in the model shop completely.

They basically realized it was simply that these are professional women and you have to deal with them as professional. Just because your only experience has been with husbands and wives and daughters, it is not professional to use diminutive names if that's not what they normally go by.

And so, but I'm telling you, it took six months for it to calm down, but, the other women weren't having any trouble afterwards either. And it never was that people...they just did not know how to deal.

But I also found I think it was triggered because I was looking for trouble. In other words, I was sensitive to it, and that fear of how to deal with it brought it on. And that was sort of my sole experience.

But see, I'd been as an under graduate in physics, there was always one other female and she always left at the end of the year. I actually watched the guys gang up on the other females, seven people surrounding one person saying, you don't belong in physics.

And I'd observed this from across the room and I'd wonder, shall I go interfere? I thought, well, it's really none of my business. But when I looked back I went and...last summer is when I finally found an explanation to it.

I went to a conference, a one-day conference in Denver and there was a woman who had written a book, Deborah Benton, and the book is titled, Women Don't...Lions Don't Have to Roar. And she talks about how non-verbal communication is

at least 75 percent of communications. And she describes things like your posture.

And I came back after this conference, one day, having heard her for an hour...I bought her books, also, by the way, and highly recommend them. And was describing to my assistant and I just, you know, basically realized that I had been waiting for those guys to come after me and I wasn't going to listen to them. Well, they never tried. They can tell.

I had that confidence and therefore they didn't pick up on the uncertainty. My roommate who was one of the ones that left physics, she was unsure, do I belong? She went on to become an engineer and works for IBM now.

And so I think it's an awful lot of...when you carry stuff with you, when you have that chip on your shoulder, then you make it awkward for the other person, whereas if you just aren't going to give it any time, it's probably not going to affect you that much.

LASEWICZ: Well, you've approached that pretty much from the perspective of somebody working in a male environment. How about from a corporate perspective? You came on board the company in the mid seventies, kind of the heyday of equal opportunity, affirmative action.

Then, you had a period in corporate life up until diversity kind of emerged and revitalized that aspect. Has any of that trickled down into say the research culture or technology culture of IBM? Have you noticed any changes over the course of time?

MITCHELL: Well, see, I've been gone for the last four years. I was around when a group of us got together before it was acceptable to try and mentor, have sort of almost grump mentoring, we'd have lunch with some of the other women that were not very happy.

And I saw so little point in it being all women and I invited my manager, a male, and my co-manager, a male, because I saw it as people needing mentoring, although I didn't use those words, people that didn't have a clue why they weren't getting the equipment, why they were having trouble, because they just didn't know enough to know that they didn't know, and they weren't asking the right questions. They were just observing things that didn't look to them very fair.

Those of us that live through what we call the sledgehammer approach, have almost formed a bond, because a few years later asking us to form committees like this. I was probably an equal opportunity hire, and I remember only

hearing this from an outsider, and I was so mad and so upset that they'd hired me because I was female.

I don't know if it's true or not, by the way, but there was a very narrow window in which anybody got hired and it may have been because I was female. But I think I did a pretty good job anyway. But most of the time I don't think about it. I don't worry about it. I mentor equally men and women. I may go out of my way to help and encourage some of the women because there are differences I think. Women, you've probably heard this story before, that if a job opportunity has 20 criteria, the man will think if he's got three he's qualified, and the women will think unless she has 17 she's not qualified.

And we told that story at dinner, and the next day I had an opportunity to invite a female to be a sub team lead, and her first reaction is, I'm not qualified -- and we started laughing. She did a superb job. Sometimes you have to realize those differences.

LASEWICZ: Somewhere in the materials that I was reading in preparation for this you mentioned that you wanted to be the first IBM female Fellow. When did you start thinking like that, and was it something that when you walked in the door you thought you could become a Fellow or that a woman

could become a Fellow? Or was there something that kind of triggered this for you?

MITCHELL: Okay. Remember that time when I was unhappy and decided to give back? One of the ways in which I decided to give back is I went to the department secretary and I asked her, anybody need help, tutoring? I need to get my hands on a real live student, basically, because I always tutored informally.

And she said, what about me? And I said, what do you mean? And she said, well, they put us through training the week before Christmas four hours a day and no backup. We now have the terminals, and this is probably April, May, five months later. And they've told us if we don't learn the computer-- how to use the things like script, word processor--in a year they're going to put a black mark on our record and none of us can use it. It doesn't make any sense. I said, oh, yes, I can do this. So it took three one-hour sessions. We tried it during lunch and there were too many comments, because what am I doing in her office during lunch? So we stayed afterwards.

And what happened was, they had not explained the difference between input mode and editing. So she knew all the facts, she just didn't know why sometimes the word file showed up in her file and the computer didn't do what she was expecting.

She had no idea of where she was and when. So what I did is I made her close her eyes, I'd get her to some stage and say, now, figure out where you are and go to such and stage. If you're in the editor, go to the input mode, go back to CMS, go to CP, log off, log in. And she learned.

And once she could do that within a week she was doing more than I'd ever done on the computer. So she sent me off to the private secretary of a Nobel Prize winner. It only took two hours; I think they'd talked -- who sent me off to the semi private secretary of an IBM Fellow. This was in 1976.

I asked her what the Fellows did, and she described, well, they do what they want to do. I thought this sounded pretty cool, and that's when I wrote down, I want to be the first IBM female Fellow.

And as far as I can remember I didn't tell anybody about that goal for 20 years, but I wrote the JPEG book because I thought I needed to be a Fellow. You know, write a book, I made an effort to become an IEEE Fellow because I thought I had to be an outside organization Fellow. I was doing things in order to become a Fellow without even telling anybody that was my goal.

Now, Fran Allen became a Fellow about a decade ago, and I was thrilled. Okay? So I wasn't upset that I was the seventh IBM female Fellow.

LASEWICZ: Well, when Fran became the first Fellow, how was that received both in Research as, you know, who's the first female Fellow, and among fellow researchers, female researchers...

MITCHELL: Well, my manager and the co-worker who became my co-author on these two books for about 10 years before that they would check every year and said, have they made Fran a Fellow yet? And it was Fran Allen.

Now, I didn't know the Fran that they knew because occasionally they went skiing with her and we'd have lunch together type things, was this Fran Allen they were talking about, because if you've ever met Fran, she's just an ordinary, lovely gracious lady.

And so until she actually became the first female Fellow and I got introduced to her, I said, oh, you're that Fran Allen, because I just knew her as Fran, I didn't know her last name.

But I think everybody felt that it was long overdue. And I mean, she worked on the FORTRAN compiler, and she's

had...when she retired I think she had 45 years with IBM, something like that.

LASEWICZ: And she was over 30 by the time she became a Fellow.

MITCHELL: Yes, and just a tremendous role model. She encouraged me to think I could make it. So, I didn't...no one was saying you could become a Fellow because I didn't tell anybody that was my goal.

But I made a conscious choice to go off the technical ladder, which the Fellow's are kind of at the top of, rather than trying to go up middle management and the management ladder. I was a manager for many years, but as a first line manager in Research you're really doing full time research.

LASEWICZ: What have been some of your greatest challenges either on a personal basis or on a professional basis here at IBM?

MITCHELL: Well, when I first started standards, I had no idea what I was doing. I didn't know enough to know anything, which means others had to kind of rescue me, which turned out to maybe be a good thing.

But when I started JPEG I knew a little bit more about standards, and it was very...it was quite a shock to me to find anti IBM sentiment, okay? I found that difficult to deal with at first. I mean, to me we were there for the good of the industry, and you know, why in the world were they attributing all these things that I never thought of doing?

And it took quite a while to finally just say, I don't have to...they don't have to like me, but as I quit worrying about what they were thinking about me or what they were thinking about IBM and just focused on trying to get that good in hardware, good in software, good standard for everybody, people kind of converted themselves.

And I had not seen myself as a leader that much back then, and first thing that happens I become chair of the...one of the three committees to get a better algorithm out of it, the predictive group. And it was basically through the standards work, and we started a US standards body to be the counterpart, because there was always a counterpart and they didn't have one.

Who was going to decide the vote for JPEG if there wasn't a committee? So they started one, I was one of the initial people on it and I had to lead the meeting. And I found that the magic for me was to not have to do it myself but to

be confident that within the people present they could come up with the good answers.

And therefore, leading was more a matter of bringing the best out of them, and one of the things I found worked very well for me is that if there was a newcomer that came to...came to the US meeting, had gone to the international meeting and was planning to attend the next US meeting, during the meeting I'd pull him aside and say, look, would you be willing to give an hour report on such and such a topic? Technical topic, to the group?

Well, they'd love it, because it's getting them exposure at the US level. Now, usually, interested in coming because they have products they want to get out, and so making those networking connections and getting that prestige that comes from being part of the agenda, well, now I don't have to do all the work. Do you see the difference?

And so it was making that transition from, I want to do it myself to I don't have to do it myself as long as I can get someone else so that you can bring the best out of them. That wasn't easy for me but it did happen. And now I much prefer to stay on the sidelines and cheer.

LASEWICZ: You've had an incredibly productive career at this point and produced an awful lot of work. I imagine

that's been an issue for you in terms of balancing work and your personal life. How have you been able to do that?

MITCHELL: Well, life balance wasn't talked about my first few years in IBM, and I used to, up until my manager demanded it, I used to assume that I would donate Saturday. That was our fun day, no phones ringing. So we'd come in maybe by 10 in the morning; we'd leave early, like about six, and we'd get a week's worth of research done. It was a lot of fun to come and do real fun research.

But when we started having to write papers and as I said, the day my manager demanded I come in and refused to pay overtime for it is the day I've tried very hard not to work Saturdays and Sundays.

And when I went out to Boulder, I consciously was looking for alternatives so I wouldn't be tempted. And so what I did is I ended up signing up for scuba, and I am now four years later a dive master.

And so again, I would help out in the pool sessions as part of being like a dive master and went through rescue diver. I have a hobby of teaching people afraid of water how to float. And right now I'm teaching a five year old how to float. And he can actually float now in a small pool; he just isn't so sure about the four foot water.

And so I've always been active in church, I always kept at least Sunday morning free. I never let anything overwhelm that. But it was really only after '96 that I tried to keep weekends free to do other things.

I think you can get kind of...work fills whatever time you allow it. And if you allow yourself, well, I can do that tomorrow, guess what? You do it tomorrow and it gets...you know.

But if you say, I've got other plans for tomorrow, then you're more likely to get it done today. And the hardest part for me is saying no. And I still am working on that. Sometimes it's just not your job to do, and so you have to let someone else go about having that opportunity. But I get some balance by just scheduling something that's a lot of fun like being in the water. [LAUGHTER]

LASEWICZ: Well, if you had your druthers would you go back and have adopted that no weekends policy prior to '96 or was it just not the right time and place to do that?

MITCHELL: I suspect that new hires have to do a little extra in order to, you know, when you're trying to learn so much and produce. I don't know how I could have done it.

One of the things that was very important is I got myself off a regular schedule. I set my alarm on Sundays to make sure I make it to church, but I usually don't set my alarm, I try not to set appointments early in the morning. And so I go to sleep when I go to sleep and I wake up when I wake up, so that I get normally almost eight hours sleep a night.

And I have what I call I can't sleep for the good reasons, which is, I'm so busy inventing that I can be up 10 or 12 times the night. And maybe about six o'clock I'll finally sleep 'til noon. Okay, so I get the sleep but meanwhile I've had a pretty exciting night, because something's been clicking and happening, and I'll get up and write it down.

And so that freedom to set my own schedule means that I can work when I'm most productive. But I've always, another thing I mentor people on, I've always taken my vacations. I may come back early, but I've never canceled a vacation for work reasons. I schedule them sometimes a year in advance, put them on the calendar, and I don't budge.

And as I said, when we...I was scheduled to be canal boating in England for a week and then traveling around England

alone for a week and I went for the first week. I came back and skipped the second week. And that's when you could go standby and not have to pay any penalties. But I went.

And my co-author, the person I did JPEG with, I don't know if his wife ever forgave me, but what she didn't understand is that I had the energy to put in that last few nights of all nighters and to get those, you know, things mailed out on time. We made the deadline.

But you know, at two a.m. in the morning a guy working with us discovers we've got a bug in our code and we have to ship it by four the next afternoon, I had the energy to work with him. We got it solved and the code worked flawlessly. And there have been a lot of those, you know, last minute crises. I used to kind of generate them and I try very hard not to generate them now because it's not fair on the people around you.

But I kind of thrive in pulling off the impossible at the last minute. And so but I think it's more efficient not to work so hard because you basically get burned out, and then you don't get any work done. So I try and be a little bit more uniform.

LASEWICZ: Or the quality suffers?

MITCHELL: Yep.

LASEWICZ: In terms of looking back a little bit, you have a Ph.D. in physics and a strong background in mathematics. Has that training really come to the fore during the course of your career, or did you move beyond that?

MITCHELL: Well, except for that resistive ribbon modeling, I've never consciously used the physics that I used in my thesis or the math I used in my thesis. I almost never go even into calculus. It's algebra, it's high school algebra that I use in terms of math most of the time.

But what I have used is the model making. What is physics? You take this messy real world and you try and figure out how to ask a question that you can measure the answer and learn something.

Well, what is data compression? You take this messy data, real stuff, and you try and figure out how to model it so you can get better compression. You can mimic what's actually happening in the real world.

And basically remember I told you I spent that...I spent a weekend, learned how to use FORTRAN, at the end of the week I had evidence that I was on to something and I never looked back, they literally put my ultra sonics into storage at the

end of the month and it never came out again. I had switched fields even though I hadn't intended to. It suited me. It's that model making, asking questions about real data and seeing if you can learn something from it.

And that's what I learned in physics. Also you learn how to solve very big hard problems by chopping them up into very small manageable steps. And so I think physics was a fantastic training in dealing with problems, problem solving.

I love solving real problems. I might mention by the way that I think I'm different. I often invent, I see in pictures, and I can know an answer and not be able to do the math. In fact, with Bill Pennybaker, my colleague, I can remember the day, it happened to be a Saturday and I was leaving town on vacation, I was trying to get stuff done.

And I announced to him when he stopped by, (I think he was my temporary manager at the time, but I'm not sure about that part) I announced to him that I'd figured out the equation that represented some question that we had about data compression.

And it had one over R, and R was the radius of something, and logs in it. And he looked at me like I was an idiot and said, what do you mean? He said, I'll prove you wrong. Well, a few hours later he had derived that equation. And

throughout the rest of our career there would be times when I'd tell him, this is the answer. I know it. I mean, I got it in the shower. I mean, this is the answer. I've been thinking about it for three months, and this is right.

And he'll look at me and say...and I say, why don't you prove me wrong? Well, most of the time he proves me right. And it's fun, but it took a long time to trust that instinct, and it is intuition. And one of the things about Boulder is that they believed in me, and they encouraged it and they had faith in me.

And so I literally gave myself permission to work less hours and try and work on more important stuff. And so I would, like, not show at work for...because I'd be home inventing and typing it up and turning it in. And it just, that freedom, I thrive in it. But with positive feedback loops.

LASEWICZ: Would you say that sense of problem solving has been a common thread throughout the course of your career here?

MITCHELL: Yes.

LASEWICZ: Are there any other common threads?

MITCHELL: Well, I was going to say, I made a conscious choice that I would rather solve a practical problem that

nobody knew I had done it but made a difference to the world than to win a Nobel Prize that nobody ever used the stuff. That was a conscious decision back around graduate school time.

And I can remember with the resistive ribbon thermal transfer, when that Quietwriter typewriter came out, I was walking behind somebody and I don't even remember now who, but I overheard them say, it is so nice to have it quiet in the office, you can think. And I remember thinking, yes! That's what I'm up to, making a difference to real people. And that's been a theme.

It's got to matter to somebody or else I lose interest. And so I try and do too much, quite honestly. I make sure people know I'm not going to actually get it all done, but I will get done that which mattered to somebody else.

And so it's the problem solving. It's real problems where if you solve it, it matters. And by the way, another talent I've discovered is that I can help research because I can pose the problem in such a way if they solve it, we can use it. And that's fun. I did a little work, figure out what the real problem is and what the deadlines are and make sure Research knows that.

And then they get to shine, because you know, I mean, I can remember one particular case they were working with [half toning], and they had a size that was too big and they wanted to go bigger, and I basically said, you do that and I guarantee you will not use it. Huh? I said, look, we can't change our hardware. You have to be this size, which is half of what you have right now. You know, in two weeks later they had it.

And so it's getting them, you know, getting them, communicating with them so they know what's going on, what the deadlines are and what the real problem is, defining it in such a way that if they solve it, we can use it. That's one of my talents. And that doesn't take a lot of time but it sure can have a lot of leverage.

LASEWICZ: Looking back, you've touched on a lot of what you consider your successes, the [fax] standard, the resistive ribbon, JPEG, MPEG. Are there any other successes that you would rank up there or close to those levels?

MITCHELL: Well, our internal teleconferencing system. And now that I'm out at Boulder there are lots of things that are happening but I can't tell about them because most of them aren't issued yet.

But most of the inventions are bigger than just Boulder, and that's fun. In fact, this morning I was sharing with one of the people here, and I mean, he's just really excited about it because I can solve a problem he has.

I might mention, I've always formed teams. I'm less interested in working alone. I really find that I need interaction with people. And in Boulder I've been able to form quite a few teams. In fact, what I've done now is I've gotten official permission to form teams with some of the newer hires.

We work on a problem that we both are interested in, and what I tell them is you have to drive it. If I have to schedule then it's not going to happen, but if you drive it, you can come talk to me, I'll act as a consultant, and you can shine. And that's been a lot of fun.

So right now four of those are taking off. And they're happening. And some of the stuff I was sharing today, earlier today, is in fact being done with someone who's wanting to change her job. And she's definitely a researcher type person.

And together, I mean, something I've been wanting to do for two and a half years, she's been working with me less than three months and we've cracked it. And it's going to

product, it's the...we don't even turn the invention disclosure in and the attorney's already sending me the claims, that kind of big answer that you know is bigger than just our particular problem. It's a lot of fun.

LASEWICZ: I bet.

MITCHELL: Yeah. And that positive feedback gets me to work harder, and it's happening because we're interacting. Something happens in that interaction that's better than I can do alone. In fact, Paul Horn paid me a compliment one time, which I really appreciate. I used to call myself matchmaker and marriage broker. Physicists don't like those terms.

But he described it about a year before I became a Fellow, he said, Joan, we've figured out what it is about you. You're a catalyst. Better things happen when you're around than happen when you're not around. I love that definition.

LASEWICZ: Yes, that's quite a compliment. Okay, I've covered pretty much all the questions that I wanted to cover, and I thought I'd wrap up by just asking if you had any further insights or experiences that you thought might be relevant to the topic of what people should know.

MITCHELL: I have one thing. I actually put it in my Christmas letter this year. I am getting more and more convinced that non-verbal communication is important. This is something I was mostly oblivious to, okay, except maybe intuitively I'd pick it up.

In different ways this last year I've seen the effect and the difference it can make what you think about the people around you, may actually have a bigger influence on them than what you actually say to them.

I mean, if you walk into a room you know if somebody likes you or not. You can tell if they're hostile or not. Well, what if your opinion of your colleagues, and sometimes it can be pretty negative, you know, you're asking them to fit some mold that would make you happiest, may put them in a negative position, well, are you helping to bring the best out of them?

What you think about them, is that putting them down or lifting them up? Because the more you put them down you're making it harder for them to succeed, to shine, to be themselves.

And I'm getting more and more convinced that our job is to do the...be the best that we can be and to help others be the best that they can be. This is kind of a philosophical thing, but that lifting up in your thought.

And I came across a quote that kind of expressed it well. Someone said, I'm in the credit business, giving people credit for what I think they lack and on the basis that maybe we all have the qualities we need as a reflection from whatever we call God.

But it's because if we are in fact spiritual then any time that I'm bearing witness to something not very good, maybe I'm helping to put you in the box that's hard for you to get out of, and maybe I want to lift you up a bit in my thought and help you become the best that you can be, and I'm getting more and more convinced that that may be the most important thing, it's what you think may be more important than what you actually say, because people can tell even if you never said it in words.

And so watch what you think about the people around you. That may be determining their experience more than we sometimes acknowledge. I guess that's my last word on it.

LASEWICZ: Well, thank you.

MITCHELL: Thank you.

LASEWICZ: I have a question. Having been here for 20 years and having worked for the company about seven years,

one of the things that I find amusing are the TLAs, the three letter acronyms, or the phrases that we come up with, or the vernacular idioms that we have in the company that I think are kooky. Do you have anything fun that you can share that...because I know Research uses them all the time.

MITCHELL: Well, I'm someone that can't remember what they mean, okay?

LASEWICZ: You're not alone.

MITCHELL: You'll notice that I didn't use an awful lot of them, because I can't remember them enough...I mean, there's a few, but I've also...it's a foreign language practically.

So I tend to avoid them because it's kind of a way of...I think it may be almost in tribes that you want your own kind of language so you feel a part of things, you're in the know.

LASEWICZ: It's the club mentality.

MITCHELL: Yes. And I think that it tends then to want an "in group" and an "out group." And for much of my career I thought I was in the out group. We used to call sort of Research politics the little leagues, the dog and pony shows, looking good to Research management.

And we used to call getting products into customers' offices that made IBM money the big wigs. And I at one time thought that we were always, the, you know, the less favored, we didn't play the game of slots and modules consciously. It was a conscious choice not to play that game.

And so we used to describe, we'd go tin-cupping around the company asking for equipment and in turn we could give them what they needed, okay?

Well, after I became a Fellow I looked back and I realized, you know what? It sets up the dynamics completely differently if they've made a decision to invest in your group, to give you the equipment you need because you can't get it from Research, or you're not willing to do all the work it takes to justify it, et cetera.

They made a decision that they want you to succeed. And that's why so much of our technology has kind of slipped in. Do you remember the old 3270 879 terminals? Okay, they had programmable character sets, right? Okay, that was the first example of using e-mail to invent.

The guy called me on the phone from England, Peter Kwaranden. We talked 15 minutes, exchanged e-mail addresses, and then he sent me data and we just e-mailed each other. I met him years later.

And he had designed a special thing for pie chart-type graphics. And I looked at the thing and did some data compression, ran some experiments on his data, and I came up with an absolute general purpose, it would do anything, and basically saying, you know, things came in at that time 9 by 16, so there were three...every third or every second one, there was probably a pattern to it.

And so you just sent a bit saying, it's the same or different. And if it's different, then here's four bits to tell you which ones are different. Including all of them, and then I'll just send you the different nibbles. Okay?

Well, as he described it, it was one-third the CPU cycles, one-third the code and the general solution. And better compression, by the way. Well, I never even knew that it got in until two weeks before the product shipped, they wanted to file his patent applications. The first time I knew it actually happened.

But what happened was, he was the guy that had to do it. He did it. You know what I mean? And it was anything that was official. You know, we were just having fun. I mean, you give me real data and I'm looking to see if I can figure out something about it and send you the suggestions, and he put it in.

And then I never heard, so I forgot about it. But that dynamic that happened, and I went up on my unpaid leave, I had a quarter time job up at Burlington so I'd go up usually one week a month, often hitting the weekends so the developers would be free to work with me.

And think about it, the manager has decided to spend money, and these were pretty tight times. Their incentive to prove they were right, totally different dynamics than Research pounding on the door trying to do technology transfer.

And so this ins and outs, you know, the out group, that that meant we didn't focus our time and energy on trying to be in with Research. We focused on the bigger IBM and became in with them.

And so when I got into the IBM's Academy of Technology, I was astonished. I basically had worked with almost 100 people in it through the 25, 27 years at that point, and I was flabbergasted. Many of them I thought had left IBM because they had switched fields, and so they had dropped off my radar screen.

But it was really fun. I mean, it was like old home week. One guy, he'd come in his first six months in IBM he'd come here for two weeks to redesign, when we got the [fax]

standard, well, it wasn't exactly what we had proposed. We had chips that we had designed and we had to do a redesign, so I got people from Charlotte, he came from Fujisawa, later became Yamato.

And two guys from Boulder and two of us here. And in two weeks we redid a year and a half's worth of work. Well, I'd seen him two or three times as I'd been in Yamato over the years, and then he meets me, he's wondering if I.... Of course I remember Yanigasawa, so how could I forget, you know. Maybe it was back in 1980, but you know, you just don't forget things like that.

And so it put us on the inside in technology transfer. And I've always found that fascinating, that in fact we were being blessed and we thought we were being pretty much, you know, left out of the goodies. But totally different dynamics. Does that answer your question?

LASEWICZ: No.

MITCHELL: Okay.

LASEWICZ: But you know what? It was a good answer.

MITCHELL: [LAUGHTER]

LASEWICZ: One of the things I've found in going to meetings, prior to joining the company, you'd always go to a drug company or you'd go to another technology company and they'd be throwing out these, you know, the JT5, and the X95, and whatever it was, all the TLAs and all these numbers, and they'd do it as a matter of fact, like a club, like you said, like calling baseball acronyms.

And I know that sometimes that's tough for women because joining a team is a little different...

MITCHELL: Yep.

LASEWICZ: ...for women than it is for men. But I've always found that that's one of the most important things I enjoy about doing this part of the business is it is a team effort, you can't do it by yourself.

MITCHELL: Yep.

LASEWICZ: So, that was one of the hardest things [about] career development for people to understand was that yes, being a part of the team is critical, but you have to be accepted by the team.

MITCHELL: Yeah.

LASEWICZ: And to be accepted by the team you have to use the TLAs, the three letter acronyms.

MITCHELL: Well, I used to basically...I actually had this image that I was creating an underground. These were the doers, they weren't playing the political games, they didn't have time. They were trying to make real things happen.

For example, back in the mid eighties I used to always make sure that I'd talk to a person's manager and that they would agree the person could work with me, [now] you couldn't get fired, right? It was official permission.

But then we'd just go get it done so fast. And I can remember that one of the estimates people, I'm really bad at estimates. I always forget the factor of two from the interrupts. I just really...I mean, how do I...how can I predict how long it's going to take to get the necessary breakthrough we need?

So I'm bad at it. And so what I learned to do is I said, look, let us work a month together and then your person can make the estimates. [LAUGHTER] Okay? And it would get done because they get trained, I had working code, they'd get it into their system, it would all be done. Or we'd be so far along that nobody wanted an estimate, it was obviously going to happen fast enough. So.

LASEWICZ: Is there anything you wanted to work on that you didn't work on, a challenge that you would have liked to have had the opportunity to work on?

MITCHELL: Well...

LASEWICZ: Like the space shuttle or...

MITCHELL: I never wanted to do that. I made the mistake and I learned from it, thank goodness. I once walked into.... A person that had been my second line manager had become my direct manager. Okay? And this was in the middle of working on the CCITT stuff. And I was so enthusiastic because I thought I had a breakthrough of an idea in error correction codes.

I walked into his office and I allowed him to kill my enthusiasm of that idea. And this is back in 1978 timeframe, when I moved to Boulder, I pulled the two particular notebooks in which I'd written down the idea...I mean, I actually had a proof of concept that it would work. Okay?

And in one hour in his office I walked out and I never worked on it again. I took those out and took them with me to Boulder thinking I might work on them. I actually did work on something, I've never submitted it as an idea, I

actually came up with something I think is actually better than what I did back then.

But I've never done that. And that's the last time I gave anybody else that power, because I let his sarcasm, his saying it's not important, stop me. And I just said, and that's the one thing I've regretted. I haven't given up that I'll never do it, but I've never followed through on it.

But most of the time I...once I made a decision I was going to dance in the halls, I basically also made the decision that if I was going to fail I was going to fail on stuff I believed in. And so I got pretty stubborn. But nobody really tried to push me in the other direction...I mean, they loved it. They loved it. They gave me an award a year later, a whole year before I thought I'd be ready for that type stuff.

They loved...and in fact they've been pushing me, trying to get me to fight back, and I am not a fighter. I'm not comfortable, I don't like that. And so it wasn't until this particular individual finally went right into the space that...ultrasonic space that I knew cold. It was in the...he was a physicist by training too. Okay? He was very glib.

By the way, he...I could tell him an hour and he would in five minutes just beautifully tell me what I'd said in an hour. I mean, really had a talent there. But he could also basically say no and 95 percent he'd be right and you'd never know about the five percent.

But I had to just make a conscious decision, I'll fail on my own decisions. Otherwise, you know, you go through the rest of your life regretting all the stuff you didn't do. And that's the only one I remember, because basically from that point on I didn't hand anybody else that power. I didn't let him do it to me.

I killed my own ideas. And I have killed my own ideas. But no one else is going to kill them for me. [LAUGHTER]

LASEWICZ: That's great.

MITCHELL: Okay?

LASEWICZ: Terrific.

MITCHELL: I'd like to thank both of you. This has been very painless.

LASEWICZ: Well, good, we try to make it painless.

[END OF SEGMENT]