# Dr. A. Michael Noll

Interviewed by

**Tom Abram**

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Via Zoom

*Welcome to the Archives of IT, I'm Tom Abraham, the Director of the Archives of IT and er, we are here today on Zoom, as, er, as most of our, erm, interviews are recorded these days, er, in light of Covid.*

*Now it's April the 13th 2022 and I'm going to be speaking today to Michael Noll, who is Professor Emeritus at the Annenberg School for Communication and Journalism and was, for a period, the Dean of that very prestigious school. Er, he-he has some notable, erm, achievements in-in-in a long career, erm, I guess he's been, er, working in technology, working, and writing about technology for over 60 years now, erm, and is particularly noted, er, for, things like, erm, the, erm, er, the-the work that he did on tactile communications or haptics erm,. The, erm, the pioneering work that he did in computer art, erm, but I suppose more mainstream, erm, I-I guess, Michael, you're basically a communications guy, aren't you?*

[00:01:29]
Well, it's hard to say because you know, looking back at my career, I've always jumped around, I-I-I've never really spent much time, well, the longest amount of time was 25 years at Annenberg school, but before that, I mean, Bell Labs doing speech research, human factors research, graphics research, tactile research. Er, a few years in Washington, er, working with computer security privacy and negotiating a science agreement with the Soviets. I mean, th-th-those were… Then marketing at AT&T, getting involved with video text, Teletext, also to new services, picture phone revisited and all. But usually, very much a human factor, always looking at the human dimension and trying to understand that better.

Then I got involved in teaching technology to non-techies. I mean, my general sense was that people going into business or communications should have a basic understanding, a basic literacy of the basic principles of modern technology, particularly electronics and computer technology. So, those were the things, a lot of it, it certainly hinged around communications and all but--

[00:02:45]
*A diverse career?*

[00:02:49]
But very diverse, very—a bunch of... I mean, I've always been jealous, you might say, of scholars who can pick a field, an area and just stay within that for their whole lives, I-I-I've never been able to do that.

[00:03:04]
*The connection between us was made by Bill Dutton.*

[00:03:08]
Yes, indeed.

[00:03:10]
*So, how do you know Bill?*

[00:03:14]
Oh, I know Bill because of Annenberg, the Annenberg School. Bill was a faculty member there and, erm, somehow, I don't know, he might have heard of me and he was instrumental in getting me to come to the school.

[00:03:29]
*Alright.*

[00:03:32]
And then we were colleagues for many, many years and became good friends too.

[00:03:37]
*Can I take you right back to the beginning then, because erm, I-I think you were born in 1939, erm, in New Jersey, were you not, Newark, New Jersey; what-what was Newark, New Jersey like in 1939?*

[00:03:57]

Well, the first thing is how you pronounce it. Er, we, who were born there pronounce it one syllable, Nork, as if it was like snorkel, Nork, Nork, not Newark, Nork, one syllable which is the cute-the cute way of doing it and all. Erm, back in the 40s and 50s, Newark, New Jersey was called the centre of New Jersey, er, large insurance companies were there, Prudential and many more, a great museum was there, a great concert hall was there, great shopping, buses galore, people running around the whole city, it was an exciting place, very much so. And of course, it was near New York city but Newark had its own culture, its own sense of being, so, it-it was an exciting place.

Wonderful schools, er, I went to school there, grammar school, er, high school, a great high school, in Newark. A great engineering school, Newark College of Engineering, still there, still doing a great job, great educat… Still, the wonderful thing about Newark is it's still a great education hub, wonderful institutions there, Rutgers has a major campus there, Seton Hall Law School is in Newark, a lot of wonderful things still there, going very, very well for the city.

[00:05:16]
*So, do you come from a line of scientists and engineers, er, what-what did your parents do?*

[00:05:23]
No, no, no, my parents did not graduate high school. Erm, my father was a carpenter, a builder, my-from-from, er, from my father I think my interest in engineering probably came, building things, making things, he was always doing that. Er, my mother, er, very much, she was a secretary/typist type person, a writer. So, I think my sense of writing came from her. So, my sense of making things came from my father, my sense of writing, probably came from my mother. And they both valued education, so, I was their only child, so, obviously, they very much cared about me getting a good education.

[00:06:05]
*But what-what did they have to do to achieve that, was-was that public education, or erm, private education?*

[00:06:11]
Well, it was private education, my-my mother was very religious, you know, all the family was very religious, so, I went to my-my grammar school was taught by nuns, the Sisters of St Joseph.

[00:06:23]
*Yeah.*

[00:06:23]
My high school was taught by Benedictine monks, some of whom came from Hungary because of what had happened over there and all. And erm, s-s-so it was that kind of a background. But the places I went, the teachers cared a lot about teaching. They cared a lot about people learning things and-and-and all. And erm, my parents, I guess were strict and I was expected to study and take things very seriously and all.

[00:06:51]
*Yeah.*

[00:06:50]
Part of that, some things happened which were interesting which I thought, in high school, one of the Benedictine monks for some reason, well, I think it was a Latin class, decided to play classical music. Now, what that had to do with teaching Latin, I'll never understand, but that got me interested in classical music, which has always been one of my major loves ever since. I don't play any instruments, I-I don't know, but I'm always a critic, so, I ended up for a number of years, having a column in some local, erm, newsletter here, er, reviewing classical music concerts in New Jersey, and sometimes in California. As a matter of fact, I wrote a review, er, of the Disney Concert Hall, the new concert hall out in Los Angeles, which I was extremely critical of the acoustics. Apparently, the only negative review of that hall. Nowadays, it's been more accepted that there were indeed some problems with the hall.

[00:07:49]
*Yeah. So-so, from the-the grammar school, you went on to, erm, er, study electrical engineering, was it?*

[00:07:59]
I went to study electrical engineering. At one time, I thought I wanted to be a nuclear physicist until I remember reading a book about the horrors of the bombs that were dropped on Japan. And when I saw the horrors of what they did to people, that was it, I want nothing more to do with that field. And then, because of my interest in classical music, I started to get an interest in hi-fi, high fidelity, audio, something very important over in your country, where so many important things went on in that field. Wharfedale loudspeakers a lot of wonderful innovations came from the UK. So, I got interested in hi-fi and I became a salesperson, working in a little local store, in Newark, New Jersey, when I was in high school, I started that and that continued on through college. And then that led me obviously, into audio, sound, electronics, and loudspeakers and that led me into an interest in hi-fi and audio and sound. And now, obviously, Bell Labs, 'cause that's where all that kind of research and work was going on. So, my career objective in college was to someday get a job at Bell Telephone Laboratories, in New Jersey, which I finally did.

[00:09:11]
*And, s-s, and-and somewhere along the way, you-you did a doctorate, you got a PhD.*

[00:09:18]
Well, Bell Laboratories, back then brought in a lot of undergraduate engineers and put them through their own in-house master's degree programme. Now, the professors came from New York University but were bussed to Bell Laboratories at Murray Hill, New Jersey and that is where I got a master's. Then after that, I felt I should probably continue on, so, I, in essence, went and got a doctorate at night school, from the Polytechnic Institute of Brooklyn. You know, that was a hard job, doing a full-time job at Bell Laboratories while taking courses and things of this variety, and then deciding, what do I do for a doctoral dissertation? That became the tactile project, the man/machine communication feely thing, and that was my doctoral dissertation at Brooklyn Poly and also, an important piece of work, I realise now. It was… Back

then, the term haptics did not exist, I mean, that-that, I mean, that-that wasn't what it was called and, er, that project ended 1971, when I got my doctorate and all, and erm, and a patent, an important patent on, in essence, broad enough that includes the whole field of what is today, concerning haptics. The idea of touching something, feeling something that doesn't exist, being able to bump into something and feel around it. Ultimately I wanted to hand in something so you could grasp, but as I said earlier, after a while, I got bored by the project and went on to other things.

[00:10:54]
*So, you-you-you started working with computers, I guess around 1960?*

[00:11:06]
*Well, the first computer stuff I did, was erm, well, two things actually, one was a summer job at a-an insurance company, Mutual Benefit Life, where they were converting from punch cards to an IBM electronic computer. So, I was, er, it-it-t was a menial task of sorting things and getting things ready. Er, but then, in college, they had a computer with punched tape to programme it, and I remember writing a little programme for that computer, so, that started to get me interested in it. Then, when I got to Bell Laboratories and discovered Fortran, which was so easy to use, er, and I started using and writing programmes in Fortran to do data analysis at the job I had at Bell Labs, in the Human Factors department, and that got me more interested.*

*Then, I had a summer job working in the research part of Bell Laboratories that exposed me more to using computers and programming them to analyse and simulate various electronic devices and things.*

*[00:12:06]*
*So, what-what sort of computers were you using then?*

[00:12:10]
Well, the one at Bell Laboratories was an IBM 7090 and 7094, a very, very large mainframe computer. And associated with that, they had a high-speed printer which had a [unclear 00:12:21] and the electron beam went through shadow masks, to-to, in

essence, it was considered a printer, but also, could do graphics. So, now, I could actually use it, rather than sitting with tables and numbers and manually plotting things, which is the way things got done then. I'm very graphical, I have to see things, so, now, the computer could be programmed, and the graphical output could be looked at and that got me into this whole world of computer graphics. Back-back then, we called this area of communication man-machine communication. I guess nowadays, you're not allowed to call it man, but we meant humanity by that, we didn't mean… There was no sexism intended back then. That got me going into that-and that got me into, on a summer assignment, somebody's programme went wild and that's when I started doing elements of randomness and graphic things to start doing computer art.

[00:13:18]
*Yeah. Well, shall we talk about computer art then since-since we're at that point and you were showing me your-your picture there? Erm, so, erm, yeah, I mean, y-you're a pioneer of computer art and, erm, I-I haven't thought about this much, er, before-before I read about yourself and talked to one or two other people about computer art. But, I mean, what, erm, what was it back in those days, I mean we're talking, what, 1970-ish?*

[00:14:02]
No, no, no, this is early 60s now.

[00:14:05]
*Alright.*

[00:14:06]
It's actually around 61, 62-62 timeframe, mm-hmm.

[00:14:10]
*So, what, erm… Well, I suppose the-the-the blunt question is what-what kind of distinguishes a piece of computer art from something that somebody has plotted, erm, on, you know--?*

[00:14:27]
Well, the computer is just a medium so, it can be programmed to do anything, but this was not interactive, so, this was, nowadays, called algorithmic art, where you would write a programme, maybe have some computations that looked random and mathematical and do graphical types of things. But back then, we always had to put an adjective in front of the word computer digital because they were analogue computers back then and analogue computers were being used to do artistic patterns too. So, this was the idea of using a digital computer to do this was somewhat innovative, a new some-a new approach and all. You know some things could be very, oh, graphical, er, an example would be a pattern like this which is Brigit Riley op art thing, which is very mathematical, so, you could easily write a programme to produce those kinds of patterns and things. And back then, this was a period of abstract, very abstract art in the 60s in the period of time too. So, op art, abstract art, and this was just a natural for the computer, digital computer.

And-and-and you know, again, er, I had some art classes in school and college and certainly back in high school and I would certainly visit various museums in New York City and the area, so, I had a sense of that and all. So, seeing the potential for this new medium, and also, at Bell Laboratories people were doing computer music so, people were [unclear 00:16:01] the idea of computers and music composing, making sounds. So, the natural to that is let's look at the other area of art, visual arts. So, the idea of computers and the visual arts.

[00:16:15]
*Yeah.*

[00:16:16]
And my idea was to do things, make things that was fun, interesting and write about it to expose others to it. It was the idea of educate others and all. I-i-it was an exciting thing. And then, my colleague Béla Julesz at Bell Labs, er, was doing things about 3-dimensional stereo and I got into 3D things, stereo, using the computers we'd do these left and right eye images that would look in-depth. And erm, a-a-a-a fella in New York, Howard Wise had a gallery on West 57th Street. He saw what Béla was doing,

some of Béla's random dots, stereograms, and he invited me and Béla to exhibit our works at that gallery in 1965, which was again, exposing a lot of people and trying to educate others to the potential of this new medium and what you could do with it.

[00:17:14]
*So, have you-have you practiced other kinds of, erm, visual art, you know what I mean, like painting, or erm, er, drawing, or, er--?*

[00:17:26]
Well, certainly, I was doing those things back then too, er, also. A-a-as a matter of fact, at one time, I actually considered taking courses in art at New York University, I thought that might help me in terms of what I was doing with computer art. In the end, I decided, wait a minute, I'm doing something with an entirely new medium, why do I have to learn about the old media of the past? So, in the end, I dropped out of that idea.

[00:17:53]
*So, I mean, there-there-there's more to, erm, the role of the computer in this computer art than, you know, a-a-a fancy brush, so to speak, isn't there? I mean it's--*

[00:18:06]
It's much more, it-it-it's something very different, this was not interactive back then, you-you know, this was programmed and all. Er, I remember seeing a ballet performance in New York, er, Stravinsky's Apollo, Balanchine's version of that. And the inter-relationship of the dances, dancers, gave me the idea of using stick figures and I had actually programmed a little computer-generated ballet, it was originally in 3D there is a 2-dimensional version of it. The BBC did a very fine documentary about that, I think that aired in 1968, a very fine documentary. But the idea again was to interest choreographers, and dance groups and the possibility of also getting themselves involved with the computer to help during the creative process, to help inter-relationships, looking at things, simulating what things might look like stage and all. Now, that, er, those ideas, erm, are now decades old and I don't think have been picked up on very much, the idea of computers and dance, that's, er, still a fresh topic area for research and innovation.

[00:19:18]
*What about AI's role in all of that artistic stuff, I mean, a-a-are people, are people harnessing artificial intelligence to, erm--?*

[00:19:31]
Well, I've never figured out what AI meant, the-the term is back in vogue again, but it was interesting as the term was in vogue in the early 60s too. I mean, is-is-is-is-is it just an old thing and all? John Pearce used to talk about artificial intelligence versus the natural stupidity of humanity, he-he thought the two went together. So, the computer had artificial intelligence, humans had natural stupidity, er, er, John used to love these plays on words and all. Erm, I don't know. One of the first publications I ever did was for a college magazine and it was talking about computers and the absolute horrible risks of computers being allowed to make an ultimate decision and act on it.

[00:20:19]
*Is that your paper, er, "Friend or Foe?"*

[00:20:21]
Yes, yeah, yeah, that-that-that's, er, that's the problem, er, you know, e-e-e-a local bank, erm, checks everything, if you try to do some money transfers, it checks your patterns and sees, did you ever do this before, does it make sense? And then it, you know, puts up a red flag and then prevents you from doing it.

[00:20:46]
*Yeah.*

[00:20:46]
I have no problem with the red flag, but the computer is now making an ultimate decision of preventing me and that becomes a problem, now you try to have to call to get a human, and the human cannot override the decision of the computer.

[00:21:00]
*Yeah.*

[00:21:03]
That s-s-s-doesn't make good sense to me and absolutely, for those who know how to break into computers is a serious security fraud. You ultimately want a human to be responsible, not a machine.

[00:21:17]
*Yeah. So—*

[00:21:21]
You don't want to go to war because some computer has decided there is a pattern that looks like we're under attack and it was a false pattern. If the computers see a pattern, yes, warn somebody, now a human gets involved, but let the human make the ultimate decision.

[00:21:37]
*Well, that-that stuff these days is erm, er, is very big business, isn't it, in the-in the cybersecurity area? There are firms er, popping up to offer services to corporations to continually scan the dark web for, erm, threats and, er, alert the-the corporation to an impending attack or whatever. And erm, I-I mean, it seems to be an area in which companies are making an awful lot of money now.*

[00:22:14]
Oh, an awful lot of money is made in computer things. Remember that was going to happen with the horrible bug that was going to be at the end of the century that was going to wipe out humanity and destroy the whole planet.

[00:22:25]
*Yeah.*

[00:22:27]
The Y2K bug, remember that disaster? I mean, this was just humanity trying to scare itself.

[00:22:32]
*Yeah.*

[00:22:33]
It certainly did a great job. Out in Los Angeles, they were predicting dams would break, fire engines wouldn't roll, I mean, the list… Aeroplanes would fall from the sky, the list of horrors, it was like Halloween all over again and everything, in the end, nothing, it-it was no problem at all. So, we scare ourselves, a-a-and-and artificial intelligence, i-i-in the end, it's nothing more than computers being used, just like they've always been used, it's a new term, it attracts the investors, that's what the game really seems to be, attract the investors.

[00:23:07]
*Yeah, although, er, I did read somewhere, er, sorry, this is a bit of a digression, that, erm, one-one of your pieces of art, erm, where-where you recreated this; was it the Mondrian, erm?*

[00:23:22]
That was the Mondrian Experiment, that was, er—

[00:23:25]
*And-and—*
[00:23:24]
I-I-I have a picture of that here, that became a classic of its own, you know, so, the two patterns.

[00:23:34]
*The independent observer, er, preferred the machine-produced version to the—*

[00:23:41]

Yeah, in the end-in the end, somebody at Bell Labs mentioned a painting by-- a series of paintings by Mondrian that ended up vertical and horizontal little bars and all. And I looked at that and I said, black and white, e-easy to do on the computer. So, I had the computer programme its own versions of that too, and then I had these two patterns, the painting, and the computer version. And I showed it to 100 people, which did you prefer? Well, the majority preferred the computer. Then I said, one of these is by a human, the other by a computer, which do you think is which? And the majority got it wrong, it was just a classic experiment, it was, statistically—

[00:24:24]
*I mean, I'm-I think I remember now, that-that-that was cited as, erm, one of the early occasions when a computer passed the Turing Test.*

[00:24:34]
In effect, it was a Turing example, yes. This idea of having a computer in one room, a human in another, you ask them to do things, can you, therefore, guess which was the computer and which was the human? So, in a way this was, er, er, wasn't designed with that in mind but in the end, it was something of the Turing Test and-and all. Er, er, an interesting experiment, that got carried on to a second experiment which was the question of, do people who have an artistic training, have a different sense of aesthetics than those who don't; in other words, does the artist have a special aesthetic sense that we normal people don't? So, the idea then, was to ease these Mondrian-like patterns as stimuli to determine that to have, to see, and to show the patterns to people who have some artistic courses and training versus those that don't and, are the preferences for the patterns different? The conclusion from the experiment, which became statistically difficult to analyse the results, the conclusion was, no, there was-there was no real difference between them.

[00:25:39]
*I-I-it's interesting.*

[00:25:42]
Which isn't a surprise, I mean, you know, you go to a concert and you listen to a performance, did you like it or not? Well, I don't… Some people say, well, I don't

really know much about classical music so, I don't know what is good or bad. No, that's not the case, everybody has a preference and your preference and what you like and dislike is as good as anybody else's. It doesn't matter what special training you have, if you're going to be a critic writing about it, maybe that's when it comes into vogue that you can use it for some reason but everybody's preferences doesn't matter.

I remember, I, er, did a… A few years ago, I taught a, er, I-I did a lecture for a colleague of mine who is a composer/conductor local here and he asked me, he-he-he couldn't make his class so he asked me to do the class. So, I had this… I talked about two American composers, er, one was Charles Ives, and, er, and, er, the other was Aaron Copland. Well, if you-you have two composers whose style is so different, it's the-the-the-the craziness of Ives, the almost dissonance of Ives, versus the Americana of Copland and comparing those two. So, I talked about their lives, and then I played snippets of works by the two and I asked the students, which do you prefer? And I gave them examples. In the end, they actually liked the Ives, they didn't realise they were not supposed to, so, it didn't matter, I mean, it was this question, what are your preferences, do you like this, dislike, like, dislike, like, dislike, it played a lot of different things and all, be open-minded.

People were talking back then about Bell Labs, the idea of a large computer that could be time-shared by hundreds of different users and the users would have dumb terminals. This project was called Multics, MULTICS, Multics, and it was supposed to involve General Electric, which was going to do the hardware, er, Bell Labs was going to do some of the software, and MIT was going to do some of the bigger systems engineering. So, we take these three, who have never, ever before done a big real-world project and put them together. This was sort of-- the-the critic in me would say, this is kind of doomed from Day 1 [coughs]. In the end, nobody figured out that if you had a hundred users, you would have to take… And also, the overhead for the software to allow them all to work together on the same piece of hardware, you would be lucky if you had an ultimate bit rate for each user of 1 bit per second. I mean, it just wasn't going to work, and of course, it collapsed and died. The people who worked on the software at Bell Labs were sent up to the attic of building 3, and there, they came forth with Unix and C. So, Unix and C programming languages were born from the failure of MULTICS and all. And the person responsible for the project was

an engineer at Bell Labs, Ed David, Edward E David Jnr. And Ed, ended up going to Washington to be science advisor for President Nixon and then I got hired by Ed to come work for him for two years, so, that's what took me to Washington.

[00:29:06]
*Right.*

[00:29:09]
But after the… I mean, the Unix dis-the-the-the-the MULTICS disaster, er, my colleague at Bell Labs, my boss, Peter Denash Hungarian, got the idea of getting his own computer, a laboratory computer, so, he got a DEC, a digital equipment machine, a DDP-124, later DDP-224, so, he had his own laboratory computer. And I then had to construct it, a 3-dimensional input device so you could do—You could draw it in 3D with a 3-dimensional joystick moving it around, while you're seeing stereo, left and right images on the screen. So, you could actually be drawing in a 3D space. Then Maurice Constant from Canada visited Bell Labs and said, "Wouldn't it be great if you could feel things in the computer?" have a mould, a clay that you could mould with your hands that was virtual, the term virtual wasn't used then though. So, that gave me the idea of motorising that device, and that became the tactile project.

[00:30:09]
*And-and what-what was that applied to then, once-once you had done that work, I mean--?*

[00:30:17]
Well, ultimately, the idea would be to, ultimately, if you were building a new telephone handset, to be able to actually pick up and feel something, you know, have a head-mounted display so you could see in 3D what it looked like and actually pick it up and feel it and design and get a shape for it. So, that was the ultimate idea, the practical relevance of it to the Bell System would be industrial design and-and using it for that.

[00:30:44]
*I suppose what I'm getting at is that is, erm, er, I mean, all of that virtual reality, er, metaverse stuff, erm, you know, seems to have, erm, found its time now. Er, and I mean, there's fantastic stuff that is being done with it, er, I was looking at, erm, looking at an article the other day, er, by one of our British journalists talking about using, er, virtual reality… Well, they called it metaverse, but I don't really see the difference, er, using virtual reality to train doctors in anatomy, erm, in, you know, because—*

[00:31:24]
It keeps stretching for all sorts of ideas and all. In the end, there is a lot of hype and again attempted. We still do not have a 3-dimensional input device; we don't have a 3D joystick. We still have the mouse, a great invention, Doug Engelbart's, a great invention, still the major way of inputting information. And now, of course, we have touch screens, another way of doing it, but no, the idea of something… You see, the problem with the 3-dimensional, if you have a-a-a light, a pen or something, if you take your hand off it, you can't leave it, it falls. So, you need something that remains in space, where, in 3 dimensions as a little input device; we still don't have that. I mean, this is amazing to me, decades, decades, decades later and all. We get so caught up on the hype of these things, and most of the hype doesn't go very far and all, it sort of peters out.

[00:32:23]
[unclear 00:32:24]

[00:32:24]
So, the day I changed my doctorate, was the day I left Bell Labs to go to Washington.

[00:32:29]
*You said when you were in Washington, you-you did some deal with, erm, the Russians, did you?*

[00:32:35]
Er, there was, er, Nixon had a science agreement and Ed's office got the job of implementing it. So, I had to negotiate the specifics of that section of the agreement with the Soviets. That was very difficult, I was a young kid, in over my head, scared to death. The difference was, I could fail and go to my boss and say, "I've failed", the Soviet could not. So, in the end, everything got done the way we wanted because he couldn't… The-the-the system-imposed things on him that didn't give him flexibility, it was scary.

[00:33:12]
*It must have been a fascinating experience.*

[00:33:14]
A scary experience, Washington was a scary place. But once you had been in Washington, you're different, so, the idea of going back to basic research at Bell Labs was not exactly the best thing for me.

[00:33:26]
*Yeah.*

[00:33:27]
That was a mistake and all. I mean, I-I go back to the early days of the ARPANET, you know, er, Larry Roberts, a name you rarely hear, 'cause you hear of the internet and you hear these other people's names who "invented it." Well, the person in the early 70s, when I was in Washington, who I associate with the ARPA and ARPANET, was Larry Roberts, w-who was the project manager in charge of the whole thing, he's the driving force for it all, in my mind. But the question was what to do with that, how do you commercialise it? And, er, that was… My little role in that history was, erm, Dick Bolt of Bolt Beranek and Newman, for some reason calls me on the phone. There was a meeting we had the-the-the science community, the national science people, the academics wanted access to the ARPANET, right, but they weren't part of that defence department constellation of people. So, ARPA was going to sell access, well, that would have made the government a common carrier, that would have been opposed to the Nixon administration's idea of telecom and

private industry. So, the issue was what to do about that and I remember there was a meeting we had, the-the White House Office of Telecom Policy met with the ARPA people.

And I remember that meeting because one person, I think it was me, who said, "What about AT&T, would AT&T want to offer this?" AT&T was approached and said no, they had no interest in packet switching, hmm. Then I thought and I said, "What about Bolt Baranek and Newman who were the prime contractor to ARPA for this, were they asked?", yes, they were asked and they said no too, that, I couldn't understand. A day or two later, I was on the phone with Dick Bolt, I told him the story, he said, "Michael, let me get back to you" and a couple of days later he got back and said, "We're starting a new company called Telenet to commercially offer packet switching; that's how Telenet was started. So, that was the-the movement that took it away from ARPA and made it something available for the whole world.

[00:35:29]
*Yeah, yeah.*

[00:35:32]
That's something I got involved with at AT&T many years later when we were looking at videotext, which was the idea of using, er, your-your TV screen with a little terminal to get access to databases, an area that your country worked a lot into and all, view data and videotext. And we got into that, and with a newspaper, a Knight-Ridder newspaper, down in Florida, Southern Florida, and… But the idea was, what they viewed was one giant computer database and all the information stored in it which would then be tree-accessed, you know, you start with the tree and keep going down. And the problem is then most people got lost in the tree and never got the end and all; it wasn't the way to do it. I realised it had to be millions of decentralised computers, we're right back to the early days, when I talked about MULTICS, the idea of one giant computer being shared by everybody versus decentralised computers everywhere.

We're back to this basic idea of centralisation versus decentralisation. In the end, it becomes into politics, big government versus decentralised government. There were

those who believed in the idea that big government, the dictatorship controlling everything, there were those who believe and everybody trying different things and having their own. So, we had a lot of computer databases, how do you find anything, how do you search it? And that is where the Google people came in, they solved that great problem.

[00:37:07]
*One-one of the things that amazes me about this-this business, [laughs] when talking to people like you is-is how much was done so early in the, erm, in the history of computing.*

[00:37:21]
Very early. Computer art, your country, the UK was very significant, Jasia Reichardt, Cybernetic Serendipity, Institute for Contemporary Art, she put that show on. That was one of the first shows talking about technology in art, very, very innovative. She did a couple of books, extremely innovative things. Howard Wise, that gallery show was 1965, very innovative. And a couple of Germans, Nees and Nake did similar things in the same time frame. So, a lot of things go back earlier than most people realise. But then again, when you think you've found that, there is always something earlier too.

[00:38:02]
*Yeah.*

[00:38:03]
The-the-there's usually not one person, one thing, there's usually a time and environment when it's right for the flowers to emerge for the innovation to occur. It's not just one flower, there are many, although sometimes, one flower grabs all the attention.

[00:38:21]
*Well, I mean, I'm stuck by you-your stories about the-about the haptics, er, about the videotext and erm, er, indeed even about, you know, the mouse in-in-in 1968 or whatever, when it was, erm, demonstrated with a graphical user interface and so on.*

*Erm, you know, I mean, there-there's, er, there's a big temptation, and I think, especially for the younger generations, think that all of this stuff has been invented in the last, erm, you know, 20 years or something. And erm, er, actually, er, it-it's-it's got a huge legacy of from-from the earliest days.*

[00:39:05]
Indeed, I mean, I've heard people thinking something in terms of haptics was done innovatively in the mid-80s and I said, well, actually, the patent on it, was applied for in 1971, I said, and this patent has a drawing in it, and-and-and that drawing, in that patent, I mean, it shows a tactile input, a computer, 3D output, force speed back, everything. That drawing is broad enough to cover all of the world's haptics, and that's what's covered by this patent. So, it was not the mid-80s, this goes back many, many years before.

[00:39:50]
*Yeah. So, you-you've been a, erm, er, a thinker, a writer, about the, er, not-not just about the technology of the internet, but the-the role of the internet and the future of the internet and erm, and er, I think challenging in the 90s on, erm, on where it was going. I mean, how-how are you feeling about it now?*

[00:40:18]
It's hard to find anything really new. I mean, when people communicate, interpersonal communication, I mean, you know, people think texting, all of this is new, no, no, no. When the telegraph came along and morse code, an awful lot of amateurs were playing with that too and sending messages to each other. I mean, these things have been around a long, long time. Maybe it's easier now because of the technology making it more available, but it has always been there. The telephone and what it allowed distance communication. But you know, back in the 50s, party lines, people didn't have their own individual telephone.

[00:40:57]
*Yeah.*

[00:40:58]

It was, I mean, calling from the United States to Europe would have required probably a day's warning to get the circuit and would have cost a fortune. The idea that I, today, I can, for 5 dollars a month have unlimited telephone access from New Jersey to a friend of mine in Stockholm, and talk for hours, is unbelievable. The fact that I can use—Do video, facetime, between here in New Jersey and my friend in Sweden, and have a 3-hour call, for-for free, with excellent quality video and superb audio is incredible; but is it a new idea? No, it's not a new idea but the fact it is so available and so easy to use, that is what makes it important and exciting.

[00:41:50]
*Yeah. Where next do you think?*

[00:41:55]
If I were… I would look at old ideas and how they could be done more easily and less expensively with newer technology, it's hard to find something really that new. When I was doing the tactile project, one of the things I was envisioning was the idea of a machine which I could be here in New Jersey and somehow feel and touch a piece of cloth maybe in China, where somebody was making a new piece of cloth and I could get a feel for it; we still can't do that.

[00:42:29]
*Can you not?*

[00:42:31]
These are old ideas but still not that easy to do yet. Some ideas keep rolling back, 3-dimensional movies.

[00:42:40]
*Yeah.*

[00:42:41]
Stereo movies. Every 10 or 15 years they come back again and then somebody does a movie, everybody goes and sees it, the novelty quickly wears off, because it isn't…

What attracts people to entertainment, isn't that it's in colour, it isn't that it's in 3D, it's the story that's being told, the excitement of the story.

[00:43:02]
*Yeah. Well, I—*

[00:43:04]
High-definition television, remember high-definition TV?

[00:43:07]
*Yeah.*

[00:43:09]
The one-liner was, all that will do is allow us to see more clearly how poor the programme content really is.

[00:43:17]
*Yes.*

[00:43:18]
So, here we go, more hype, the idea is attract the investors, get the investors to come in with their money and all, but is it new? I-I, what I tried to teach my students was, there are 5 factors that are involved in understanding the future, one of them is technology, obviously, important. You've got to be able to make some money, finance, how are you going to pay for it, and how—what is going to be the profitability? Is there any government policy involved or against it or for? So, the policy government issue has got to be looked at too. And also, business, how are you going to get this idea to the consumer; do you have a business structure to get it there, get it out in the real world, you know, supply chain issues you hear a lot about today. And last, the consumer, do they really want it, is it something that is going to make their lives different or not? I mean, we hear a lot about the Internet of Things, er, er, though that seems to be dying out if you've noticed a little bit, it-it went too far, after a while you get this, er, I-I don't know.

I remember the idea of automobiles that would talk to you and all and tell you your speed.

[00:44:24]
*Yeah.*

[00:44:25]
I mean, that became the vogue for about a year or two and then that died out. People got so angry with their cars talking to them, they couldn't figure out how to turn it off. You get to keep trying things, but be prepared that when you drop a new idea into that funnel—

[00:44:44]
*Yeah.*

[00:44:46]
Very few make it all the way through and finally come out with success.

[00:44:49]
*Mm-hmm.*

[00:44:50]
Most of them die inside. It doesn't mean don't try, but the other thing is, don't try something that's been done before and all, things do change.

[00:45:01]
*Can I just ask you one-one last question, a very difficult question, what-what-what out of all of those things that you've done has we've talked about has given you most satisfaction in your life and career?*

[00:45:19]

That I-I-I don't think I have the answer to that, er, that's a hard one. I could be a little bit political and say teaching my students, you know, taking students who had no sense of technology or engineering and-and you know, and run them through a course that they now know about. Tesla, they understand the difference between AC and DC and why. And have some basic sense of that terminology so that they're not going to be frightened if they're in a meeting and some engineer is up there giving them a lot of hype, they can ask the right questions and say whatever it is, you should be able to explain to me so I can understand it. Don't get lost in the terminology and all, that perhaps is important to me, yes.

[00:46:05]
*Do you-do you ever get asked by the younger generation for advice on their career direction?*

[00:46:13]
I wish more would ask, but the answer is not… You know, er, er, very few young people will listen to older people.

[00:46:25]
*Well, look, I-I-I've really enjoyed talking to you, I-I-I—*

[00:46:30]
I've enjoyed chatting with you too, it's been a l—a lot of fun, a lot of interesting questions.

*End of interview*