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David P. Anderson

Interview
An Interview with Maurice Wilkes

Maurice Wilkes, the designer and builder of the EDSAC—the first computer with an internally stored program—reflects on his career.

PRESENTED HERE ARE excerpts from an interview with Sir Maurice Vincent Wilkes, the developer of the Electronic Display Storage Automatic Calculator (EDSAC), microprogramming, symbolic labels, macros, and subroutine libraries. Wilkes, the 1967 ACM A.M Turing Award recipient and winner of the ACM lifetime membership award, is a former member of Olivetti's Research Strategy Board and an emeritus professor at the University of Cambridge Computer Laboratory in the U.K. David P. Anderson, Principal Lecturer in the History of Computing at the School of Creative Technologies, University of Portsmouth, U.K., conducted the interview with Wilkes, 96, earlier this year.

When did you first get involved with computers?

Well, you've got to realize that although there were no digital computers in the immediate pre-war period, there was a lot of digital computing. The importance and power of it was beginning to be recognized.

The actual computing was then on desk machines with people to work them, mostly research students, but professional computers were beginning to be employed for organizations such as the army, for calculating range tables or firing tables as they were called in America. That was all beginning to grow up. Cambridge was a very lively example of this digital computing.

PHOTOGRAPH BY BILL THOMPSON

Who was leading that activity?

We had here [John] Lennard-Jones[a] who was a great pioneer of structural chemistry. And he and his small group of very able people showed that in spite of the computational bottleneck you could, in fact, achieve quite significant results. Lennard-Jones was a man of much vision and he was successful persuading the university to establish a computing laboratory, which was initially called a mathematical laboratory. It was Lennard-Jones who gave me my first opportunity to get practical experience of computing.

What was your role?

The university took me on as the boy who did the work! Analog computers were much in the air then and a differential analyzer was ordered. We were starting up this mathematical laboratory when I received an invitation to join in the war effort working on radar. Of course, I didn't know the exact nature of the work at the time of the invitation but I was one of a small group of people from the Cavendish who were let into the secret.

Who was it that told you?

It was [Robert] Watson-Watt[b] himself at the Air Ministry. So, I went off to do that, deserting Lennard-Jones very ungratefully because he'd got it all fixed up.

How did Lennard-Jones react to losing you?

He didn't mind—I went off anyway. When I came back after the war, in September 1945, I found myself temporarily, but later permanently, head of the Mathematical Laboratory.

How much latitude did you have in deciding the priorities of the laboratory?

As head of the laboratory I didn't have to ask people if I could do things. The overall terms of reference were to develop mathematical methods and equipment for doing computation. So that was all fine. As I had been doing

a Sir John Edward Lennard-Jones (1894–1954)

b Sir Robert Alexander Watson-Watt (1892–1973) radar I didn't know anything about what was going on with mathematical machines but I soon began to learn.

Did you have any help with your education in computing machinery?
I learned a great deal from [Douglas] Hartree[c] who was in touch with American people and one day I had a telegram out of the blue from the Moore School at Philadelphia asking me to go to a course. I got there with great difficulty as crossing the Atlantic in those days was no simple matter. I missed the early part of the course.

Did that cause you any serious difficulties?
No, I had got a singular set of qualifications because I had done some computing as a student. I was one of the people that worked a hand-operated calculating machine. I was a thoroughly qualified electronics person having done ham radio and all that sort of thing. I had the mathematical background insofar as it was necessary for computing.

[John Presper] Eckert[d] and [John] Mauchly[e] were the instructors and they put me absolutely and fully in the picture. I heard them talking about stored-program computers—people say the Von Neumann[f] computer, it's really the Eckert-Von Neumann computer and I thought I might have a shot at building one.

Was that the first time that you had encountered the notion of the stored-program computer?
No, John Von Neumann wrote a report on behalf of the group and [Leslie] Comrie[g] was given a copy in America and he showed it to me. He lent it to me and I sat up all night reading it, so it wasn't the first time.

How did Comrie come to have a copy of the report?
They gave copies away to people who visited. Comrie's copy is now in the library of the Computer Laboratory.

What did you do next?
The first thing to do was to make sure an ultrasonic memory would work and we did that by January 1947 and then we went ahead.

This was quite a departure from the pre-war work of the laboratory. Did you need any special permission to start this work?
Cambridge is a very strange place, there are little departments like mine, and big ones like the Cavendish. But from the administrative point of view they are on a level. That meant I didn't have to ask anybody or make any proposals. I was able to just go ahead and do it. There were some funds that went with the lab in effect and I guessed that more funds would become available in due course.

Did you have a large staff at your disposal?
No, no; very small. Most projects—in industry and university—depend on a small handful of three or four people and we had less than that to provide the drive. There were a lot of people who were paid on the funds, mathematicians and other hangers-on and there were also a number of assistants. We had instrument makers and electronic people on the assistant level. But I was the one who brought all the information about computers into it so there was no argument with me you see; it all came from me. I had a very loyal team and so we went ahead.

How long was it before you achieved some success?
The EDSAC began to work in the summer of 1949 on May 6th. That was the day we did the first program and we'd all got little programs ready to run.

How was computer development viewed at Cambridge?
Oh I don't know, I always like to make a joke and say that they thought we were mad and if, at a cocktail party, you enlarged on your enthusiasm you would find people moving away from you!

You see, I never tried to do any proselytizing, I simply built a computer.

Did you have a clear sense from the start of who your users were likely to be?
They were all around me, they were students who didn't like spending weeks, or a week, or more computing. They rushed at a computer, even an unsatisfactory experimental one, as EDSAC was to begin with. And it was through those students that the idea spread. They went to their supervisors and said "Look what I've done." The supervisors were duly impressed and before very long important people in Cambridge were saying that computers were important. It was very low-key, bottom-up, students-upward. That's not a bad way for ideas to spread.

Did you have any concerns about how the computer-building work of the laboratory would be funded going forward?
Well, I assumed it would all happen. We were a very low-cost outfit because we didn't have a lot of the mathematicians and people on the payroll for the sake of the money and I was in 100% charge, which made it very easy.

Am I correct in thinking that the initial capital budget or the laboratory in 1936 was around £10,000?
Yes.

That was a very large sum at the time.
It was. Lennard-Jones was a man of enormous vision and although analog computers were in the air the laboratory was not biased toward analog computers. We could drop them as soon as it appeared that they didn't work out and I could go ahead and build a stored-program computer.

Although there were no digital computers in the immediate pre-war period, there was a lot of digital computing.

c Douglas Rayner Hartree (1897–1958)
d John Presper Eckert Jr. (1919–1995)
e John William Mauchly (1907–1980)
f John von Neumann (1903–1957)
g Leslie John Comrie (1893–1950)

That must have been a very liberating environment in which to work?

Very. Yes, it was a very responsible one. I mean no one else in the laboratory was sure that it was going to work but I was the one who could see it first. And so you see, we then had an enormous advantage. This is what really gave us the edge. Because quite a number of these computers, especially the one in Manchester, were beginning to work at the same time. But they all had to hire an engineer to build a computer for them but that wasn't the case with me.

I was fully qualified on both sides. I got a group of students working on programming before the computer was running and so we could make a very quick and rapid transition to the user side and that was where we got the edge.

Could you say a little about the different contributions mathematicians and engineers made to early attempts to build computers? Was there any tension between them?

Well, of course. Mathematicians weren't particularly well qualified. They'd all done a bit of numerical analysis but it wasn't the same as digital computing. I think perhaps tension arose from entirely different backgrounds. Take the question of Boolean algebra. Mathematicians often write and speak as though Boolean algebra and mathematical logic was at the basis of computing but it wasn't that way at all. The mathematicians did not understand switching really, electronic switching; the engineers did.

Mathematicians, when it was pointed out to them, that Boolean algebra modeled electronic switching at once understood and because they could understand digital switching to a certain degree by understanding mathematical logic, they assumed that everyone would look at it that way.

Whereas engineers, when they were first told about Boolean algebra, thought "What a daft idea this all is!" and it was only later when Shannon told them about the connection that they saw any use for Boolean algebra.

But there wasn't any use. Boolean algebra has no time element to it and while it is good for shaking up a bit of

M.V. Wilkes during EDSAC I construction; EDSAC I became operational in 1949.

complex logic we didn't have complex logic. We all had very simple logic in the early days. Eckert is on record somewhere saying that he looked at Boolean algebra but it didn't seem to him to be useful. None of the practical people made much use of Boolean algebra but it was regarded as absolutely essential to the mathematicians. But there was a tension between them that is perfectly true.

Did that give rise to any problems at Cambridge or elsewhere?

Of course so many of the physicists of the period had been through the mathematical tripos that was one of its strengths. But not all of them, many Cavendish people and supervisors like [John Ashworth] Ratcliffe[h] had no understanding of mathematics.

I was ensconced in the four walls of a computer laboratory and I never counted myself as a mathematician.

Von Neumann, of course, rather despised engineers. He got on with them all right but I don't think he regarded them as important for such matters as having credit for what they were doing.

[Alan] Turing[i] was an exact contemporary of mine and that means that I don't have to regard him as a great man because you don't regard your contemporaries as great men. I don't remember him very clearly from the undergraduate days but he was certainly in the class and we took the tripos together and we both got the highest honors you could. So that was all right.

He was a real mathematician except that he only learned one little bit of mathematics and then didn't learn any more. He was no practical organizer and, well, if you had Turing around in the place you wouldn't get it going.

That certainly wasn't a problem with the EDSAC.

No, I mean we just barged ahead on the EDSAC and the rule was that if you had got something that would work you didn't spend another hour on making it simpler or cheaper, you went ahead with it.

It demanded very strict discipline and keeping your eye on the ball. There were all sorts of interesting things to follow up but we resisted them.

We concentrated on the one objective with no demonstrations on the way. We didn't need to show that the ultrasonic memory would work. I mean when the electronics end, it was working that was sufficient. Whereas, you see, at Manchester they had an electrostatic storage depending on quantum theory and they had to be very sure that it would work. It was [Tom] Kilburn's[j] idea to build a 'Baby'. He was able to do it. Validating the memory was what the Baby was all about. It was absolutely essential because they had to validate it not for themselves but for their sponsors.

I wasn't troubled with sponsors. Somehow the money came.

To what extent would you say that the work of [Charles] Babbage[k] was significant in shaping the early development of stored-program computers?

I didn't know anything about Babbage. People started writing letters to the *Times* and Hartree got interested and I remember him coming into our building with a copy of Babbage's memoirs in his hand. It was Hartree who got me interested in Babbage. Of course, Babbage never had the concept of the stored program, instructions being coded as numbers; Babbage certainly wasn't influencing me.

h John Ashworth Ratcliffe (1902–1987)
i Alan Mathison Turing (1912–1954)

j Tom Kilburn (1921–2001)
k Charles Babbage, FRS (1791–1871)

Looking back, what would you say was the significance of Turing's 1936 Entscheidungsproblem paper?
I always felt people liked to make a song and dance. Something like the doctrine of the Trinity involved whereas to an engineer you've only got to be told about the stored program idea and you'd say at once "That's absolutely first-rate, that's the way to do it." That was all there was to know.

There was no distinction in that paper that had any practical significance. He was lucky to get it published at all but I'm very glad he did. I mean [Alonzo] Church[l] had got the same result by other methods.

I liked Turing; I mean we got on very well together. He liked to lay down the law and that didn't endear him to me but he and I got on quite well. People sometimes say I didn't get on with Turing but it's just not true. But then I was very careful not to get involved.

Was he a difficult man with whom to get along?
Yes, I think that's probably true and he was not in any sense a team leader. He didn't know how to get things done.

Of course I had another advantage there. I had war service, six years of it, and I had done real staff jobs and that teaches you a lot about how to get things done. [Max] Newman[m] was a great admirer of Turing. But he was not in the line management of the computing work; I mean Newman was never an engineer. The professor of electrical engineering did that.

[Freddie] Williams?[n]
Yes, everybody at TRE [Telecommunications Research Establishment] had some experience of management. Williams was in charge of the computer at Manchester and he was a very strong-minded person. Mind you he was a leader too—he ran it like a dictator!

You can't design or build a computer unless you're an engineer. I mean that's what you mean by being an engineer. Newman exerted very little influence on what went on in Manchester. Williams saw to that all right.

l Alonzo Church (1903–1995)
m Maxwell Herman Alexander Newman (1897–1984)
n Sir Frederic Calland Williams (1911–1977)

Did Newman's involvement with the Colossus have any effect on developments at Manchester do you think?
No, I don't think Williams would have been interested in the technology because, as I say, when technology moves, it moves very fast. And the technology that was used in the Colossus was very different from the sort of technology that took root in Bawdsey [radar station].

Was there any rivalry between the various computer-building projects about who would get there first?
Well, as I always say, it was a funny race because we were all aiming at different finishing points. You see, we wanted something that was business-like and would fit into this existing digital environment. Eckert and Mauchly wanted to produce a commercially viable computer and I don't quite know what Williams wanted to do. He had no permanent interest in computers. He wasn't very interested in computers at all. He was interested in showing that CRT memory would work but I don't think he had any interest beyond that and he handed it over to Kilburn who made very good use of it. Kilburn was a very, very great success.

What are your recollections of Kilburn?
I knew him very well. Of course we were very good friends and we were both determined that we wouldn't allow any Manchester-Cambridge rivalries to show up in our groups and we achieved that on the whole, I mean we always had a high respect for each other. It could so easily have happened, you know. But it didn't and that was due to Kilburn's common sense really and mine. It was very important but I mean we were complimentary.

What was Kilburn's interest in computers?
He was interested in providing a computing service as I was.

Returning to Newman for a moment. We now know that in 1945, Newman took Willis-Jackson, who was William's predecessor, to Bletchley Park to see the Colossus. Did Newman ever discuss the Colossus with you—even in the most general terms?
No, and I don't think Williams would have been interested in the technology because, as I say, when technology moves, it moves very fast. And the technology that was used in the Colossus was very different from the sort of technology that took root in Bawdsey.

Another important figure at Manchester at that time was Patrick Blackett.[o] Did you have anything to do with Blackett?
Blackett? Oh, I knew Blackett, he was always very nice to me. He said he didn't know anything about computers and that was perfectly true. He was of an age. Above a certain age people are never really happy with computers.

He helped Williams and Newman though?
Well, he was a busybody so he would be everywhere. He was very energetic and he knew how to get things done. He thought socialism was a great thing, whereas I thought socialism was a great mistake and indeed it was.

What have you found most surprising about the developments that have taken place in computers since 1949?
Well, of course, it's the speed. We had great vision, we saw that computers were going to be a big thing, not only for arithmetic calculation but in other things as well, business and whatnot. We had great vision but we could have no idea of timescale. For one thing, young men don't but the other reason was of course we couldn't see the coming of semiconductors. Now semiconductors have given us various things, small size, small cost, high power but the important thing they have given us is reliability. We used to pray for reliability—our prayer was answered. In my lectures on this sort of thing I say that it was St. Theresa who was credited with the remark that it is prayers that are answered that create more problems than those that aren't!

o Lord Patrick Maynard Stuart Blackett (1897–1974)