The Brookhaven TV-Tennis Game

by W.A. Higinbotham

Video and arcade games.

Some of my friends who subscribe to Creative Computing read an article in the October 1982 issue which credited me with inventing video games. Other friends heard this on the public radio network about 6 p.m. on 18 February 1983. This has reconnected me with a number of old friends. Whether or not inventing video games is something to be proud of is another matter.

This recent notoriety is due to the fact that I designed a tennis game for two to play, that displayed the court, the net and the moving ball on a cathode ray tube in 1958. Although many hundreds of people played this game at Brookhaven National Laboratory in 1958 and 1959, it received no publicity then, and it only began to attract attention in the 1970's, when video games became big business.

Every year Brookhaven National Laboratory has had visitor days, to show the public something of what it is doing in physics, nuclear energy, chemistry, biology and medicine. In the 1950's we had three visitors days on successive weekends in early fall; one for high school students, one for college students and one for the general public. Buses took people around the campus to see the high-energy proton accelerator, the nuclear research reactor, the biology department's radiaton field, etc. The main exhibits were designed by the different departments and displayed in the gymnasium. Most of these exhibits were picture and text displays or static instruments or components. The Instrumentation Division, which I headed, displayed examples of its wares, along with the others.

It occurred to me that it might liven up the place to have a game that people could play, and which would convey the message that our scientific endeavors have relevance for society. We used oscilloscopes in designing electronic circuits and sometimes to display experimental data as it was being accumulated. An oscilloscope has a cathode-ray tube, which is similar in principle to a black and white TV tube. However, it is designed to display traces or patterns, rather than complete pictures. We also had a small analogue computer (not to be confused with a digital computer) that contained 10 "direct-connected operational amplifiers". The instruction booklet that came with this analogue computer described how to generate various curves on the cathode-ray tube of an oscilloscope, using resistors, capacitors and relays. Among the examples were the trajectory of a bullet subject to gravity and wind resistance, ICBM trajectories and a bouncing ball. The latter suggested the tennis game. Four of the operational amplifiers were used to generate the ball motions and the others to sense when the ball hit the ground, or the net, and to switch the controls to the person in whose court the ball was located.

The display showed a two-dimensional, side view of a tennis court. A horizontal line, below center, represented the floor of the court. A shorter vertical line in the center represented the net. Before start of play the ball was shown at a fixed position above one or the other end of the court. Each player had a small box which he held in one hand. On the box were a knob to aim at the ball (up, down or level) and a push-button. To start play, the person with the ball at his or her end of the court, would select an angle and push the button, whereupon the ball would proceed over the net or hit the net and bounce back. If it went over the net, the other player would select an angle and attempt to return the ball. He could hit the ball as soon as it passed the net or after it bounced, or wait to see if it landed beyond the end of the court. There was some wind resistance, and some energy was lost in each bounce. The raquet was not shown and the strike velocity was pre-set. We had controls for velocity but judged that a player would have trouble operating an additional control.

In order to generate the court and net lines and the ball, it was necessary to time-share these functions. While the rest of the system used vacuum tubes and relays, the time-sharing circuit and the fast switches used transistors, which by 1958 were coming into wide use.

The game was a great success in 1958. Long lines formed to wait for a turn at play. The oscilloscope display in 1958 was rather small, as the picture shows, being only 5 inches in diameter. In 1959 we used a bigger tube (10 or 15 inches in diameter) and added a novel feature. You could play the game on the moon, with very low gravity, or on Jupiter with very high gravity.

My children and friends ask, why didn't I patent this and become a millionaire? I agree that I should have applied for a patent, but I would not have been any the richer. The patent would have belonged to Uncle Sam. At the time it did not appear to me to be more novel than the bouncing ball circuit in the analogue computer book.

To explain how I happened to be so inspired, it is necessary to go back many years. At the end of my freshman year at Williams College I had no idea as to what major to choose. At the start of sophomore year I decided to take beginning physics because I had enjoyed it in high school. I got all A's and decided to major in Physics. Senior year I was permitted to do an "honor's project" in lieu of a course. The physics lab had an oscilloscope so I reproduced a system, recently described in the literature, to display the audio modulation of a radio station's high frequency radio output.

After graduating from Williams I was accepted as a graduate student in physics at Cornell, where I passed the required courses and qualifying exams, but did not complete my thesis in all of nine years! For the last six of these I was employed by the physics department as a general purpose technician (40 hours a week, 50 weeks per year, salary $900 minus $150 tuition). Among other things, this job gave me the opportunity to learn the new and rapidly developing field of electronics.

In December 1940 I was invited to join the staff of the M.I.T. Radiation Laboratory, which was being established to develop micro-wave radar, and where I was assigned to work on cathode-ray tube displays for airborne, shipborne and land-based radars. This involved designing means to present the echos returned from distant targets on cathode-ray tubes, in angle and distance, not far from the problems involved in the tennis game display. The last system I worked on before going to Los Alamos in December 1943, was the Eagle radar display system which presented the radar returns of ground targets as seen from a high flying B-28. The display could be "locked" to the ground during final target approach; by which I mean that the picture of the target area stood still on the display although the airplance was travelling toward it, and in spite of yaw, pitch or roll of the aircraft for maneuvering. While doing this I was later granted patents for inventing circuits to take the integral of or the derivative of electrical wave forms using operational amplifiers like those in the analogue computer which I used in the tennis game, although the term "operational amplifier" came several years later.(1)

So, it was a natural progression for me. I guess it took me about 2 hours to lay out the design and a couple of days to fill it in with the components that we had at hand. As I recall, it took the technician, Bob Dvorak, about 3 weeks to put it together and a day or so for the two of us to debug it. Several of the scientists and engineers of the Instrumentation Division had fun showing it off on the visitor's days.

The first video game patent, by Sanders Assoc., was applied for in 1964. It was purchased by Magnavox which brought out the first and quite inferior game that you may have seen in bars in 1971. Magnavox sued all other entrants to the field and, I assume, often collected. About 1976 a patent lawyer for a competitor found someone who had played the game at Brookhaven and tracked me down. By good luck, we had made drawings of our system. Thus began an on and off relationship with patent attorneys. Some interviewed me and got affidavits. Others phoned to confirm rumors. Finally, in 1981, one of them determined to break the Magnavox patent. In February of 1982, I made a depostion in his office before the Magnavox lawyers and others. In June, two of my colleagues and I were scheduled to testify at a trial in Chicago to break the Magnavox patent. At the last moment the case was settled out of court. Magnavox offered to be magnanimous and the defendants decided it would be cheaper to settle than to go through more suits and appeals. So we didn't get our day in court.

One thing I learned from this is that patent law can pay well. At my deposition, one of the lawyers said that he was sorry to see the end of an enterprise that had paid him well for five years. It was then obvious that I should have applied for a patent.

It is kind of nice to get this recognition. However, I consider my tennis game to have been one of my minor accomplishments. The radar displays I designed at M.I.T. were more important, and the Government patents in my name from my days at M.I.T., Los Alamos, and Brookhaven are more basic and more valuable to society. What I find most distressing is that my efforts during the last 38 years have done very little to slow the nuclear arms race.

(1) U.S. Patent Nos. 2,436,891 and 2,589,807.

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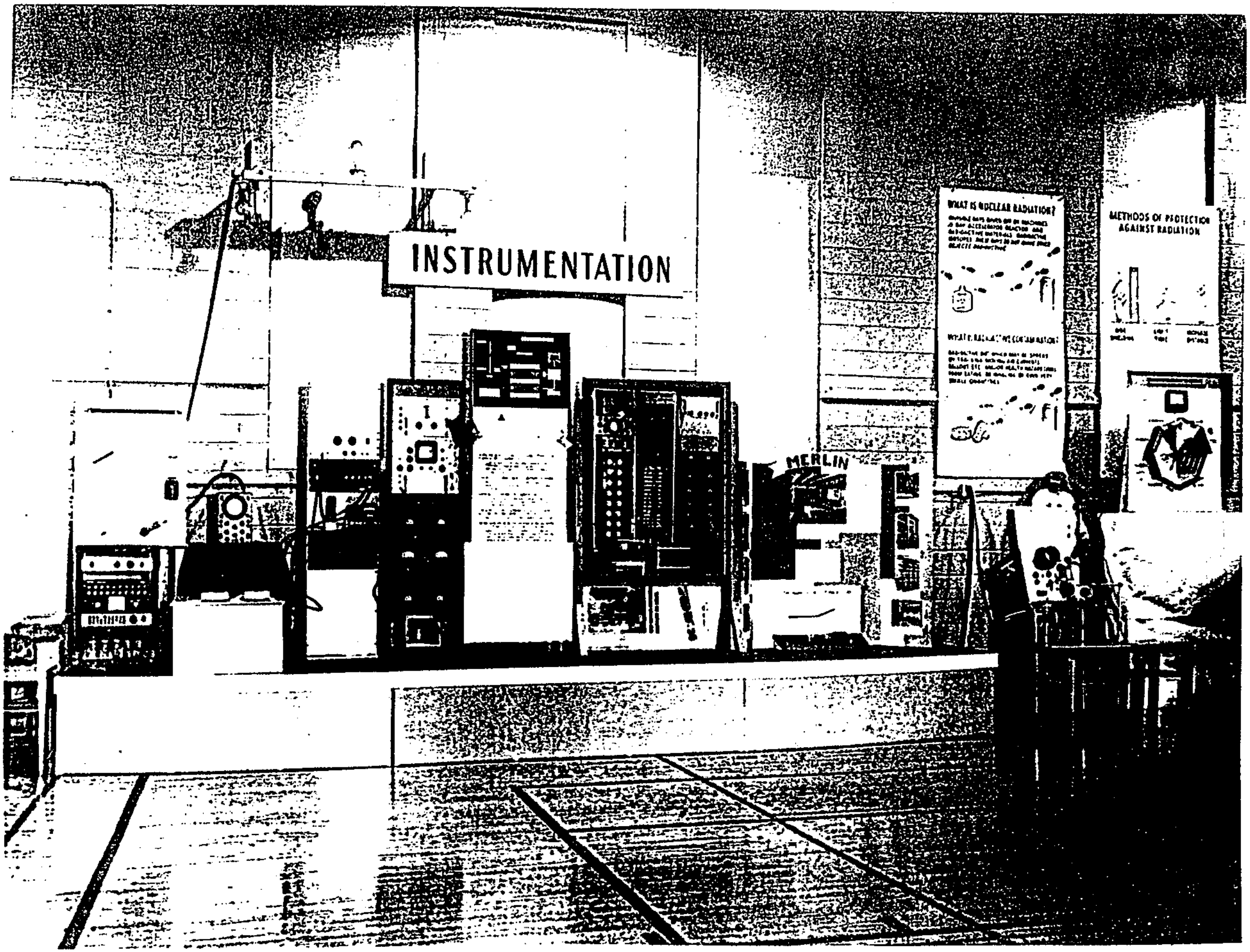
Picture Caption

The Instrumentation Division exhibit of 1958. The tennis game is second from the left, a small oscilloscope on a black box that housed the circuits which generated the display. The two oblong white objects in front of the black box are the player's controls.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