# The Disk Drive Story
# Chapter 1: IBM's RAMAC

Transcript #5

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| | **Wesley Edward Dickinson (Wes)**<br>Joined RAMAC Project – Sept. 8, 1952 |
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## Transcript:

**Jim:** We are ready to start again. We have gone through a lot of discussion during these sessions about all of the problems, difficulties and challenges in making disks that would work, making heads that would work, and making the logic that would understand how to operate this system, but how did all of those heads move back and forth to accurately get to the data? Today we'll take up many of those issues. First, let's introduce Lou Stevens, who has been in all of our sessions and is one of the organizers. Lou, please define that problem.

**Lou:** Early work had been done on different kinds of mechanical motions to move the head back and forth. Finally we concluded that a servo scheme should be used. But nobody at 99 Notre Dame had any experience on servos. So, Wes Dickinson took over the task of doing the electrical work on the first disk drive. As I said last time, if it had not been for Norm Vogel, we wouldn't have had the first disk drive on the mechanical and air head side. If we hadn't had Wes Dickinson, we wouldn't have had the disk drive on the electrical side.

**Jim:** Wes, can you give us a little bit of your background and tell us about what you did before you joined IBM?

**Wes**: I was working in Los Angeles for the North American Company. They were getting into space flight and things like that. There was a fellow there by the name of Walt Evans, who came up with a method of servo design called Root-Locus. After working with him on that, I came up with a simplification of where we were trying to get in Root-Locus. He put it in his book. But then at IBM I was faced with moving heads around all these disks and finding out how to do that. I came up with the mechanical side of it in terms of how we'd move the heads around. There were a pair of magnetic clutches being turned steadily. If you turned only one of these clutches, it would cause the motion to go one way and the other one went the other way. This happened a long time ago, back in the late '50's. As I remember, one of the things that concerned me was that the drives were pulling these things around with a cable. I wondered if stretching of the cable would be a problem. But when we finally tried it, it didn't seem like that was a problem at all.

**Jim:** Lou, you were overviewing this research as the project leader. What was your thinking about the difficulties of this project as it proceeded?

**Lou:** It was a tough tough assignment to get the thing to be stable. We had lots of experiences in an early version that wasn't quite stable. They tended to run away every once in a while. The design of this servomechanism was a pretty elementary self-balancing potentiometer-type arrangement. Wes put his expertise to work to make that thing zing along. I can remember coming into the 99 Notre Dame lab late in the afternoon, late in the night and there's Wes, sitting making that thing hum.

**Wes:** As far as the servomechanism is concerned, in the circuitry there was one place which controlled how it worked. Basically there is a capacitor and a resistor in a typical servomechanism. When the resistance was reduced in this setup, it moved much faster. But when it got to the supposed destination, it would go beyond, pull the arm and go back and forth -- oscillating. On the other hand, if a very high resistance was used, it would go to the place you wanted it to go, but it would take a long time to do it.

**Jim:** How did you fix it?

**Wes:** Somewhere or other, in a previous lifetime, I heard of a thyristor. A thyristor has a nice characteristic. If you put a large voltage across it, it has a low resistance. If you have a low voltage, then it has a high resistance. By putting that into the place where we needed a resistor, it fit perfectly. When you're far away from something it would go really fast and when as we were approaching it, voltage would go down and we'd shift into the other mode. It's just like having a little man riding along with the thing.

**Jim:** It was quite a challenge wasn't it? The specifications kept changing didn't they? Weren't there several different motor speeds and different arrangements on tracks.

**Wes:** I wasn't really involved in that.

**Jim:** Things had settled down by the time you were working on it?

**Wes:** I think so. That wasn't a big point with us. By using this way of running the servo, we were able to travel the farthest distance that we had to go from the inside of the bottom disk to the inside of the top disk. It did that in about .55 seconds. Seemed to be pretty stable – no problem in terms of overshoot – our little magical thyristor.

**Lou:** Wes was the poster boy when we finally got the apparatus working. It was kind of fascinating to watch the thing move back and forth to the disk then a track on a disk. Rey Johnson was trying to get recognition for this fine piece of work that his young men had done. Rey invited the *PG&E Progress*, which was the little newspaper that came in your PG&E bill every month, to come visit the laboratory and see what his boys had done. The July 1955 *PG&E Progress*, which was a couple of years after they started the thing, featured a picture of Wes and the early disk drive as 'The exciting device that stores 5 million thoughts." Thoughts and bits are not quite the same thing.

**Jim:** Actually this was one of the first public disclosures.

**Lou:** This was **the** first public disclosure of the disk drive and Wes was the 'disclosee'.

**Wes:** After we got the thing running to this stage, then the next step was to be able to write some information on the disk somewhere and go back and read it. Some of the information that was written on the disks or read from the disks was clocked by a track on the very top disk. We soon found out that we weren't doing very well in terms of reading information we had written earlier. There was always a little bit of movement of the head and the clock track as well as the other heads that were moved in and out to various disk positions. So it was necessary to overcome that clocking problem. Leonard Seader, a recent graduate of Berkeley, worked for me. He stepped in and solved the problem for us. Once we knew we had a big problem, he tackled it and came to me one day and said, "I've got the answer, I think." It turned out that he was using the data track to clock the thing. He had two oscillators in his setup and they were running very close to the right frequency. It didn't have to be too close because one oscillator was on at a time and when it went off the other one came on. It switched every time you got a '1' bit. We were then able to read everything we wrote on the disk very easily. In fact, before we had that, we rarely could even make out what we had written at all. After that we could go through the whole disk file without making any mistakes time and time again.

**Lou:** Interesting, the tolerances necessary on that pivot in the head made the head jiggle in the air flow and jiggle on the signal. Leonard's invention allowed us to read through that jiggle.

**Jim:** So finally the design settled down a bit?

**Wes:** Well, an incident happened that sort of scared us a little bit. This actually happened before we were reading anything at all. We were just setting up to run the machine with one disk on the very top and one disk on the very bottom. The mechanical guys had devised how the thing was put together. There was a huge washer that would sit on the shaft and then a disk sat on that and so forth – stacked all the way up to the top.

**Jim:** Let me interrupt Wes, to point out to people when they see this, a little bit of background. Wes lived through the Second World War as a bomber pilot. At one point in the South Pacific, Wes's plane was shot down and several members of his crew were killed. He was lucky to get out of the plane, lucky to get out of the jungle that he had to go through for several days to survive. Yet when he went to work for IBM he almost got killed by a disk drive. *(laughter)*

**Wes:** The thing that kept us from getting killed was a shield that Don Johnson invented to put around the whole RAMAC disk assembly. It slowed down the shrapnel. Leonard and I were the only ones in the room. We started it up. It didn't even get up to full speed before it started to fly apart. The shaft spacers were without any disks on them because we just had one disk each on the bottom and top. There was nothing to contain the spacers. The spacers started to break because there was an intentionally cut slot through on one side to make them easier to put on the big shaft – it was about six-inches in diameter. Leonard suffered a cut tendon in his thumb. In my case it hit me on the nose and broke my nose. The same piece hit me near my right eye and on the side of my face. Both of us went to the hospital. In my case it was much easier, I only had a little broken nose. I have a big nose anyhow. For Leonard, they had to go in and do some work and tie things together in his thumb. That really preceded the time we were able to read and write or try to read and write. Without Don Johnson's plastic shield on there – I think they were actually Plexiglas – we probably wouldn't be around today. That reminds me, when I got shot down if I would have been this much *(a few inches)* to the right, I wouldn't be here today.

**Jim:** In each case you were in the right position – didn't lose your eyesight; didn't lose your life.

**Wes:** When I wrote my autobiography, I called it "I Was Lucky". I have lots of things I have been lucky about.

**Jim:** I think you and Leonard are the only ones in the history of the disk drive industry that were ever attacked in that manner.

**Wes:** That's right.

**Jim:** In due course the design did tend to settle down a bit I hope.

**Wes:** Yes, I think they probably stopped putting the slots in the spacers, but with all the disks on the spacers they couldn't have flown apart because the disk would have contained them.

**Lou:** The slots were there only to make it easier to replace. They weren't permanent.

**Wes:** As I said, we had the problem of actually clocking properly. We also realized that sometimes when reading a disk, there was a problem about the location in and out on the disk. If you weren't exactly on the same track you had written on, then reading could be hard. There was a little bit of tolerance in all of these things. So it was rather simple to come up with the solution. In order to write, we actually had two heads in the same arm on the reading heads.

**Lou:** One on the top and one on the bottom.

**Wes:** Even on one disk we had two heads – one wider than the other.

**Lou:** Oh, two gaps – write wide/read narrow.

**Wes:** I think the way we actually ended up doing it was erasing everything with the front head while writing with the back head. It cleaned the track up. Somewhere in the RAMAC system, the information was held for the complete track to be written.

**Jim:** This was an interesting challenge since it hadn't been done before in the history of mankind – to figure out exactly how to do that.

**Wes:** Yes, putting two heads together.

**Jim:** Using an air-forced head and of course there had been drums which used magnetic heads before, but they didn't move in this manner – new to the race of mankind.

**Lou:** There had been write wide/read narrow schemes proposed and used elsewhere. We weren't the first to do that application.

**Wes:** I have the patent on it.

**Lou:** Do you? So you were the first. I didn't know that.

**Wes:** Yes. We first did the machine traveling which we thought was about as fast as we could go – maximum distance in .55 seconds. Next we had to get on to the case of how reliable it was to write data and read data. We would put certain characters on a disk, something else on another and on different tracks. We loaded the things up and ran them all day long and into the night to see if they made any mistakes. We finally had it to where it was very reliable.

One day after we got the thing going, Leonard Seader, the inventor of the scheme for self-clocking, came in and said to me, "I'm going to work somewhere else because I don't think we'll ever get any more information on disks." *(laughter)*

**Jim:** A lot of people have come to similar conclusions over the years. It does seem to be moving ahead though doesn't it?

**Lou:** If he got that little IBM Microdrive that holds like 200 RAMACs, he'd be amazed. 1 Gigabyte is equivalent to 200 RAMACs. WOW.

**Jim:** That's only the beginning.

**Lou:** Probably so.

**Jim:** Again, being the first to do these things was quite a challenge. When you think about what this team was doing: being the first to make such a disk with the proper magnetic coating on it; the first to figure out how to make heads that would fly at the right distance reliably off the surface; the first to move those heads – developing electronics to control them like Wes did. These are very interesting challenges to be done for the first time ever.

**Lou:** We were young and didn't know that you couldn't do it.

**Jim:** That is probably one of the keys – not knowing that you can't do it.

**Wes:** I was confident and excited by the challenge and it just sort of fell out. I think probably while I was working down in Los Angeles I came across the thyristor. I remember one of the head honchos down there said, "If you bring me a linear servomechanism, I can make it better by making it non-linear." This was definitely non-linear.

**Lou:** I think the interesting thing is, and I have to repeat, that the environment Rey Johnson created at the 99 Notre Dame facility was so remarkable that everybody had a chance to contribute what he **could** contribute. Rey's rule or guidance was to find out what's going on – put your nose in and find out what's going on. Everybody did.

**Jim:** And respond to anybody else's request for your help.

**Wes:** I don't know when it started, but every Friday afternoon we were supposed to invent stuff.

**Lou:** Every Friday afternoon was 'do your own thing'.

**Jim:** So when did you feel that you had all these problems solved? Or did you ever feel that way?

**Wes:** When it went out the door and over to manufacturing. Incidentally, when I went over to manufacturing one day, one of the engineers working over there asked, "Could you come over and take a look at your RAMAC machine, it doesn't seem like it's working anymore?" I went over and I found out that he didn't have a thryistor. I said, "That's what you need, a thyristor." He put that in and then it worked. *(laughter)* That really was magic, because it did exactly what you wanted it to do in a servomechanism of that sort.

**Lou:** I didn't realize that you had invented the write wide/read narrow technology – that was a key ingredient in making things work and a key ingredient for all future disk drives that had problems with positioning.

**Jim:** The principle is still used.

**Lou:** It was very important to removable disk drive packs.

**Wes:** It was sort of an obvious thing.

**Lou:** Maybe so, obvious to you, but I didn't realize you were the inventor thereof. That's wonderful.

**Wes:** Yah.

**Jim:** Lou, it sounds like it's a completed job at that point.

**Lou:** I think we wouldn't have ever gotten the first disk drive if Wes hadn't been there with his thyristor and write wide/read narrow servo experience all put together.

**Jim:** And somehow make all of those vacuum tubes work.

**Lou:** All of those vacuum tubes worked.

**Jim:** These were some of the last of the electro-mechanical devices that used vacuum tubes before the transition to transistors.

**Wes:** Yes, it would have been a long time before transistors could have given power to this thing.

**Lou:** That's right.

**Jim:** Very good.