Tim Berners-Lee Oral History

COMPUTERWORLD HONORS PROGRAM INTERNATIONAL ARCHIVES

Edited Transcript of a Video History Interview with Tim Berners-Lee
Chair, MIT Laboratory for Computer Science
Director, W3C

Recipient of the 2001Cap Gemini Ernst & Young Leadership Award for Global Integration

Location: MIT Laboratory for Computer Science
Cambridge, MA

Date: April 23, 2001

Interviewer: Daniel S. Morrow (DSM)
Executive Director, Computerworld Honors Program

TABLE OF CONTENTS

Origins of Innovation

DSM: Good morning. Today is Monday, April 23, 2001. I'm Dan Morrow, Executive Director of the Computerworld Honors Program which was established in 1989 by Pat McGovern of the International Data Group and Computerworld, a committee comprising the Chairmen and CEO's of the world's leading information technology companies and Roger Kennedy, then Director of the Smithsonian Institution's Museum of American History.

We are interviewing today Tim Berners-Lee, inventor of the World Wide Web. Currently holder of the 3Com Founder's Chair at the Laboratory for Computer Science at the Massachusetts Institute of Technology, and Director of the World Wide Web Consortium. In June Tim will receive in Washington D.C., the Cap Gemini Ernst & Young Leadership Award for Global Integration. This interview is taking place at Tim Berners-Lee's offices at MIT in Cambridge, Massachusetts, and is part of an on-going series of interviews with leaders of the information technology revolution, made possible by a generous grant from Cap Gemini Ernst & Young.

This interview is being recorded for the Computerworld Honors Archives on-line and for distribution to more than 140 museums, universities, national archives and research institutions in more than 40 countries on six continents around the world. Without objection, the complete video, audio and transcripts of this interview will become part of these research collections, and made available in edited form on the World Wide Web. This discussion however, is private and should any participant want to withhold from the public record all or part of these recordings that request will be honored for a period not to exceed 25 years. All present in this room are honor bound to respect such a request and by remaining here, accept personal and professional responsibility to abide by these agreements.

DSM: I would like to begin by asking you to identify yourself formally for the record and tell us when and where you were born.

TBL: I am Timothy Berners-Lee. I was born in London in 1955.

DSM: And your parents, can you tell us about your father and mother?

TBL: My father is Conway Berners-Lee. He was born in Birmingham, I guess they were both born in Birmingham. They certainly lived in Birmingham. He was born in 1921. My mother Mary Lee Woods didn't know when she was born that she was going to marry somebody who had Berners-hyphen-Lee as a second name.

DSM: She was Mary Lee Woods-Lee?

TBL: She was Mary Lee Berners-Lee. And when they were around mathematicians she was referred to as sometimes as Mary Berners-Lee squared.

My father studied math at Charter House at boarding school, and then at Trinity-Cambridge.

DSM: He was eighteen, would have been about eighteen, nineteen when the Second World War broke out. Was he touched by the war?

TBL: Yes, he was involved in it. He was largely an engineer. He was in Egypt at one point. He was in England. He was involved in radar, keeping radar working with strings of anecdotes about going around on a motorbike trying to find things that had gone wrong with cables and wires and things. And my mother worked at the Radar Research Establishment at Malvern. I was surprised when I started taking up electronics. I started soldering things and she caught me running from the kitchen one time and sort of pulled me back. She found out I had a soldering iron; I had repaired the flex, had a little piece of tape around it and she pulled me back and said, "What have you done there?" And she said, "Look, let me show you how to do this. This is how you do this. You use some of that, and keep these apart, and you take this off like this, take this off like this. And you don't need any of this stuff. I have done a little electronics in my time."

DSM: Your mother had a degree in mathematics?

TBL: In math and geography I think.

DSM: Very unusual for a woman of that generation.

TBL: I think she pushed the limits on being a woman in that generation in mathematics, and in a lot of other ways.

DSM: And your parents met working on Ferranti Mark One?

TBL: Yes, on the Ferranti Mark One, which had been a computer developed at Manchester University. There was a tin hut, which is described in a *Guardian* article a few years ago in which this commercial version of the computer was put together, and she was programming it. In those days programming it involved writing the code so that it would take the right amount of time, so that as the drum rotated the piece of the matrix which it would need to picked up next, would be roughly in the right place so it wouldn't spend all its time waiting for the drum to come around. There was an art, a lot of art to it.

He was a statistician doing analysis and theories about how processes work efficiently and was involved also in supporting customer sales. That computer was actually sold to—I forget who the first customer was. I think their claim to fame was that it was the first computer sold to a non-government agency.

DSM: Was it a biscuit company?

TBL: Was it? I can't…

DSM: We'll find that out. You were born in 1955. Describe London as you remember it. I guess that would be around 1960.

TBL: I grew up in suburban London. I felt I had inherited my parent's love of getting outside into the countryside. I never realized how lucky we were to live close to Richmond Park, which is three miles across. There were no cars allowed after dark and you could walk up into the middle of it. And you see around you the orange glow of neon everywhere and you can see beyond the Crystal Palace. I felt that London was endless, but my little part of it was East Sheen, which was between Putney and Richmond on the southwest of London about twenty-five to sixty-minutes drive to the center, depending on the traffic.

It was friendly, and now I go back and think what a nice part of town this is. Especially with the park there and Sheen Common and other places to play, to take a go-cart and play and have picnics and things. But the whole family really liked to get out a lot, made a point of getting out. Maybe escape, when you're from Manchester and Birmingham, you head for the hills when you can't get out of the smog. We would go down to Cornwall, to Wales whenever we could.

Learning to Read from Road Signs

DSM: I know in 1969, at about age fourteen, you started at Emanuel School but what was your first formal school experience? Where did you go to school before you went to Emmanuel?

TBL: I went to a nursery school, which was right across from us. Nursery school was at the age of four, and at five went to an elementary school, which was a slightly longer walk. The nursery school was a one-classroom school; otherwise it was a girl's private, girls' elementary school. All the preschoolers were all sort of huddled together in one room with these huge girls in uniform rushing past at the breaks. Then I went to Sheen Mount County Primary, which was the elementary school.

DSM: Did you learn to read in school or did you know how to read before you got there?

TBL: You'll have to ask my parents when it was. I think I read from road signs. On the way up to the park the street signs in London are black and white, have nice easy-to-read letters and are two feet off the ground. You can walk right up to them and run your fingers around the letters. Some of them would have little letters in red, like the name of a borough, or the postcode, SW14 would be underneath in red so I vaguely remember that having something to do with learning to read.

DSM: Who is the first teacher that you remember?

TBL: Miss Heinemann, Class 8. Mrs. Young was in the nursery school and Miss Heinemann was a teacher in what I suppose would be kindergarten, which we called Class 8.

DSM: You would go into what we call in the states 'high school' when you were about 14?

TBL: At 11.

DSM: At 11?

TBL: Yes the split was 11. At that point they split. There was a "11-plus" class exam. When you're at 11 class you go into a grammar school or a secondary modern at the time. There was a streaming of schools, which was not a very satisfactory situation, but that's when I went to Emanuel.

DSM: It was a public school.

TBL: No it had at one point been an independent public school. At that point, it was funded by the government. It was a school, which had been taken under its wing by London, so it was called a 'direct grant school.' It had a direct grant to function, and fairly autonomously. I think it still had a board of governors, and that went on under the administration at the time. Since then it had become independent, again because I guess as the politics swung to the right, but at that time it's when politics swung to the left that it could get public funding, so I didn't have to pay to get there. I did have to take an entrance exam.

The alternative was to go to the local 'public' in the American sense, grammar school; Sheen Grammar, which we liked. My parents thought Emmanuel had slightly higher standards. It would be better for me to go there. In retrospect I think I that the social break of going to a school which was a train ride away instead of a school that was a walk away, was quite a stress, and I'm not sure if it merited. It meant that all my friends were based down the road, and I'm halfway to the center of London, which made it very difficult to meet up at weekends. It was quite a social impediment.

DSM: I was going to ask you about that; you're a teenager in a period where everything British was really hot. I mean this age of the British invasion of the world with pop music. What was it like being a teenager in Great Britain during that period?

TBL: I didn't have the rest of the world to compare it with at the time. School was interesting. At school I had a small number of good friends with which I do sort of electronics and things at home, and go walking, staying in youth hostels, those sorts of things.

DSM: Special chums or school rivals that made a difference?

TBL: In elementary school a very good friend was Nicholas Barton. He's a doctor, and now Professor Nicholas Barton, who is a Professor of Genetics at Edinburgh now, and Fellow of the Royal Society. He and I would wander around the school. At recess we would run around and talk about scientific things. He learned to read really early on and was quite precocious, and he had a lot of words in his vocabulary, which he had only read to pronounce. We would end up pronouncing them, he would tell me about them. He had a Junior World Encyclopedia, sixteen volumes which he had read cover to cover. He was a good influence and we did a lot of fun things together. We built a cart out of old pram wheels, baby carriage wheels and took it around the park. And we made a lot of chemical experiments and wound electrical magnets while walking around the school playground.

DSM: One of the common themes I found in this very serious series of interviews is a lot of young peoples' chemical experiments. They tended to blow things up. Did you do a lot of that?

TBL: I did a little bit of that, not enough. We had another friend Christopher Butler, who died very tragically a few years later after experimenting with things. In secondary school, Nicholas went to the other local school, so we went to different schools. Another buddy was Jan Wikramaratua Aster who I went to high school with. Steve Moss was another we went youth hostelling with, walking over the hills.

DSM: I would be remiss if I didn't ask you about another encyclopedia, *Enquire Within*.

TBL: *Enquire Within About Everything,* yes. People have been very kind to me; have given me a couple copies of the book that they have found. You can find the book and you can look through it. *Enquire Within About Everything* was this compendium of all the essential knowledge for the Victorian household. It

held a wide variety of things, and as you read through there's a little saying or motto at the top of each page. It's a fun book to have on the shelf, and the title I used many years later in 1980 at CERN, for the title of a pilot program.

Beautiful Minds: Early Mentors

DSM: Frank Grundy?

TBL: Frank Grundy, math teacher, great guy. Great guy because of the twinkle in his eye, because of the fact that he found math so exciting. Also Derrick Pennel, my chemistry teacher. They both had this excitement, sort of this unstoppable excitement. Derrick Pennel had been given a Ph meter and he would come in all bubbling, "Hey look at what I got! Somebody brought this in. They thought they couldn't use it. Would you guys like to try it, see what you can do?" We broke it. It was a little delicate, but he trusted us to do more things.

And Frank also, he loved playing golf and playing bridge. I didn't play golf. I wasn't very good at bridge either, but I could appreciate bridge to the extent that those who had finished their math problems would play bridge in the back of the class. And he would come back and comment on it, that it wasn't a very good bid and so on. He could give problems to the class in a way that, if he would see that a few people could solve that problem as it stands, he knew how to add a little side line to it which was really intriguing. Or just sort of ask quietly if that would generalize for any value of 'n' or something. This partly came from just his excitement of how beautiful and neat math could be. Which my parents had as well, they would be excited about it.

DSM: I have also heard that railroads were important early on to you, the school was located on?

TBL: Yes, Clapham Junction was a rather big one—one of the biggest railroad junctions in Britain. I would get the train there and some of the lines coming from Victoria and Waterloo central terminals would come together at Clapham Junction, get mixed together and head out to Brighton, and Bournemouth, the two south coast resorts.

As they split a few yards outside the station, they went off in two deep cuttings. There was left a piece of land in the middle, on which Emanuel School was built. Access to the school was from the bridge, which crossed the railroad lines. Once you had gone in, you couldn't easily sneak out. It was enclosed with fences and four electrified tracks and a deep embankment on both sides.

DSM: It was an orphanage I gather.

TBL: Was it? Yes that sounds right. It was back in the 16th Century?

DSM: In the mid-19th Century. I looked it up on the web. It was an orphanage during the mid-19th Century Crimea War.

TBL: Yes, so some ancient buildings and a few modern additions.

Oxford: A Rebel's Choice

DSM: Your father was a Cambridge man and your mother's degree was from?

TBL: Birmingham, but check on that.

DSM: But you chose to go to Oxford. What inspired you to go there?

TBL: Well, for two reasons I suppose. One is my father went to Cambridge so it seemed quite reasonable for me to go to Oxford. I didn't do enough rebelling as it was. The alternative would be for me to grow my hair and go to India. I just missed the hippie era. I think that my age group felt that it was just too young for Woodstock. I was just too young to go to the Isle of Wight Festival. We trailed that by a little bit, and felt that we missed really being complete hippies. The psychedelic glamour was starting to fade by the time we went through that.

But all the same I went to Oxford. Although at one point I noticed that the school was sending everybody up for Oxford entrance and they hadn't mentioned Cambridge a whole lot. A lot of the masters, the teachers at the school had been to Oxford. And at one point I asked Frank Grundy who was the admissions teacher, "Frank, you know I could go to Cambridge right? I could do the same sort of thing to apply to Cambridge? Could I, should I, should I also, could I apply to Cambridge as well, or instead of Oxford?" And he took in a deep breath and he thought for a moment and said, "Yes you could." And that was the last time I mentioned it. Obviously it wasn't something he was going to encourage. There was no twinkle there.

DSM: Were there any teachers at Oxford, when you were reading at Oxford that future generations should know about?

TBL: John Moffat was my tutor. A lot of people had various different tutors for different subjects. At Oxford you have a tutor who is the person who really ensures that your life at Oxford is a success. You have a moral tutor who makes sure you get through the three years without disaster, and a subject tutor. And for me they were the same person. A wonderful man who in fact, apart from a certain amount of math in the first year, he taught all the physics, all aspects of physics. He was a nuclear physicist who later became the Provost of Queens College, which is the college that I attended.

I think I had a slightly different way of looking at things at times because given a problem, I would have go at it, and not necessarily end up doing things the way the books nor he did, and not always doing it right either. He would take a bunch of papers in which I would work through a problem, and use a really obscure way of looking at it, and sort of invented different variables and used very obscure notations. I would use Greek notations, the way others would use Latin. And he would take all these misguided things, and where other people would say, "This is all wrong I will show you how to do it," he would say," This is intriguing the way you are doing things. You are using rather odd notations, but in your notation let's work through your assumptions. This one is very

good. This one is real interesting. This one is real good. This one in your notation you know, from that, this would follow this and this and this and this. So your conclusions are inconsistent with that. That's why your notation doesn't work. Let me show you, if you replace that assumption with this one," and he would work it all from my point of view, which is a very significant thing to do.

DSM: He was a true mentor.

TBL: It's very good for mentoring. It's also, I mean right now the World Wide Consortium is trying to get people to agree on standards. And if you get two groups together, what is the art of actually coming to harmony? It's being able to work through the problem from there, from the other's point of view. It's just a very important human art. He had it in spades. He is a very sort of warm, friendly person too.

"You! You! Off!"

DSM: The stories about your early manufacture of computers from spare parts and keyboards from calculators you had found in a dumpster has been told several times before. I also came across a story that you were using the Oxford physics lab and were thrown off. Is that true?

DSM: Joyce Clark, yes an old friend of my mother's. My nemesis. She was the systems manager on that and she had been, she was an old friend and colleague of my parents. She lived in Oxford and ran the PDP10. Most of the undergraduate physicists could use this PDP8, but later on there was a course in which we learned basic Focal language, interpretive language on the PDP8, a delightful language, but we were allowed to use Basic. And that ran on the PDP10 which was a much more serious computer, a time sharing computer which would also compile languages, Fortran and all of those things. It also it was used for analysis of nuclear physics data, it was actually up in the nuclear physics lab.

My practical partner Pete Hammersly, who was known as Peter at that point, otherwise as Julian Hammersley, we were doing practicals together. You have to pair up to do practicals, and neither of us had any misunderstandings about our complete lack of ability to do physics practicals and getting them to work out. Some of these things you had to measure were the positions of different gratings to great accuracy so you could determine the wavelength of sodium light or something. And we were both a little cack-handed, and neither of us trusted ourselves. Our approach was to make sure that our readings were reasonable by doing the analysis backwards.

Basically you had two phases. You had to take all the readings and then you had to analyze it and deduce the result. We would look up the result and deduce what some of these readings should look like, and deduce that for what the results should look like. As we were taking the readings it would take so much time, you would waste days if you actually missed a digit in the middle and you could end up at one point miles out. Now I have to admit that this sound like a great story, but we spent a lot more time in fact planning this, and trying to make it work. We only had to use it in series on one experiment, which was the compound pendulum, which rocks on two optically flat plates, which rest on small, sapphire spheres of known diameter. The thing is a heavy pendulum this long with a weight at either end. And by timing the swings of this thing you have to determine the acceleration due to gravity. It's supposed to be done so accurately that you have to calculate whether the position of the moon or passing traffic could be affecting your results, from the gravitational pull, things like that. That terrified us.

We found that the accuracy of the result was so great that the normal, the basic programs that we were provided with didn't print out enough numbers. They only went to eight decimal points, and we had to go to twelve or something. We had to do extended length arithmetic in order to do this. We had to calculate these things back, and then add a random error, which made it look like real experimental error. If somebody analyzed the results they would determine in fact we had cheated because we made sure that we had a nice rectangular distribution. Normally you would get some results—you get a bell curve and

there would be a few on the tail. We didn't. We knew if **we** ran a random error series, all the results would end up on the tail. We made sure we chopped them carefully at two sigma. Yes, we had fun using the computer. But there were limits to what we were taught to use. We had something like ten disk blocks of space when you logged onto the undergraduate course. We invented a couple of spare undergraduates who logged on. We wrote, "We're sorry to say we missed the course. Please enroll us. Signed, Herridge Maddox from Corpus Christi College." We invented people. We signed onto the course and used their disk space.

Curiously enough there was a bug in the Basic system, so if you took a four character string and concatenated it with a one character string, so for example "a, b, c, d" + "e", just the act of trying to put together a four character string and a one character string, would crash the Basic program. The undergraduates were forced to, when they logged on they automatically ran basic, but when they crashed out of that they could get into the operating system in general and run other things. At one point Pete and I were both involved in the rag week, which is sort of the student charity, festivities, big collection for charities and lots of crazy events. And there was an organizing committee, which we were on. At one point I had a list of people on the committee on the computer, and I had just run out a list of everybody on the committee for everyone on the committee. That was a like a list of 100 names, 100 sheets or so with that. But the teletype we had to use was going to take too long so we needed a line printer. We snuck down to the system area over lunch, a couple of floors down. Looked around, the place was completely empty. Not a soul was there. The line printer was full of paper. We rushed upstairs, ran the command, which Pete knew, he'd used it in some situation before, ran the command to run 100 copies of the file to the line printer.

We ran back downstairs and the place was absolutely seething with people. There were people running around all over the control room. In fact there had been a problem with, I don't know whether it was some system that had to do with the van de Graff accelerator or something, some panic. One of the other systems had gone down, and immediately there was Joyce trying to bring it all back up and trying to dump everything into the line printer. As we walked in there she was upside-down looking at this stuff pouring out, and she says, "You! You! Off!" And she went straight to the terminal, delete, delete, and from that point on we were no longer users of system. That was perhaps a motivation to become more autonomous when it came to computing time.

Physics of the World

DSM: Indeed, great story. You didn't choose a career, thank goodness, you didn't choose a career in academic physics, but I've read that you always felt that physics gave you a feeling that you understood the hard side of the technology, the components and quantum physics, and that the combination of the physics and the intuition element in the mathematics.

TBL: Physics is neat because it's about the real world. It's about defining mathematics, which is what the real world does. And I think that getting the big picture of how things fit together was important to me. But I felt a lot, every now and then when we were studying physics, that we were studying this piece over here, and this piece over here, and they didn't really match. At one point I took a piece of line printer output and stuck it on the wall and marked off, every ten centimeters was order of magnitude, was a factor of ten. And I put up an energy chart. At the bottom was energy corresponding to the mass of the neutrino or something, and at the top was the energy corresponding to the mass of the universe. Well, that may have been off-scale but all the interesting physics we did was inside.

You could see when you put different things on the same scale, you'd see that the electronic energy levels of atoms such as copper, the electronic bands come at the same level as, in electromagnetic radiation, the visible spectrum—a little rainbow which is about this big, which goes from red to blue. And when you look across you see under the different sort of sorts and interactions, you see all the things which lead to visible phenomena. You see the arc, right, in the electronic bands. That's why copper sulfate is blue. That's why you get certain dyes because they have this sort of interaction, and because they match the visible. And so that sort of thing would give me the feeling that I knew what was going on.

There's also a similar feeling, although on a different scale that I've been really lucky I think. Perhaps, maybe everybody feels like this but I felt that my generation was very lucky, because we were playing with electronics in elementary school. Nick and I were winding solenoids and got to the point to where we could make relays. But really relays were not going to take us much further. As we got into secondary school, transistors were there. If we had to do things with vacuum tubes it wouldn't have worked, but at that point you could go down the road and buy these little transistors, discount transistors, packets of fifty. Rejects that you could test and find out which ones actually worked and were incorrectly rejected. We taught ourselves to make things out of transistors. We were just getting to the point where we could make counters, and we actually were making a digital display on his oscilloscope. We knew how to do it out of transistors, out of flip-flops. Flip-flops is two transistors, it's a memory cell. And just as that was happening the 74 series integrated circuits came out which had nand gates. It had four nand gates and increasingly more nand gates. And as we grew up things we wanted to do became more ambitious. Miraculously industry produced things that you could buy with pocket money which do exactly that.

In high school it went from what was available, from transistors through integrated circuits. When I was building, out of 74-series integrated circuits, these little things that had gates and visual display units, the idea of making a computer was possible. We knew how to do it but it would have taken a lot of chips. And then suddenly when I'm at university, out comes the microprocessor which puts all that back, a memory chip, a ROM chip and a processor chip suddenly come on the market. In fact the first big chip I used was the character generator for the VDU. Just at the end of, must have been 1976, because I remember taking this whole contraption into physics lab, and the lab technician looking at me very askance when I asked, "Can I attach it to the P2P." I said, "I made a computer terminal." He said, "Right." "And I want to link it up to your machine." He said, "You know these machines have to be optically isolated." I said, "Right- here's my optical isolator. Check it out okay. I won't put any current on your machine." He let me connect my terminal to his computer so I could test it out on the PDP8 and of course it came out OK. That was very lucky.

At the end of that I brought in my processor, but I knew I could build what was in it out of gates. I also knew that I could build what was in a gate out of transistors. Now physics? Somewhere I did take one course in solid-state physics, which tried to persuade why that one could understand how a transistor worked. And that was the most difficult bit because actually why a transistor works is quantum mechanics.

Quantum mechanics of a hydrogen atom is simple, but the quantum mechanics of a transistor is, you're making a lot of approximations and stuff. And that is probably the biggest gap to that feeling of, "I know how a computer works down to the electron." But it was really the timing, because anybody that hits computing now they don't get that excitement. We were riding the crest of a wave of excitement all day long. But you're given a computer that runs Linux the size of your palm, and go see what you can do with that, and inside it must be a mind-blowing complexity.

Heroes, the Web and Dr. Who

DSM: One of the questions I like to ask people about their youth is about their heroes. Given that the web is such a marvelous exercise in trust and people have to trust each other to do the right thing on the web in a sense, and integrity, is there a person who comes to mind when you think of honor and trust and integrity, somebody who was a hero when you were a kid?

TBL: I want to take you up on that first point actually, because the Web is designed to be something, a neutral medium. And I don't feel that the web itself forces you to trust people. What it does is allow you to communicate. It gives you a medium of communication with people. To communicate with people in the world you need to trust them. The Web doesn't change that. It just means that you have the power to communicate more. You can for example, just as easily find people to trust and people you can't trust as well, but the Web itself is just passive. In other words the Web doesn't inherently make you more dangerous. When you pick up a piece of paper blowing in the street and you read it, you have to decide whether to trust that or not. It's just you grew up before you went to kindergarten being taught by your parents whether or not to trust pieces of paper. Whether or not to keep pieces of paper. Whether or not to read pieces of paper or let them blow across the street. And I think we've had to learn since then how to do this on the web. To treat a Web page as something which blows across the street, and take it with a pinch of salt. But inherently I think that I put it to you, that trust is something about society rather than something about the Web.

DSM: You grew up in a period when I mean many of the, especially in Britain, many of the heroes of the Second World War were still alive, also the popular media, television and radio, when you were a kid were there fictional heroes that you tried to emulate, or politicians that you used to admire?

TBL: I just, well I wasn't very aware of politics. My parents were liberal which was a third party. There was conservative, labor and liberal, and they were always more liberal.

That was always a minority, that is, there was a two-party system being challenged by a third party, which was trying to come into existence. And television, we didn't watch a lot of television. For periods of time we didn't have a television. We watched "Dr. Who" (laughs.) You know "Dr. Who?"

DSM: I know "Dr. Who," great, great, great sci-fi series.

TBL: When you look at them now you can see how it was done on a flat screen. How the planet surface would have a remarkably flat studio floor with some lumpy rocks stuck on it and so on. But it was, yeah! There was a series called "Juke Box Jury" beforehand, which we wouldn't watch, but we'd be lined up in front of the television to watch "Dr. Who" and that the Juke Box Jury signature tune would produce that pounding in the heart.

DSM: I know exactly what you mean. Because we're short on time, I'm going to just walk through some chronology, and you let me know if there are some stories you want to tell. 1976-78, first job outside of the university at Plessey Telecommunications. I gather that you chose Plessy because Poole hadn't been destroyed during the war?

TBL: Because it hadn't been, that's a funny way of putting it, because it hadn't been completely destroyed by the war. There were three telecommunications companies. One was in Harlow, which was in a new town. One was in Coventry, which had been bombed heavily and rebuilt. One was in Poole. Poole was basically a fishing town. It 's in a very beautiful position. When you go to Harlow you go on a train. You then take a cab and drive through all the various industrial and residential sections. It's a very carefully planned town, and as you drive through town you may notice that there are some concrete cows painted black and white. When you go to Coventry, they say one of the great things about Coventry is how great it is to get out of it into the hills. And a town which is credited with how to get out of it is a little iffy. As you go, you arrive at the station at Poole, and the train stops and it's quiet and the seagulls wheel above you. On one side of the track are the little marshes and the bridge from which you can see the rest of the harbor. You can see Brown Sea Island where the first Boy Scout camp was, and there's a row of hills between you and the English Channel. There are daffodils, seagulls, clanking from the few dinghies moored.

DSM: Were you ever a Boy Scout?

TBL: No, quite too introverted.

DSM: Okay DG Nash Limited, Dennis and John Poole.

TBL: Yes. I met Kevin Rogers, a good friend I met at Plessey. He and I joined at about the same time I think. We both understood the microprocessor software and worked in a lab, which had been mainly making hardware, and was just making the transition to microprocessors. Kevin found that somebody who he played squash with was running a small company with a couple of guys. Dennis Nash and John Poole had a company, which was making interfaces between different machines. If you wanted to plug in something like a Linotron typesetter into a computer, it didn't have to have an interface. They would build interface cards. They were really in the hardware business. Then a customer with a certain amount of vision about what he wanted, talked them into taking dot matrix printers and converting them to print from Linatron typesetting codes so that you could use paper instead of bromide for proof checking. These things called proof printers were originally made out of hardware. They were all made out of logic, and Dennis and John realized that they could use microprocessors for this and save a whole lot of logic. They looked around for someone to program it and they got to hire Kevin. After a while Kevin, as I recall said, "Tim there's work for two here. I think they should hire you as well." We had a lot of fun. The company was like four people, and it has grown since to I think one or two dozen. But we had a lot of fun, and we had a lot of fun windsurfing on the harbor.

DSM: Were you married at all during this period?

TBL: My first wife Jane I met at Oxford. We got married after and she and I both went to Plessey, she was working in another division.

The Proton Synchrotron Connection

DSM: Mid-1979 to 1981 you were an independent consultant, and between June and December of 1980 you had your first job at CERN. I think in the earlier interview we pretty well covered your developing "Enquire" there, any particular story that you would like to talk about?

TBL: Well, I don't know how you mix this in with the rest but the geography of the Proton Synchrotron lab was that there was this thing like a warehouse, like a factory floor with a catwalk around it, the second floor level. And the control room for the Proton Synchrotron booster, which was part of the particle accelerator, which was buried in the hill, was actually attached to the walkway, off the catwalk on the other side. If you came out of the terminal room, the control room or the computer rooms were off this catwalk. To get to the offices you would walk along the catwalk to get to the corner of the building.

The offices, the corridors continued into two other lengths of the building, which went off in different directions. This was a meeting place in the corridors. There, there was a very strategically placed coffee place where you could buy a coffee and croissant at the right time of day. They had standing-height little tables. Sort of mushroom-like tables which, because there wasn't a lot of space, were kept on either side of the corridor. This turned out to be a great communications system. (They later took it apart. I don't know if, maybe it was fire regulations.) But the neat thing about it when it was functioning was that everybody passed through it to get to the terminal room—at that point the terminals were in the terminal room, we didn't have them in offices—so to get around, people were always walking across there. You could, if you were talking, there would be a stream of people and you could pluck them out of the flow and bring them into the conversation. That is how you would tell somebody what to do, ask somebody what to do. They would bring in other people and you would have an ad-hoc meeting. You would get a coffee and croissant and sit around and chat. And there was a lot of informal chat and there was also, "You really need to know the pulse number—it's in the global variable on some other computer on the PSC computer or something. Martin knows what it's called. Martin! (snaps fingers) Hey Martin come over here. What did you call that global variable which was the pulse number? It's not the pulse number? It's the pulse number plus three? There you go. Didn't I say you should talk to Martin and ask Martin when you could read it and when you could not read it?" All this information about how these systems worked was sort of loosely coupled by these computers, which could all talk to each other. You could read variables on the computer and you could send programs to run on another computer. So a very, very, potentially disorganized system was organized by peoples' heads and the connections made at this coffee space.

DSM: Well I have heard you talk about how the smell of strong coffee triggers, for the lack of better words…

TBL: For example the smell of especially stale coffee for me was, the room I had in Queens College over the—I had the room on the corner of a Queen's end coffee house, on the corner of High Street and Queen's Lane.

Weaving the World Wide Web

DSM: My question about John Pool spun off from when the DG Nash Image Computer Systems Limited was established. You were there from 1981 to 1984?

TBL: If you think by saying these dates I'm verifying I'm not. You tell me.

DSM: That's right. If you had stayed at Image Computer Systems Limited would it have been necessary to invent another Tim Berners-Lee, or do you think this Web would have evolved without you?

TBL: I think it would have evolved one way or another. I think that, but I still can't tell exactly how and when. For example the Gopher protocol, which is very similar to the HTTP standard, came pretty much the same time. It didn't have hypertext but sooner or later somebody may have put hypertext. But there were some hypertext projects such as—Hytel-net was a hypertext database of all the telnet connections. There was somebody who made a hypertext, you

actually downloaded or you would get it on a floppy and put it on your machine. You could follow links as you went between different network resources, where a network resource was something you logged into. When you got to the end, then it would connect you to an interactive session, a telnet session to another computer, where you would then have to figure out how to talk to that computer; you just have to log onto it is all. There was somebody that had hypertext and also knew about telnet. I think that person could have put the hypertext stuff on Gopher. And if they had put it on different Gopher pages, and that would have started to go towards the World Wide Web. In a way it was, the time was really right for that. The Internet had spread to the point, and hypertext was not really spreading, it was still really a niche thing. It was considered a little obscure and something which had seemed fun but had failed, had failed to take over where the Internet was spreading.

DSM: Tell me the story about NeXT, about you buying a NeXT machine.

TBL: Oh, the group I was in was computing support to the real time pieces of physics. We were doing real-time data acquisition software, which for example was done on microprocessor and analyzed on a mini computer. I was working on Remote Procedure Call (RPC) software, procedure that between the two as a general tool for getting data out and controlling what's on the microprocessor. The microprocessor sometimes would be down there in an experimental pit where you couldn't go when an experiment was running, as it was too dangerous. Mike Sendall was running that group and we were always looking for new software techniques. Mike, in fact, had a glossary of software, new software terms. We were looking at object-oriented design techniques, real time software techniques. And then along came this NeXT which had the Mach real-time kernel; it was Unix with a real-time kernel built into it, which was really interesting in itself. It was an interesting operating system.

It also had revolutionary software for allowing you build in a new application just by pointing and clicking. If you had a new application, new program, just by answering questions and filling in, it would give you sort of a window and you could drag menu items and then right click on and then set up what they were, what the name of the menu item was and then to an extent, what would happen when you would click on it and it would arrange all the sub menus into menus.

A lot of the job of making a new program would be made a lot easier by this thing called the Interface Builder. It was some sort of interface building in the sense of human-computer interface builder. The NeXT was interesting for that. It was also a cool machine. Came in a magnesium cube, optical disk drives, a DSP which would allow it to do all kinds of cool things with sound, movies; really before its time from a lot of points of view. I had suggested to Mike that we should get one of these. I think Ben Segal had probably found it; somebody had shown me this thing.

DSM: They were incredibly expensive as I remember.

TBL: They were a little too expensive, a lot too expensive yes. They were leading edge. The real problem with them was not the price but the fact that you

had to buy the software and all these pieces together. When people noticed the optical disk, then they got nervous about the whole thing.

The way the Web spread was a piece at a time. You could take html without taking HTTP. The failure of NeXT was a lesson: don't try to sell it all at one time. Sell each piece on its own merits. Never insist that everybody take all. They will take all the pieces once they see how it fits together. Once they got this, they will find that that is really cool, but wait. If Steve had produced some really cool software, and then a really cool machine, which was just really cool to run it on. But if the software would run on other things as well, that would have given more flexibility and maybe would have gotten it in there, I don't know. But that wasn't the way Steve's mentality would work.

Mike said, and this is the point where I had already put around the memorandum about the hypertext system twice and nothing had really happened. But when I sent out the NeXT, he said, "I've been thinking about it. Why don't you get a hold of a NeXT, or get a couple of them? Why don't we buy a couple, see how they work? We can experiment with all these things, because after all there are lots of interesting things we should know about. It's a justified expense on those grounds. We'll need some sort of trial test project, play project to put together just to see how it runs. Why don't you try that hypertext thing that you've been talking about so much?"

The only thing about the NeXT, which was similar to the Web was Steve's motto of interpersonal computing, and the fact that he insisted even though it had cool software on the inside, it should not be geeky on the outside. He put this Mac-like very nice user interface on the front, a positive user interface copied by Windows later. He believed very strongly that the user interface could be really nice even though it had sophisticated stuff inside. In that way it is similar to the Web.

The Challenge of Being Human

DSM: In the five minutes we have left, I want you to comment on some random thoughts I have written down. I'm sorry we don't have more time to follow the chronology here. You called the Web a force both for unity and diversity. Comment on that.

TBL: In society, we need harmony and we need diversity. We need harmony so we don't fight each other, we don't kill each other in wars. So that we understand each other and communicate, we need a certain amount of shared concepts. If we share all the concepts then we will fail because we won't have enough richness of ideas. When a problem comes up it's really important that somewhere somebody has, is thinking differently and has got that alternative solution when the mainstream way of thought doesn't solve it. I feel it's really important to the world that there be cultures which differ, that we should not all end up adopting the same McDonald's Least Common Denominator. The way we use the Web has to allow us to keep different cultures, different languages hopefully, which is very supportive of different cultures. But at the same time allow enough harmony so that we don't end up beating each other up. That's the challenge of being a human being on the planet, whether or not it's with the Web.

DSM: I have a million other questions I would love to ask you, but I will ask you one of the harder ones, then I'll let you go. The Web has been compared to Guttenberg and printing. You're a very young man. When your children's, children's, children look back on this time and this place and this information technology revolution how would you like to be remembered as part of this revolution?

TBL: As just a regular person. I think one of the myths, which make it difficult to—I know people say they love role models and interviews like this are justified. Young people now want role models. I think it's great to celebrate the project's work. I think it's great to celebrate because I've started enough projects, which didn't work. It's wonderful that this one actually did. But to a large extent I was in the right place at the right time.

If you trace back, you know the things that have taken me through different places in my life were pretty much random. You know we talked about seagulls, and going to Geneva where, and I came with a certain set of experiences, and being put in a certain environment at CERN where the Internet had just arrived. There was a desperate need—I had a desperate nee—for document systems to talk to each other. There were all sorts of other people who could have been in that situation.

History selects people, chooses people to be pivotal in some way, but to a certain extent that's self-reinforcing in that once you get the idea, you have the duty to go and carry it. But also remember that people look at, that society looks at, who is the person? And they interview that person then the name gets attached to it, even though at the time there were lots of other people who had that twinkle and had that sparkle.

There were a lot of other people who pushed. There aren't a lot of people whose bosses allowed them to do this work in a time, because they felt just there was something potentially very interesting about it even though it wasn't officially on the agenda. To me what was exciting about it was the grass-roots effort and the fact that it was enabled by the Internet. We spread the Web with email and news and the initial Web servers allowed the thing to spread across to a lot of people.

I think that I've been very lucky, I suppose, to be seen to have this pivotal role. But there were a huge number of people involved and really any one of them could have had that pivotal role. You can't really tell who will, all you can do is to try. It only worked because the vision was shared by all the other people who were doing things, who were putting up Web servers in their spare time, or adding a little bit here. Steve Putz's first maps servers—you know he had a powerful vision of, wow we could do this! We can make a dynamic Web site where every page is calculated on the fly. It was really a vision that was shared in a rather special way between very many people.

And this in a way I can see—I've been told it's important phenomenon, but in a way historians with all due respect, can do the world a disservice by only picking out particular people because it makes the history easier to just talk about Benjamin Franklin, Thomas Jefferson. But you have to remember there were an awful lot of people involved. The way ideas transmogrify themselves as they wander through, as they percolate through society is very, very complex. And you're trying to just trace it, you know, just a few threads. I would hope I would be remembered as just a regular ordinary person, totally full of faults just like everybody else. Rather in awe at the process, the sort of this combined creative process, which I have been involved in.

DSM: Thank you very much that's a wonderful way to end the interview.