INTERVIEWEE: Dr. Ben D. Wood

INTERVIEWER: Henry S. Tropp

DATE OF INTERVIEW: September 15, 1972

Tropp:

This is a discussion with Mr. Ben Wood in his apartment at 106 Riverside Drive, near Columbia University on the 15th of September 1972. And, I think I'd like to start with that 1919 problem of solving a ninth order determinant. What was the problem to begin with?

Wood:

Well, the problem was the revision of the Army alpha and, alpha, Army alpha..Army beta tests. Those two tests were made, constructed early in the first World War period or some parts of it had been constructed earlier by A. S. Otis of the World Book Company. And he had really invented a method of using objective tests that could measure not only facts but also reasoning items. But, the Army alpha test, purely verbal, was almost entirely an information and a reading test. That was the limitations of that instrument and for non-readers we had a special group make up what they called the Army beta test which was entirely non-verbal. It consisted of figures comparing a triangle with a square and with a hexagon and so on--that kind of visual recognition of different shapes on a flat surface.

Tropp:

That kind of thing, I would gather, is still used with pre-schoolers.

Wood:

It's still used with pre-schoolers in some instances. Of course, greatly improved.

Tropp:

Right.

Wood:

Those that we had then were as primitive in that type of test as the verbal tests were primitive in the sense that they called for nothing except reading and information available in the recruit's mind. And, .. I forget what organization--maybe in the Army, Department of the Office of Education or some other agency--decided that the Army alpha tests were worth analyzing--you see, it had five or six parts--some vocabulary and some information items and a few simple arithmetic items and they wanted to develop a unitary total score that would give each of these various parts of the Army alpha test its maximum desirable weight in the summation of the part score. So, they put Dr. Truman L. Kelly in charge and Teachers' College assigned him for the summer of 1919 the attic of .. of that building up there, [it] is on Broadway between 120 and 21st street, which I always remember as a hell-hole of heat and mugginess. I don't know how we ever stood that three months of the worst summer in history up in that furnace. Our hands would get so wet with sweat that we couldn't pick up the papers without smudging them. And Kelly got a fair sampling of test results on each, and then got separate scores on each of these, I don't know, remember now, I said nine variables. It might have been six, seven, or eight or nine, but I know, I think it was about at least eight and maybe nine. He got all the other correlations and made up a determinant, a matrix and then with Monroe calculators, we had to add all the columns, one after the other, and then all the rows. And finally, we reduced it down to one figure. And the thing--I'm not sure but I believe that Kelly thought that the result that we got were not really accurate but that was the best we could do. There was no time. It took us all the summer and I had other jobs to do.

I then became assistant to E. L. Thorndike.

Tropp:

When you say you were solving a determinant, does this mean that you solved a single determinant or that you were solving a whole set of determinants?

Wood:

Well, I believe that there was a smaller determinant that one of the other clerks--I was simply working as a clerk for Dr. Truman L. Kelly--and the only one I worked on was the one that took us all summer.

Tropp:

That was one determinant?

Wood:

One determinant--seven, eight or nine variables.

Tropp:

Yeah, a determinant of that order is just an incredible amount of work.

Wood:

Incredible. Although we checked it--I have a suspicion that he felt that it was not accurate enough. But, anyway, he issued the new edition of the Army alpha test, and it was called the National Intelligence Test, which was very widely used and eventually very severely criticized, so that other test-makers began to make tests which became more and more a test of intelligence and reasoning power and of inference, inferring power than mere memory of information. And the great

objection during the twenties was that they were mere memory tests.

Now, my--I don't claim to be a great psychologist, but some who did make that claim asserted that memory was unimportant: that what you ought to measure, what we ought to try to measure, develop tests to measure, [was] pure intelligence uncontaminated by memory.

Tropp:

Well, of course, today we go one step farther and we are striving for a lack of contamination in terms of environment and experience.

Wood:

Well, that's a different sort of thing, which is very much more valid and much more valid, I think. Because, of course, these people who wanted to measure thinking uncontaminated by memory were apparently forgetting that you can't think without something to think with, so my policy has always been to test general cultural, informational background and, in addition, as a separate thing, test thinking powers probably so that each question will involve at least one or two or three degrees of reasoning. And, in addition, I always felt that mathematical, like musical, ability is more or less independent of verbal ability, and not enough independent of it to require separate measurement, and that is generally the policy that has prevailed since that is, the College Board, for example--Brigham, Carl Brigham, made up his college entrance examination, and he had the VAT, the Verbal Admission Test, and the MAT, the Mathematical Admission Test. And so that prevailed for many years and in 19--am I getting off the track now?

Tropp:

Well, just slightly. Because we're going to be dealing with testing, I think that's, that's valid. We're

interested, as I say I am, more in the mechanical aspects that begin when the Statistical Bureau is formed

Wood:

Yes. Well, the fact is that at that time, sometime in, I think, the late twenties or early thirties, Thurston went to Chicago from Washington and he began to make these analyses, the partial correlation technique which was also quite expensive, and you had to do it manually. And, his analysis of matrices, determinants, and so on and in the early--well, this is '28, I think '28, that I became aware of the fact that, from my own experience and from that of others, that we simply could not have real progress without more accurate and more expensive ways of doing all this arithmetical work: this pure arithmetic really that held us back. And we had all these adding machines and that sort of thing, but they were still very slow. You had to read them and therefore every time you had to read the transfer of something, you involved error. You can't avoid that. And so, I, in 1928 or early '29, I addressed a letter to the heads of ten of our American corporations that, at least I thought, were making electrical gadgets of various sorts.

Tropp:

By the way, is a copy of that letter still around?

Wood:

No. I'm sorry. I had ten four-drawer files stored in the attic of Hamilton Hall, and when they converted the attic into rooms, the workmen just threw all of these things out and sold them for junk.

Tropp:

Oh.

Wood:

I'm sorry that I haven't--very sorry, because there were a lot of things that should go into the record, but were unhappily burned. They also stole a $200 rug from my office during the alteration process. But--I wrote a letter to these men, and two, three or four weeks later I got answers from nine of them written by some third assistant secretary of a vice president saying that they were not compet--it's outside their field of competence. But I mailed this letter at noon one day to the IBM, and at ten o'clock the next morning I had a telephone call from him saying "I received your letter and am very much interested. I am very sympathetic with your ideas.

I have one hour today, if you'll meet me at"--not the Century Club as I indicated, but, I think at the University Club; he never was a member of the Century I was told later--"meet me at this club at one o'clock and go to room so and so and we'll have a one hour's talk; and I'm going to have to leave at two, because I have a very important engagement." So, I got there at ten to one, and went to this room; and he came in. hurriedly, with his secretary, and he said, "Now, you stand outside that door and at two o'clock, you drag me out of here if you have to do it by force." And we started--I didn't eat anything because I wanted to make an hour count. So, I told him that his tabulators and card sorters and other devices then available, which were all electro-mechanical, could do marvelous things in science and education, civil service, government, logistics, military, aviation, astronomy, every science in the world, its beacon light is really mathematics. And I said "that what you're dealing with is mathematics, the Arabic numbers, whether original Arabic numbers or the binary system, you're still dealing with quantities. There's nothing in the universe that does not exist in some quantity. And so you're dealing with the very warp and woof both of all science and all education, and all government, and all human

affairs even from blood counts and micro..micrology of living things up to the invisible galaxies." Well, he was surprised and very greatly pleased. I never saw a man's face shine as his eyes and face shone when I told him about all of these areas in which his machines might work miracles. But, I did make one goof. When I told him all these possibilities--see I was anxious to get a set of his machines because I had a couple of young geniuses in my staff and I was something of a gadgeteer myself, as I'll tell you in a moment. I did one thing, at least. And finally, about halfway through the hour, he said, "Well, now you've told me all these possibilities." He said, "I want to work with you. I think you're the right kind of person to have on our staff." I hadn't even thought of that. And he said, "Tell me, what's wrong with our present machines?" And I blurted out, "they're too slow." Well, you know, if you know Mr. Watson, his whole history, he could never, never tolerate any adverse criticism, no matter how constructively it was intended. Well, his face got purple and I said, "Don't misunderstand me, Mr. Watson, I'm not saying that as it sounds. I mean--What I meant to say is that we've got to, your machines are capable of working much faster." He said, "How much faster?" I said, "Well, indefinitely faster." He said, "Just what does that mean?" "Well," I said, "what I mean at least is that the primary thing that you're dealing with here is electricity: using electricity in various ways to do the things that are much more efficiently done at lower cost than any other medium that you can use for calculating." I said, "All your calculating is done electrically. The only thing that's mechanical is the printing. You have to slow down your electrical system to conform to the top speed at which you can safely print the results." And he said, "Well, just how fast do you think we can make these things operate?" "Well," I said, "the speed of the electrical currents, if you discount resistance, is the same as the speed of light--184,000 ...

Tropp:

186, I think.

Wood:

What?

Tropp:

186,000.

Wood:

186--is it eighty-six? Yes, I guess it is--186,000 miles per second. There's some fraction recently added.

Tropp:

Right, right.

Wood:

But I don't know what it is.

Tropp:

But that's a—

Wood:

Anyway, I said "184" then just by lapse.

Tropp:

That's a trivial [chuckle].

Wood:

Trivial difference anyway, from his view-point, and he repeated under his breath while he was fuddling

with his food, he said, "184,000 miles per second." He said, "Are you sure the electric current goes that fast?" I said, "All the books I've read indicate that." That if you eliminate resistance,"--later in cryogenic experiments, I think, they did get the measurement up to that figure, but I don't know.

Tropp:

I'm not sure either.

Wood:

And it doesn't matter, anyway. And when he finally had digested that a moment, I saw a gleam come into his eye, which meant he was going to get after his inventors and engineers and give them hell, which he did the next morning. And I later got an account of that. One of these men said, "Well, Mr. Watson, we can already calculate four or five or six times as fast as the printers will work. What good is it going to do us to speed up the calculation if we can't print it?" And he roared; you know, he could roar like a lion. He roared, "Get faster printers."

Well, I saw--he ... rented a house up in Westchester ... and I went up to see the work on a big tabulator there in which they were speeding up the printer. And this printer was throwing ink all over the ceiling, going so fast. Well, that's when--just after that they gave that up. They said the mechanical printer is out, at least for this fast work. And, then they used--instead of using ink, they just turned up the--turned the same wheel but with white on black background figures. And, every time they wanted to preserve, or write down, or take on paper a result or an intermediate result, this automatically would, stroboscope would flash on the figures in the machine and you'd take a picture of it. And that way there were no transfer errors because a camera doesn't make that kind of mistake.

So, then the stroboscope gave way to the greatest single invention that's made possible nearly everything

after the original tabulator with the memory, the discovery of a way of preserving memory--memory, disk or drum. Originally, I think it was called a memory drum, the magnetic drum memory.

Tropp:

Core memory. But that was, when you were talking to him in 1928 or '29, that was two and a half decades away.

Wood:

Absolutely. Exactly. Two or three decades away, but there were--he then asked me to serve as his consultant at $5000 a year, which was very good at that time. And so, a week or so after that interview--oh, by the way, we stayed there and every time the poor clerk would come in to drag him out, he'd wave him away. We were there until 5:30. God knows how many VIPs he'd disappointed that afternoon but this shows the fact that his mind was like Leonardo DaVinci's. He was always looking forward to something better. And, I don't suppose he had ever even thought of the fact that the speed of electricity was that high. And I said that would be, as I think of things now, my present ignorance of physics, that would probably be the upper limit of speed. Well, I was wrong, and I'm still incredulous. But recently I saw that some gadget that IBM had put out is able to do 1000 operations, arithmetic operations, in a billionth of a second. Now is that feasible?

Tropp:

Yes.

Wood:

It really is. Well, you see how much I underestimated. That is just my ignorant estimate that you couldn't go beyond the speed of light.

Tropp:

Well, you can't go beyond the speed of light in the sense of the passage of a particle. There's still an upper bound.

Wood:

Yes, but the upper bound seems to be in the billions now.

Tropp:

But in terms of repetitive operations

Wood:

Yes.

Tropp:

I guess the two are really, you're not really equivalent, they're not really equivalent categories.

Wood:

I suppose they have a great number of these from the--

Tropp:

You just have a lot of them individually who are travelling at that rate.

Wood:

What do they call them? Solid state or something circuits on a thumbnail biscuit.

Well, two or three weeks later, or maybe one week later, two or three huge trucks arrived at my office over in Hamilton Hall and they brought in this whole installation and every IBM machine they had.

Tropp:

Now, this is the beginning then of the Statistical Bureau at

Columbia?

Wood:

That's right.

Tropp:

Was that endowed? In addition to giving you machine equipment, did he also give you ...

Wood:

Took care of all the repair work, the usual customer service so that if it went out of whack, we'd just telephone ... I don't know how many million dollars we spent there in the next five or ten years but the first--I, of course, advertised the presence of these machines to every science department in the university. And the only one that responded was Eckert in the astronomy department because he had this stuff from Yale University--Dr. Brown, I think it was.

Tropp:

I think so.

Wood:

The lunar fixes for every degree or something, I don't know what. And, later Eckert, when the war came on, Eckert and his lunar fixed tables were requisitioned by the Naval Observatory. When we were losing 300000 tons of shipping on the North Atlantic shipway to England, we lost that for two years and we had escort vessels and airplane observation vessels to spot these submarines, but it took a man twenty or thirty minutes in an airplane to give, fix his position. So, you didn't know--by that time the submarine might be miles from there and so Eckert got the idea of just taking that band, the ten-degree band across the Great Circle Route to England. And he turned out that ephemerides table. It was never

more than a week ahead in time and that enabled every observer and navigator and so on to get his fix in half a minute with these tables. It was sent out on mimeographed sheets to all our patrol vessels.

Tropp:

So, they got a new set of sheets once a week?

Wood:

Once a week; even oftener sometimes, depending on how lucky he was in getting the machines to work efficiently, or no interruptions, or what not.

Tropp:

Well, when you got this IBM equipment delivered from T.J. Watson and sent out the notice, was this your first contact with Professor Eckert?

Wood:

Well, I think I had met him, of course. He was a very outgoing sort, a very quiet person, but very friendly. And I had seen him at the Faculty Club and had talked astronomy. I never did sit at tables with fellow psychologists, but I sat normally at the astronomy table or at the geological table because I needed--you see, I was planning to make tests over the whole gamut of the curriculum. And, way back before 1928, when this meeting with Mr. Watson occurred, I had induced Dean Stone, head of the Law School, who was later attorney general and founded the FBI, and later became Chief Justice of the Supreme Court, I induced him to write his next examination in his special course on what he called a Special Theories of the Torts of Trustees, which is a most popular course in the Law School. And three or four of his other professors of contracts, and of pleadings and I forget what other--two or three other courses in law--to make objective tests. And when Justice Cardoza became head of the Court of

Appeals, which is the highest court in this state, of course, he began to get these complaints from people who took the law bar examinations. And the complaints were so thoroughly well justified that Justice Cardoza, who was a man very sensitive to items of justice or injustice, he appealed to Dean Stone. He was still with us in 1924 and 5 and 6, I think. And Justice Stone, Dean Stone, told him to see me, because I was, at that time, head of the Bureau of Collegiate Educational Research and had put out a dozen or so objective tests in college areas and high school curriculum areas. And I'd gotten to be quite a nuisance to most of the people in the university because when they were asked to cooperate in making objective tests, and the college board especially, they vilified me most unprofessionally and viciously sometimes. But we did the Law School tests and issued three reports, annual reports ih the Law Review of Columbia University Law School. And then I got to Dr. Cleveland down in the Medical School in anatomy, which is a natural for objective tests. And then I got the professor of pharmacology, which is also a natural for objective tests, because in every case both of those are memory, you see. Now, law it …not only includes memory but you have to reason things out. That's why we have so many millions spent on courts to interpret these laws because it's very complicated. But, in anatomy and pharmacology they're just natural for--you just have to brute memorize those just as we have to brute memorize spelling and English, which Noah Webster called "vicious." It's a vicious influence. It accounts for the fact that one-third of the adults in this country turn out to be illiterate or--functional, or total illiterates.

Tropp:

Let me digress for just a moment. This is a total digression. In your association with the dean of the Law School, Professor Stone, and others, did you know of a study that was done, I think, in the New York Municipal Courts that involved something on the order of three million tab cards related to

decisions in these courts over a period that would have spanned, oh, I'm guessing, roughly 1920-1933, I had an inquiry about those and I wondered if that particular study had crossed your...

Wood:

I don't remember it under that name.

Tropp:

OK. We'll ignore that question then.

Wood:

All right. I'm sorry, but I should have known that, but there was so much happening in the twenties that, and the thirties, too.

Tropp:

I think this was a study that was done by one of the government departments in Washington.

Wood:

Oh. Well, I do remember now that they came to see me, and they came and borrowed copies of several of these early law examinations that I had then. Only one of our professors refused to let them see his copies because he kept them secret. He didn't want to have to go through the misery of making a new test every semester. But that finally emerged as the National Law Examination Movement, which I think is now operating in nearly all states. The same as the Nursing Examination is now, which was--I helped develop that. Miss what's her name here in Teachers College--she came over and used this first set of machines that Mr. Watson had put in in 1928 and early '9 and I helped her develop these nursing tests.

Tropp:

Let me get a little more specific because I haven't seen this in the material that you've done so far. You were using objective tests and so students then were getting an answer by marking a 1, or a 2, or an A, or a B, C, D or E, whatever it might be.

Wood:

Yes.

Tropp:

And then how were you using the tabulating equipment? How mechanically--how did you take the test data that you had, this raw data from each student and in what manner were you, in that early period, using it in terms of the tabulator?

Wood:

Well, remember I made most of my--the tests that I personally constructed with aid of experts in each field, of course, were all made beginning in 1923 up to about 1927 or '8. And, all of that time, up until 1936, we simply scored these things by hand and transferred the scores to the lists after the names of the pupils

Tropp:

Right.

Wood:

By hand. That's the only way we could do it.

Tropp:

You did that by hand up through 1936.

Wood:

Yes.

Tropp:

Then, when the Statistical Bureau was formed in 1928, '29, then you were using the IBM equipment primarily for the records

Wood:

Processing.

Tropp:

and processing?

Wood:

Processing the scores and getting their averages and their standard deviations, their squares, ... and correlations.

Tropp:

So, it was really what the name says--you were really handling the statistics then of the raw data which you accumulated by hand?

Wood:

That's right, that's right.

Now, the first machine scoring of tests--well, first, I'd rather finish with this original installation.

Tropp:

Right.

Wood:

We finally developed a method by which you could handle second order data, that is, squares ... on the old tabulators just by actually summating a number by its own number.

Tropp:

So, if you wanted the square of ten, you just added ten ten times.

Wood:

136--we just added it up 136 times. But, what's his name, Warren developed this nine bank or ten bank tabulator.

Tropp:

This is Richard Warren, who was your assistant at the Statistical Bureau?

Wood:

Yes. And, I'm not sure that the other one, the other drunkard, genius, who worked with me and drowned himself and his sister in Long Island Sound, whether he helped Warren any or not, I doubt it. But, anyway, Warren developed this, what we called the difference tabulator, which had nine banks, instead of the usual five.

Tropp:

Now is it correct that that difference tabulator is what you called the IBM Model 805?

Wood:

No.

Tropp:

No, that's another machine.

Wood:

No, that's the Reynolds-Johnson machine which came in '36.

Tropp:

OK. Fine. You don't remember then--this didn't have an IBM number?

Wood:

No, this was the only one ever built, in fact, because it was soon superseded. This was in 1931 or '32 that we got this. Warren sent his designs up to Endicott and the engineers up there developed this nine bank machine so that we could handle ninth order differences. And, of course, that eased the problem of dealing with squares or any other higher pow ers because we could get correlations.

Tropp:

Was McPherson involved in that development at all?

Wood:

Yes, I think he was one of the younger men at that time who probably helped the chief engineer and inventor and the man who later developed the Harvard Automatic Sequence

Tropp:

Calculator.

Wood:

Electronic calculator.

Tropp:

That was electro-mechanical.

Wood:

Still electro-mechanical but it was automated.

Tropp:

Mhm, it was sequential.

Wood:

But it was still confined to one thing--it would repeat anything you would tell it, but nothing else. It could have no variation. It wasn't until 1947 that Mr. Watson had me come down there and see the new real electronic machine which occupied five floors including two basements. And it had 3700 tubes that cost $150 each and I don't know how many thousands of the IBM invented relays--it made a terrible clatter. One whole wall of relays there were just chattering all of the time like a street digger, or whatever you call them.

Tropp:

Going back to this nine-bank machine, was the engineer at IBM lake?

Wood:

I think that was the man, yes. He was in charge of it. Mr. Lake.

Well, that quite a contribution. It waked up the engineers at IBM to a whole new horizon of possibilities. That plus Mr. Watson's bawling them out every few months. "This is still not fast enough," he'd say. "Remember it takes only 8 minutes for the sunlight to reach here" and so on.

Well, it was in 1931 or very early '32 that--wait a minute, I think maybe Eckert worked for Dr. Brown at Yale. No, it followed this. Dr. Rulon, then at Harvard I believe ...

Tropp:

What was that name again?

Wood:

Philip H. Rulon, R-u-l-o-n--he was in the West at the time, I believe, although he was very soon thereafter, if not before, at Harvard. He died accidentally only three or four years ago. He was a genius and he had figured a way of reducing the cost and errors of scoring the Strong interest blank, as he called it. E. K. Strong had a test of 400 items in which all you did was to express your instant reaction to something listed. It might be a heavily bearded man. Well, nobody could justify that except on the basis of experimental evidence. That people that don't like bearded people are often good mathematicians or scientists but very few of those that like bearded men were literary.

Tropp:

[Chuckle]. Yeah.

Wood:

But, we had--it cost about a minimum of $5 when clerks cost only 25 cents an hour to score that test. And Rulon's scheme was to punch the weights--is this still all right?

Tropp:

Yes.

Wood:

To punch the weights for each of the three answers for each of those 400 items--like, indifferent, dislike. And so instead of doing that by hand, the taking these cards out according to the answers given by a given student and putting them in the tabulator and running them through the tabulator, we had the tabulator do it instead. By punching the weights in the cards first, in three or four cards you could put nine different professions--science, medicine, physics, chemistry and so on, and salesman and so forth,

psychologist--for each of those professions, each item had--each answer, each of three answers had a different weight: a variable weight test item is what we called it. And this--he had a file with all these three cards--like, indifferent, dislike--and if the answer here was like on either one, I'd pick out the like card and stack it up here and pull the divider. And number 2 is dislike, I'd take out the third card and stack it up. And then we'd run those cards through the tabulator. And I did that once and halfway through this 400 item card file, I suddenly decided that--a brainstorm hit me--that we could get that done by electrical method: that is, by the ordinary, old five bank tabulator, which was the first one he brought me in 1928; and this was, I think, early '32. And I said, "What we need is a tabulator with three heads." You know, three heads, where you put "like" answers here, and "indifferent" and "dislike." But, actually that would have been very expensive to build, because it would be a hand job. You couldn't make more than three or four in a year and there's no market. So, what we did was to divide each card in&o three parts--like, indifferent, dislike. And we could still get nine professions on each card. And we had four cards which gave us twenty-eight professions--thirty-six professions.

Tropp:

Were the IBM cards then eighty columns?

Wood:

Yeah, eighty columns. The forty-fives we never used. Well, that reduced the time and cost of scoring the Strong Interest Test from $5 or $10 to 50 cents or 75 cents. You could score four of them in three or four minutes as you could score for nine professions in three or four minutes. Put in another batch of cards and in another three minutes you'd have eighteen professions scored. Well, this machine became available in September, late September of 1932 ...

Tropp:

This was basically an adaptation then of the first machine.

Wood:

Just an adaptation of the old electro-mechanical five bank tabulator. And, up to that date Dean Hawkes had found that test very valuable in guidance work with students. As you know, Dean Hawkes was the one who said, "The college exists only for what the students can learn in it. That's the only way we can make any contributions, is by working through the next generation." So, he was extremely careful and devo--dedicated to dealing with individual students and their needs and hopes.

Tropp:

What is Dean Hawkes' full name?

Wood:

Dean Herbert E. Hawkes. He succeeded Keppel right after the first World War. And he used to come around many, many, many times for several years after. He had become president of the Carnegie Foundation; and that's how I got acquainted with him. When I was a Judge Advocate in the Army, all of my work had to be submitted to Keppel for capital cases through the Judge Advocate General's Office. And my courts convicted one man of treason and the death penalty because the crime was committed in wartime, but I recommended to the Judge Advocate General that the sentence be reduced because the man was simply a moron. And they gave him Keppel [who] as assistant to Newton E. Baker, who was Secretary of War, had jurisdiction over the Judge Advocate General's Office. And he crushed all of the

convictions as I recommended and reduced this moron's death sentence to a life sentence in Leavenworth Penitentiary. And he wrote a letter to the commanding general of my office, of my division down on the desert of New Mexico saying he could not understand how any people in the Army, any officers in the Army could reconcile the sentences they'd imposed either with their consciences or with their duties as officers of the United States Army. You see, I had read the Manual of Arms, I had--I'm not a lawyer but I've had law courses and I had mastered the Manual of Arms, which is the law book of the Army. And I read these provisions that the Judge Advocate was to not only prosecute the individual but to see that all of his rights were respected by the court. And I took that as a big a duty as to prosecute them, submit the evidence, so I recommended that all these convictions be quashed. This was just after the war, you see, although the offenses had been committed before November 11th. And the Judge Advocate General evidently sent this on out to Keppel, and he not only quashed all the convictions, but he changed the death sentence to life imprisonment at Leavenworth. And, later on when they finally let this guy out on good behavior after nine or ten years, he didn't want to leave. He was a very low-grade moron who was just a messenger for the highly trained and skillful evaders of the German spy system which combed Mexico one hundred percent. Well, that's an aside. But, up to the time that this brainstorm machine, as I call it, became available in late September, Dean Hawkes had had me score for three or four or five dollars each only about 175 scores in the preceding two or three years that he had been using the Strong Interest Test, because he didn't have the money to score more than a few of the professions for each boy. And, during the following three months after we got this machine--in October, November and December--we turned in about 17,000 scores at less than the cost of the preceding 175.

Tropp:

A couple of orders of magnitude.

Wood:

Yes. Well, that, of course, was quite a--that made E. K. Strong, who deserved it, a wealthy man, because in the Second World War they used millions of those tests. And, in between, the years in between '32 and '40 or '39, all kinds of corporations, civil services and augmented government agencies, the Army, Navy, and Air Force, and Marines and so on used these tests

Tropp:

Right. I remember them.

Wood:

To fit their candidates. So, E. K. Strong, who had been getting two or three hundred a year royalties on his tests now began to get four or five or ten thousand a year. And so I made him the first millionaire test maker in history.

Tropp and Wood:

[Chuckle].

Tropp:

Going back to the nine-bank machine that you said Richard Warren developed--

Wood:

Designed. And Lake put it into hardware.

Tropp:

Well, this was essentially the machine that Wallace Eckert was using?

Wood:

No. Well, he did use that, yes. He did use that but his first big stunt--if I remember rightly, we asked Mr. Watson to loan us another, a newer tabulator than this old five bank which, I think, only five years after we'd got it, it had been put in a museum. It was outdated. But we asked for a loan of a seven bank tabulator of the vintage of 1931 or '2 and it was that machine on which Eckert did his, confirmed the Brown Lunar Tables. And he ran them on the machine twice and the miracle was not that he did it in six weeks for only $1800: the miracle was that he didn't find one single error in old Professor Brown's hand calculation.

Tropp:

That is incredible.

Wood:

Isn't it?

Tropp:

It really is.

Wood:

Well then, then later by using the seven-bank machine, Wally found a way--you see, this first table was, I think, only in degrees or tenth of a degree or something, and what they needed for quick calculation, where you didn't have to interpolate in your calculation, they needed tables that told you for each minute and each second of time, sidereal time, just where, what the bearing of a certain star would be. In muggy weather the observation planes accompanying our convoys rode under the clouds, almost hidden away, so they could see the submarines. But, to get a fix they had to get up through the clouds quickly

and get a sight on the sun or whatever, the stars, if it was night.

And then all they had to do was look at a table and then they'd radio their position and all of our patrol boats and bombers would come and concentrate.

And I believe that after that system eame into full effect, we reduced the monthly loss from 3 or 4 million tons a month to 300 tons a month, or 3,000--some incredible figure like that.

And, then a little later during the war, when this, I think it was this same kind of seven bank tabulator that was used in Eckert's own office, the astronomy division, which was then at the top of the Physics Building, when the B-29s were converted into central fire control--see, before that each machine gun and each cannon on a B-29 had to have its own gunner so you carried nine people. You had one artillery piece and three or four or five 50 caliber machine guns and several smaller caliber machine guns.

Well, they also developed a proximity fuse and this was so secret that not even I was ever permitted to go into that room on the top of the Physics Building where Eckert, or rather his companion--he was now in the Naval Observatory in Washington doing these ephemerides for the Great Circle Route to England. But his fellow astronomer--I can't think of his name now--was in charge of about ten or twelve of these tabulators grinding out mathematical figures that would enable the control of all the gunnery, the fire power of a B-29, into one person's hands. And, at the same time synchronized them with these propeller blades which are running at 38,000, or hundred revolutions per minute so that the bullets could go through them when necessary without it destroying the propeller.

Well, the first B-29 that went out to knock down the flight of, wing of nine Zeros was knocked down itself.

And we came back--this is all gossip now; I know absolutely nothing about this except from gossip. It seems that in the eighth decimal place, one figure was in error so while no propeller was ever destroyed the aim was inaccurate even for a proximity fuse projectile. So, with the added experience they knocked them all into the ocean before they got within range of the Zero machine guns. And that's how, that's why in a matter of three weeks, the Japanese air fleet disappeared. And also why the submarines disappeared and most of their shipping.

I've heard somewhere an estimate that the Japs didn't have more than two submarines left when the signing of the Treaty was made on the MO, the Big MO.

Tropp:

I honestly don't know.

Wood:

And that 90 percent of their commercial shipping had been destroyed, sunk by submarines and air power. As a matter of fact, only one battleship was sunk by another, by an American battleship. All except for the Gulf of Leyte, there were whole Japanese fleet in that narrow channel were subjected to heavy artillery fire from our battle wagons and destroyed. But, other than those, every ship sunk, every battle wagon of the Japanese fleet was sunk by air power.

Tropp:

OK.

Wood:

And if you want to read the most interesting book that I've read on the war, The Incredible Victory by Dr. Lord, I forget his first name now. You probably know it. The Incredible Victory: don't start reading

that book if you have another date within ten hours, because you simply can't leave it.

Tropp:

[Chuckle]. Aha.

Wood:

And, everything happened by accident. We did every--we committed every error in the book and the Japanese just committed one error more than we did and, therefore, after the islands were completely bare of defense, the Japanese fleet suddenly ordered the retreat to Japan when there was nothing left to defend the islands, the Midway--

Tropp:

Before we get off into that wartime period can we go back to Wallace Eckert and the computing laboratory and the astronomy department and what you remember about its formation and some of its pre-war--

Wood:

Well, after the war Wally came back, of course, to the university with these--and he never once bragged about his having saved our millions of tons of shipping. He never said a word about all this apparatus ...

Tropp:

No, excuse me. I'd like to go back to the formation of the Computing laboratory: back in the thirties.

Wood:

Oh, well, that was simply an effort to get more of our scientists--you mean the Watson Astronomical Computing Bureau?

Tropp:

Well, yes. That, I guess, was founded in about '37

Wood:

Yes.

Tropp:

but a few years earlier Wallace Eckert already had a computing laboratory going in the astronomy department.

Wood:

Well, that was simply on these loan machines that I had ...

Tropp:

The same machines that you had.

Wood:

Well, as I say, we had asked for another seven bank and we had asked for three or four plug boxes that would fit in, that could be, so you could change the whole wiring system without individual plugging. And that's what he called his computing laboratory.

Tropp:

Then the Watson Laboratory was--

Wood:

Then the Watson Laboratory was formulated and, I think, after the war it was changed. It was scattered between my office and the Astronomy Division right on the campus. And then we bought an old fraternity house on West 116th Street west of Broadway and that was called the Watson laboratory of

Pure Science. And that's where Wally developed his machine for measuring the position of stars automatically.

Tropp:

Well, do you want to just talk about Wallace Eckert without me ...

Wood:

Well, of course, he was a remarkable person. I don't know of anyone who ever made more significant contributions either to peace or wartime needs than he did and do it all so completely quiet. You never heard of anything from him.

Tropp:

Well, we've talked about his contributions in terms of the tables for ephemerides—

Wood:

Lunar tables, yes.

Tropp:

His checking of the lunar tables of Professor Brown. As you look at his career and, although you are outside of astronomy, but you are in science, what would you say some of his more significant scientific contributions were?

Wood:

Well, I'm just not technically qualified to say that. You see, I had to depend--a good deal of this work was done in secrecy. A lot of it was for government that I never even heard of in gossip: never heard it named in gossip even. But I happened to be over there to see actually with my own eyes his star gazing machine, the automatic--using photographic plates to measure each star's position and put it in terms of

whatever the angular measurements are that you need to locate a star. Now, that's the only machine that I know of personally, but there must have been many others that he did because, as I say, he was the most dedicated, the quietest person on the campus, the most modest. Mainly I think because after he went down to the Naval Observatory, the Naval Research [Laboratory], he had drilled into him the need for secrecy so much, and so much of his later work was secret--ballistics and so on. I don't know even what the names of them were. But I know that he supervised the construction, the design and construction of the NORC--the Naval Ordnance Research Computer. And I attended the luncheon, I was invited to the luncheon. I believe this was in early 1953 over at the Faculty Club, where some rear admiral or something and his staff came down to receive it formally from Mr. Watson. And the chairman of that meeting, of that luncheon was Dr. Eckert, Dr. Eckert.

Tropp:

Did Von Neumann give a talk at that dedication luncheon?

Wood:

Pardon?

Tropp:

Did Von Neumann give a talk at that particular luncheon?

Wood:

Who?

Tropp:

John Von Neumann.

Wood:

Oh, yes. Yes, he spoke there and he spoke at two or three other meetings under IBM auspices. We had quite a few meetings at the Faculty Club because at that time Mr. Watson was a trustee, a very active trustee of Columbia and, of course, Von Neumann I believe was on the Watson staff, wasn't he for a time?

Tropp:

He was a consultant I guess to almost everybody.

Wood:

Almost everybody, yes, the government and everybody.Well, at this particular meeting, the thing had to be kept within a certain time limit. And at the last minute, before we walked over from the Watson Pure Science Lab to where this machine was designed, just the minute before we started walking over to the Faculty Club, Mr. Watson said, "Ben, I'm going to call on you for a little speech." And, Eckert, who had made out the program, had very carefully timed everything, and he said, "For God's sake, Ben, make yours short, because if I run over time the old man will chew me up afterwards." So, of course, he had to call on Mr. Watson first and Mr. Watson made his usual gracious sort of speech and then he said, "While I'm here on this .. heights of Manhattan, Columbia University Heights, I would like to pay tribute to one of the Columbian men who has made such wonderful contributions to IBM and to me personally." All of which was grossly exaggerated and the rest of what I am going to say was eliminated from the official newspaper and in the magazine later that month,because it should never have been said in a competitive--by the head of a company in such a highly competitive industry. He gave--he said: "Before Dr. Ben Wood came to me in 1928, IBM did not have a single account outside of business establishments. We had nothing in the government. Nothing in civil service. Nothing in the

Army, Navy, Marine Corps, Air Force. Nothing in educational institutions except maybe hired time in some neighboring computer center by a university that was using part of their account, money account. And, today we have 476 accounts and all these government and science centers that account for forty or fifty percent of the company's income, gross income." You see, that was very unwise.

Tropp:

That would have been good at a meeting of sales. a meeting of district sales managers.

Wood:

Yes, yes. That was all right for a sales group but not for public. Of course, the editors--the stenographer though took it down and later through Dwayne Orton, who was one of the things that Dr. Watson mentioned specifically as my contribution. He said, "I asked Dr. Wood to find me a man who could become IBM's ambassador at large: a man who was a great platform speaker, who could command even a hostile audience in one minute." And I happen to have had him, he was the first man we recruited at our barnstorming at the air-conditioned, the, the American. I had heard him speak ex cathedra, what do you call it, without notes, off the cuff.

Tropp:

Extemporaneously.

Wood:

Extemporaneously, that's the word I was trying to think of. I'd heard him two or three times at a junior college meeting in Austin, Texas, in the summertime in 1928 or '29, and I've never yet heard anybody that could step out even in front of a hostile audience and in one minute have them sitting on the edge of their chair. The only other man that I know of was George T. Venner.

Tropp:

Who is this gentleman you're talking about?

Wood:

Dr. Dwayne Orton. He died last year.

Tropp:

How do you spell the last name?

Wood:

Pardon?

Tropp:

How do you spell his last name?

Wood:

D-w-a-y-n-e

Tropp:

Norton.

Wood:

O-r-t-o-n.

Tropp:

Orton.

Wood:

Dwayne Orton. Well, he became--he was taken on at my recommendation in the middle of the war. I had to release him from--I was then chairman of the National Commission on Aviation Education for

the government and the Army. And I released him, and he took this job at $15,000 and a big house up in Endicott for his family. He was head of the education department of IBM, which was a university of 4,000 pupils. Half of the curriculum hours were nothing to do with vocational education. They were all literary, artistic, general education courses and then he was made editor of the Think magazine a few years later and consequently to the headquarters office here.

And, the last--in about 10 years, his salary had then been raised to $36,000 and l believe that when he retired five years ago--I attended the luncheon party--his salary was then $46,000. And, when Tom Watson, Jr., got up to pay his tribute to Mr. Orton, he called him over and he said, "Here is just a parting gift. Just a token of our appreciation is a check for $50,000." Well, he was a great ambassador for IBM. He would have been great for any company, but I've never seen a more gifted platform speaker. Never looked at a note: he just tore it out like a crystal stream or mountain creek. And, everything he said was wise and relevant. But he was a man with a very broad background and culture. He could talk to the Japanese about their own diplomatic problems just as well as he could with our man in this country and did.

Well, now, that's an aside. But that was just one only one that I think that really--except getting Ray Johnson in, of course. And I got him because he was recommended by Professor Alvin C. Eurich, then at the University of Minnesota, whose student assistant was a brother of Reynold Johnson and this brother told Al about his brother Raymond having made an electrical gadget that could score ... tests in one-tenth of the time it took by hand.

Tropp:

Now, what's the professor's name in Wisconsin again?

Wood:

Professor Alvin C. E-u-r-i-c-h. He is now president of the Educational Development Corporation in the city. He was once chancellor of all the state colleges in New York State. Before that I think he was president or vice president of Stanford University but he's now an educational advisor for nearly every country in the world. He spends one month every year in Ethiopia as a guest in Haile Selassie's home. Al is a great guy. Well, he wrote me and I immediately, I wrote Ray Johnson to send me an account, a written description of his gadget. And it had been noised about for several years that I had been seeking somebody who could construct a test scoring machine and so I received about a dozen suggestions: long, thick papers which I religiously read. I stuffed them all in the bottom drawer of my desk and when I finished reading Ray's account, which was written almost illegibly on an ancient Corona machine: you know that type that you fold over, and on thin paper with a very ancient ribbon. Hardly visible. I went through 12 pages. And on page 3 there was a mathematical formula which he had put in in ink. But, when I finished reading it, I just stuck i t in this drawer as so much trash. Well, that night I couldn't sleep. Something kept trying to ring a bell in my mind and finally, at 2 o'clock in the morning, I realized it was that formula. And, you might want to write this formula out because it's a historic point in the whole development--it was the scientific basis for the first analog computer ever built by anybody anywhere for any purpose. That's the formula on which all analog computers were developed, or based.

The formula is: V (for variation or variability) equals--put a long line after that as a fraction--EMF (that's the electrical force, the amount of current, whether it's amperes or what, I don't care) and under that a parenthesis (500-5000) plus 2NM (that means two-million-ohm resistor units).

$$V = \frac{EMF}{(500\text{-}5000) + 2NM}$$

This we found to be the variation between the heaviness of graphite pencil marks that students make. Their resistance--a very light mark ranges from 5000 ohms to 500 ohms. Ray put this formula into each--between each electrode and the central collecting circuit. So, you see this variation of 500 to 5000 was less than half of one percent of two million. So, he reduced the error to less than half of one percent. And, of course, you know all tests have a standard error of three or four or five points, whole points. So, this was a negligible error compared to what was inherent in the test itself, so that's what led to the 805. The first hand-built model was tested for, in the Educational Records Bureau in 1936, I believe.

Oh, on the, the Eberstein story--you may not want to use this. It's detailed but an interesting one. When I read this formula, I got up at 2 o'clock in the morning and went to the Security Office in Columbia to get into my office. And, I pulled this paper out and saw that it was--the formula was valid. So, I called up Western Union and sent a telegram to Ray Johnson. I said, "Bring your machine at earliest possible date to New York."

And only a few days later, he called up from Newark Airport on a very hot, muggy August day and-- I shouldn't mention this, but he said, "I've used all my money. I can't get a cab." Well, you get a cab and tell them to come to 120th and Broadway and I'll pay the cab. So, in about 25 or 30 minutes I was there on the corner, he arrived, and I paid this cab S22 something. It's funny because I had to borrow the money from Dean Pegram. See, we were both out of pocket change. And, so we took his machine up to Dean Pegram's private laboratory in the Physics Building. You know, Dean Pegram was chairman of

the committee that developed the atomic pile in that Chicago Stadium. What was that called?

Tropp:

Well, the Manhattan Project

Wood:

The Manhattan Project.

Tropp:

... Fermi's group, as you know.

Wood:

Yeah, Fermi. Fermi was a marvelous person. He was just as quiet as Eckert. I had lunch with him many times. He married a Jewess and so he had to escape from Mussolini. Well, he brought this machine up and he put it on a table like this right in the middle of Dean Pegram's private laboratory, which is about half as big as this room. And plugged it in and he started putting papers through to show it and the damned thing wouldn't work. Poor Ray on this hot day was just pourin g wet. His shirt was absolutely--as though he had been in a shower. Mine, too, for that matter. And, finally Dean Pegram said, "Wait a minute, I just thought of something. How did you get here today?" He said, "Well, I got a plane to Cleveland and then one to Pittsburgh and then flew from Pittsburgh to Newark." "What kind of a plane was it?" "Well, it was a four or five passenger plane," which, of course, was an open cabin. And he said, "You remember coming over the mountains, don't you?" And he said, "Yes." And it usually took about an hour to get over the mountains--that's called an aviator's graveyard, because they had to go up 10,000 feet in order to be safe. And some of those earlier planes couldn't make it because of the awful powerful up and down drafts on both sides. And he said, "Do you know at what speed your

plane was?" And he said, "Well, it was something like 90 a little bit, the girl said on the plane, 90 miles or something like that an hour." "Well," he said, "I think I know why that doesn't work now. Write that formula for me again." And he looked at it for a long time and he said, "Well, this machine doesn't work now, but that formula means it will work." He said what happened was that he brought it on his lap and wrapped in a newspaper and, of course, at that elevation metal gets very cold if it's not in direct light of the sun. And when he landed at Newark and got in a cab in that 93-degree weather and muggy, very muggy, the cold metal of this gadget condensed to vapor and messed up most of the contact points. So, he said, "Let's put this in a hypocaust at 100 degrees or something like that and then try it out."

Tropp:

Dry all the ...

Wood:

Dry all the points, get all the moisture out. Well, we left it in that baker thing in the Dean's office for, I think, two hours, just talking generally. Then we put it back on the table and it worked like a doll. So, a month before that Mr. Watson and I had had a talk and I'd said, "Mr. Watson"--this was before I'd heard of Ray Johnson-- "Mr. Watson, I'm beginning to feel guilty." You got to change ribbon?

Tropp:

No, not yet.

Wood:

I said, "I've used I don't know how many hundreds of thousands of your dollars." I said, "I don't see anything ahead. We've tried everything that I can think of or that this drunken genius can think of."

Tropp:

Who's the drunken genius you're referring to?

Wood:

Richard Warren.

Tropp:

Richard Warren, ok.

Wood:

Once I went downtown to a little restaurant on the west side and suddenly, I remembered that he lived in that neighborhood, so I walked down the block about half a block and found him hanging over an iron rail, dead drunk and asleep. The temperature was probably somewhere around 30. I don't know how long he'd been there so I called a cop, whom I had seen on the corner, and the cop was a big, hefty guy. And I said, "let's get him up." And he to this little room where he stayed with some girl-friend and left him there. And he got over it all right. He was back on the job within a week. I think he had nothing more serious than a cold from it.

Tropp:

But that's digressing from your conversation with Mr. Watson. Well, when Mr. Watson gave this, my 25th anniversary party, he referred to this fact that so far as he knows I was the only person who had ever gotten a drunkard to make a very important, constructive contribution to science and education.

Tropp:

[Laugh].

Wood:

Well, now what was I going know say. Oh, you also know the rest of this story, I think. Well, Mr. Watson said, "you let me worry about the money. It's still important, isn't it?" And I said, "Yes, it's more and more important than ever." And he said, “Well, you keep on it and just let me worry about the money. I'm going off. The doctor says I've been worrying too much, so I'm going off for two months to Maine." And, he said, "I've told three men down there to watch things for me, but not to call me except when the house is burning down." So, we took this machine after proving it down to these three men, including Philips and Major somebody--I can't think of his name now. He got to drinking, so Mr. Watson had to turn him off. And one other man, I can't think of his name. And they kept this thing there for three weeks. Poor Ray, he was living in a vacant room in a dormitory at no cost to him and eating in a two-cent cafeteria nearby and fretting and wondering. Finally, after three weeks, one of these men called up and said, "We've given this thing very careful consideration and we've decided that IBM has no interest in it." Well, Ray was sitting by me when that call came through and he heard every word of it. And you should have seen this man wilt. I never saw a more tragic thing in my life. And he said, "Well, you know, I haven't even got money to get back home." So I said, "Don’t worry about that." I called Dean Peagram and he came over and I told him the story. And I said, "If you will hold my hand, so, to speak, I'll take the risk of calling Mr. Watson in spite of his prohibition against being called while he's on this rest cure." So, I called him, and I said, "Mr. Watson, this is Ben." And he said quite affably, "Yes, Ben, what is it?" And I said, "I think we have at last solved the scoring machine problem." "Really," he said. "Who has done it?" And I said, "A young science teacher from the Middle West, Reynold B. Johnson. And I said, "Dr. Dean Pegram is sitting here right by me and he agrees that this is the solution. Dean Pegram, would you say that to Mr. Watson?" And he said, "yes, indeed, it's

definitely the solution." "Well," Mr. Watson said, "so our three or four year effort has paid off." And I said, "Yes," I said, "I'm so happy I don't know what to do." And he said, "Well, have the men downtown taken it in and given Mr. Johnson a laboratory?" I said, "No, they have just telephoned me that IBM is not interested in this gadget." And you should have heard the roar that came over that telephone.

Tropp:

[Laugh].

Wood:

Oh, he was simply beside himself with fury and his voice rose so high I could hardly understand the syllables. He said--but, the gist of it was "You tell Harrison (he was director of research for IBM then) to give him an office, put him on the payroll at $12,000 and if that doesn't satisfy him, give him more. Give him a laboratory and tell him to make a working model." So, that story is told in this proceedings book and I'm going to give it to you for fear I might forget it.

Tropp:

This is the second side and we'll conclude a few remarks of Professor Woods.

Wood:

Have we covered all of the technical ...

Tropp:

I think you've covered most of the aspects that I was interested in at this point in time. I think there will be others and I would like to return at some time to talk to you about them and perhaps about some documents that you might have.

Wood:

Well, you know ...

Tropp:

I also want to reminisce with you. I think I'd like to come back and for my own thing kind of do a biography of you, which may not be totally related.

Wood:

Oh, well, I'd be greatly flattered to think that you would want to do that. But you read that one there and that, of course, was up to 1960 or '65 and now we're--

Tropp:

Because it's heavily oriented towards your work with the Pennsylvania study and I was interested in getting a broader look than that particular volume.

Wood:

Yes, well, he was limited, you see, to 100 pages, so he left out a great many things that I consider--I was on three committees, for example, to inspect the work of the City Board of Education Teacher Examining Board. Three committees and about every three years I was appointed on those committees and we, it took us 15 or 20 years to modernize them. They were the last to adopt objectively comparable methods. And they had separate examinations for each school grade teacher. You see you had--if a person is a teacher at all, he's as good for 10th grade as he is for third.

Tropp:

Well, except for the specialized knowledge that a 10th grade teacher might need that a third grade teacher should have at a different level or a different ...

Wood:

If she can't get that as she goes along, she isn't a teacher.

Tropp:

On this other, in this other area, Wallace Eckert and his contributions, who are some of the people who are still around in the Columbia environment that you might suggest me talking to?

Wood:

Well, I think perhaps--unhappily Dean Pegram would be the one that would be ideal but he died before Wally. I suspect that the people in the astronomy department and I don't know any of them. The head of it retired a few years ago.

Tropp:

Is that Jan Schilt?

Wood:

Jan Schilt.

Tropp:

Is he still alive?

Wood:

I'm not sure even of that, but if he is, he would be, and also this mathematician who worked with Wally over in the Pure Science Lab--the man who looked at the determinant once and said "this figure here is wrong."

Tropp:

Now, that's not a name I've run into. I've not run into ...

Wood:

I can't think of his name now but if you could--I'm sure if Jan Schilt is still living, he could remember the names of all of Wally's colleagues over there in the Pure Science Lab.

Tropp:

Where was Jab Schilt living in New York the last time you knew him?

Wood:

I'm not sure that he wasn't living in Jersey.

Tropp:

In Jersey.

Wood:

You know a lot of them come across here because over there they have no income tax, no state income tax, so some of the people--

Tropp:

Well, how could I locate or find his present location if he's still alive?

Wood:

Well, I would simply either write or telephone to the Columbia--let's see if I can find a Columbia directory.

[Recorder off]

Wood:

In this letter to the editor of Pic de lingo [?], Mr. Gerras, G-e-r-r-a-s, I said "English in its various pigeon forms is already the nearest to a worldwide spoken language. For nearly 400 years a number of

farseeing scholars in England and America, and other nations, have been trying to make English autography feasible as a worldwide written language. Our present autography, which Noah Webster correctly described as vicious, is not even feasible for children or adults in English speaking countries. During Mr. McNamara's tenure in the Pentagon, he conscripted 1,800,000 draftees. But he had to reject 600,000--that's 33 percent--as too illiterate for any kind of military training. The reason is not lack of intelligence in pupils or teachers but our crazy and idiotic spelling conventions which include over 2,000 ways of spelling the 40 sounds of English or about 565 ways if we use only lower-case letters.

You see the upper-case letter is a completely different alphabet, seventeen of the 26 capitals bearing no resemblance whatever to the lower-case forms. Think of A, for example, think of B, think of D, think of E.

Last year I received a personal letter from the president of a publishing firm that had just spent over a million dollars developing an elementary school reading series asking me to endorse his product by which he guaranteed "to teach each and every child the sound of each letter in less than the usual time." I agreed to endorse his product if he would satisfactorily answer one simple question: "Which sound of which letter do you guarantee to teach?"

Tropp:

[Chuckle].

Wood:

Now, you see, most people miss the implications of that. Think of a president who is getting $150,000 a year plus that much more in fringe benefits, recognized as a worldwide scholar, putting over his

personal signature a guarantee of that sort. And then you don't wonder that some of our kids don't learn to read. But, that's the kind of pap or craziness that all of these publishers--and Gates made a multi-millionaire out of his series. So much that--he and Macmillan were making so much money on it that they set up a foundation to escape taxes.

To help him apprehend the meaning of my question, I gave him this sentence, which was given to me by a seven year old boy, in Garrettown one day when a man we all called the fat father, a gifted man, a multi-millionaire, who was giving his time to boys' work--I saw him out there on the edge of this crowd that had collected at this end of the thruway bridge and I said, "What's the matter, Sonny? What's all this crowd for?" And he said, "The fate of the fat father was to fall through the thin ice. The accident was fatal." You know there are springs all along the edge of the water every few miles and these springs make very thin ice even on the coldest days. And the fat father, weighing 230 pounds, got on some of this thin ice and went under and, of course, was swept down the river. The tide was out.

And the letter "a" appears nine times but is sounded in seven different ways--fate - a (aye), fat - aa, father - ah, was - woz, fall is a diphthong faul, fatal - fatul, as we call it, and many, we pronounce many m-e-n-y but it's spelled m-a-n-y; so there are really eight sounds of English of the one letter "a". Now, think of what that means to a young beginner three or four years of age, or even six years of age.

But the thing that is important is that this man, recognized as a worldwide scholar, a publisher of great reputation--I don't give his name naturally--but he and all of the other publishers of these beginner series are guilty to the exact same extent that he was. And, that's the only thing that our kids who are beginning have had to start with. So that we learn to read and write English in spite of the schooling, not with its help.

The letter "a" appears nine times, sounded in seven different ways in this particular sentence.
The diagraph "th" as in "thin" and "the" has two sounds.--the, thee and thin. Two terribly different sounds, one is voiced and the other is unvoiced, and neither one of these sounds has the remotest resemblance to "t" as in tan or "h" as in hand.
"S" is more often pronounced as "c" than it is as "s". "C" is either "k" or "s". Accident is a-k-s-i-d-e-n-t if you spell it right. I is either i-t or i in ice. O-u-g-h is pronounced as oo in through the thin ice.
This simple sentence is only a minuscule sample of our spelling idiocies. Now, I had this reproduced to send to some of our friends and to supplement that, to show that that is just a miniscule sample, I took the six letters that are most often used in English. The six letters that account for fifty percent of all of the printer's ink used and there are only six that do that--fifty and one half percent of all the letters printed. In the New York Sunday Times for example or in an encyclopedia are one of these, of these letters: e, t, a, o, i, n. Those six letters account for half of the printer's ink used.

Tropp:

In that order?

Wood:

In that order--e, t, a, o, i, n. And I said taking these six letters, consider the numerous ways in which they are spelled. Here is e as in let. There are nineteen ways of spelling that and I list them all here, samples of these misspellings. E as in me is spelled twenty-four different ways. And I don't show all of the twenty-four, I just give a sampling of the misspellings. T as in tan has fourteen different spellings. It seems impossible, doesn't it? But, that fourteen--

Tropp:

Well, nothing is impossible with our language.

Wood:

A as in part, or father--that has fourteen different spellings. I just give a sample of them. And A as in am or have has eight different spellings. A as in age has the most--thirty-one. The sound of the first letter in the alphabet is spelled in thirty-one different ways.

Tropp:

You don't have to read the whole list.

Wood:

No. Thirty-nine spellings for a letter, nineteen spellings for a sound, nineteen [?] letters have only one sound each. Ten words account for twenty-five percent of all words printed in English. Eighty words account for fifty percent of all words printed in English. Professor C. C. Freys [?] has found that the 500 most frequently used words in English are given 13,000 meanings in the unabridged Oxford dictionary.

Tropp:

[Laugh].

Wood:

And that's something you'll probably never run across.

Tropp:

That's right. I do want to put you in contact with Dr. Atanasoff.

Wood:

I'd like very much to meet him.

Tropp:

Because, again, I have avoided the detail work with him because of the time element.