Computer Oral History Collection, 1969-1973, 1977

Interviewee: Ida Rhodes (1900-1986)
Interviewer: Henry Tropp
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TROPP:

This is a discussion with Mrs. Ida Rhodes in her apartment on Georgia Avenue. The date is the 21st of March, 1973.

Let's start with the origins of the Math Table Project.

RHODES:

It was the outgrowth of the Depression. It [is an odd fact] that a great and opulent country like the United States should have been the very last of the big powers to become interested seriously in computation. Twenty-five years before [we started the MTP,] Mauro Picone of Italy [established his] magnificent Istitutto per el Calculo in Rome, and soon after that there were the absolutely inimitable Mathematical Tables being prepared by - in England - by —

TROPP:

By Comrie.

RHODES:

Not only Comrie, there was J.C.P. Miller, and [many other geniuses.] Comrie [headed] a computation laboratory. The British Association for the Advancement of Science [were our teachers and guides.] And if it hadn't been for them, we would not have achieved what we did.

Dr. Lowan, [who] was chosen to run the Project, had been one of the first batch of brilliant students who were sent to Princeton University to study under the very great men at the Institute for Advanced Study. [He worked] directly under Einstein because he was interested in physics; and when he left, he got a very low paying job at Brooklyn College in the evening, teaching two courses in thermodynamics. [Drs.] Gertrude Blanch and Milton Abramowitz were his most outstanding students.

[The Mathematical Tables Project (MTP)] was the brainwork, of course, of Roosevelt, Hopkins, and [of the late] Dr. Briggs, [Director of the National Bureau of Standards, who knew] that, although scores of WPA projects had already been in progress, there [was]

still [a large] number of people left on the [Welfare Rolls. So it was decided to start another project for unemployed mathematicians.]

[However, most] of the people [who] came to us really knew nothing at all about mathematics or [even] arithmetic. Gertrude Blanch says that they were all High School graduates, and they may have been. I never checked on that. But if they were, very few of them had remembered anything about the arithmetic or the algebra or whatever mathematics they had [studied].

The Project started officially on January 1, 1938, with Dr. Arnold N. Lowan as the Director, and Mr. Murray Pfefferman as the Administrative Officer. Dr. [Lowan] had no one to help him, [so] he [asked] Dr. Blanch and Milton Abramowitz [to join the Project as Unit Supervisors.] And those three people, Dr. Lowan, Dr. Blanch, and Abramowitz, were the real pioneers in the field of computation in this country. Since, unfortunately, Dr. Lowan and Milton are no longer with us, I am so [very] grateful to the fates that you can still have an opportunity to speak to that miraculous woman, Gertrude Blanch. She is the only woman who has received the Distinguished Award for Government Women Workers from the United States twice for her recent work at the Air Forces in Dayton, Ohio. If I had anything to do with awarding medals, I would have given her [one] made all of diamonds for the early work that she did, in welding a malnourished, dispirited crew of people, coming from [the] Welfare Rolls, [into] a group that Leslie J. Comrie said was the "mightiest computing team the world had ever seen."

TROPP:

Can I go back to something that is in this paper that you gave me, written for Dr. Lanczos's Festschrift? In both this and the little book by Arnold Lowan, the little pamphlet of the Computation Laboratory, it mentioned the very first meeting of people, people like Archibald, H.T. Davis, Lehmer, Van Orstrand, Crittendon and Tuckerman. Now that's a pretty distinguished group of mathematicians to start this particular project. Do you remember any comments or ideas that came from that particular group?

RHODES:

That I would not know, because this was in 1937, and I did not [join the Project until] December of 1940. Gertrude would know all about that, and Pfefferman.

The reason that I wanted to start with those first three years is because Gertrude Blanch is so modest that she will never even hint at the miracles that she had accomplished. And she did accomplish miracles. There is no doubt about that. It wasn't just the question of teaching those people, who never heard [that numbers have signs, how to compute.] That was an important thing, but not her most important [deed.] The [crowning accomplishment] was the raising of the morale of these people who had [felt] rejected by society and [thought] they were useless. For years, [members of the] Mathematical Tables Project as well as [of WPA's] other projects, were called "boondogglers." [Dr.

Blanch changed that notion. Moreover,] Dr. Lowan was as kind as a Director can be, as sympathetic as a man can be. But what they did was something that nobody discusses. [People] said we [produced] marvelous Tables — Tables without errors.

Philip Morse said that our Tables are "more enduring than bronze." And, oh - Einstein was telling Dr. Lowan "what a marvelous job you're doing down there!" But everybody was thinking merely of the Tables. Very few people realized the social work, the [salutary benefit conferred on] the spirit of those people [by] raising them from abject and self-despising people into a team that [acquired] a magnificent esprit de corps. So that is what I would like to bring out about our dear Dr. Gertrude Blanch, who will never mention one word about what she had accomplished. And I want that to go down on tape.

TROPP:

Well, I think your early description, when we talked weeks ago about Arnold Lowan getting there without supplies and without anything, I think that's a marvelous —

RHODES:

Shall I tell you that story?

TROPP:

Yes, yes.

RHODES:

When Dr. Lowan first started, they began to send hundreds of people. Now, here is where Gertrude and I do not [have the same recollection.] I believe that Dr. Lowan told me there were 420 people to start with, but since I [am] deaf and didn't have a hearing aid, and he had a very thick Romanian accent, I may have mistaken the one hundred for four hundred. She says there were 125 people.

Well, whatever [the number,] it was a big horde of people. They hired a huge [hall.] It had been a stable for horses which was changed into a garage, but it still looked like a stable, because it was just one [big] room with windows on one side [only,] which certainly did not give enough light anywhere near the [other] end.

They brought [in] a bunch of rickety tables [and] rickety chairs. [A] tiny corner at one of the windows [was] partitioned off to make an office for Dr. Lowan, and they sent in a box of supplies which included a typewriter and [appropriately headed stationery —] just for Dr. Lowan. But nothing, absolutely nothing else for the crowd. They must have thought that Mathematical Tables come out from the brains of workers, the way Athena came out from the brain of Zeus.

TROPP:

Yes, except they gave you tables. [Laughter]

RHODES:

That's the way, apparently, they [reasoned.] Well, fortunately, Dr. Lowan's wife was a remarkable woman. She was private secretary to [Morris] Ernst, and after work - at night and [on] weekends - she would sit at that typewriter and he would dictate to her begging letters to the Bureau, "Please send me paper, pencils, books. I need so many things [and] supplies. These people are just sitting there. They are not doing anything. How in the world do you expect me to start without any supplies whatsoever?" But no answer came.

Finally, Dr. Lowan, Gertrude and Milton just put their hands into the pockets of their jeans, walked into the nearest stationery store and bought paper, pencils, rulers, erasers, and pencil sharpeners. And everybody was given one sheet of paper, one pencil, and they had to share the rest of the things. And that's how the Mathematical Tables [were] started. It's unbelievable that, what I consider [the] most magnificent Tables in the world, should have been started under such circumstances.

When Dr. Gertrude Blanch and Milton began to explain what had to be done they discovered, much to their amazement, that at least eighty percent of the people had never heard that numbers had signs. [So the three mathematicians] had to spend a little more money and get red pencils, and, from [then] on, [the workers on] the Mathematical Tables Project never heard the words negative number or positive number. We had black numbers and we had red numbers.

TROPP:

[Laughter]

RHODES:

Now I cannot, [please] remember, take credit for any of this, because [it] all happened long before I came, but Dr. Blanch will probably pooh-pooh [the affair if] you ask her about this, and say, "Oh, that was a simple thing." What those poor dears did was to paste together a lot of sheets, lying on the floor, and prepare gigantic - absolutely gigantic - four charts, one for each wall: for addition, multiplication, subtraction, division, [always using the] locution of black numbers and red numbers.

By this time [they] had a pretty good idea who was fairly good, who was not so good, and so on; so of course, those that could only add were put on addition, and the [brightest] ones were put on division. The really brilliant ones [were made checkers.] (They did have a few quite brilliant people who, unfortunately, were on the Welfare Lists because of

their physical disabilities. We had one [legless] man who killed himself to save a child. I will [later] tell you about him, Billy Horenstein, who was really outstandingly brilliant.)

The way they organized the [program] was [fantastic.] On the addition sheet - on this huge chart - they said, "Black and black makes black?" "Red and red makes red." "Red and black?" That, you see, was too much for them, so they had to hand over the sheet to the subtractors, who knew about those things.

TROPP:

[Laughter]

RHODES:

The multiplication chart was the one that bothered even the third, the better group. They were terribly [puzzled] by the legend that was on their sheet. It said, "Black and black makes black." Now that sounded reasonable. But "Red and red makes black?" That was obviously an error.

TROPP:

[Laughter]

RHODES:

So, every time Gertrude Blanch went through they would ask her, "Please, Miss, didn't you make a mistake?" The dividers really didn't have to be told much. They wouldn't have been [given the task] if they hadn't proven to be pretty good.

Now Gertrude will never admit that we had anybody who didn't know much. To her they were all marvels. Well, they were such marvels that the first Christmas, when I came there and wanted to give everybody a [small] gift, I was told many times, "Buy them a little soroban, a little abacus, so they could at least learn how to add."

RHODES & TROPP:

[Laughter]

RHODES:

The reason that I emphasize this, Henry, is because of the miracles that Gertrude and Milton [performed.] I don't include Dr. Lowan because he was too busy in the office. And he didn't bother with these things, [only] Gertrude and Milton and [a few] others [who] were there before I came — and let me tell you [why] I haven't mentioned their names. They are [quite] important people [now] and I never met them personally, [so] I

do not know whether they would be willing to admit their humble beginnings. Some of them are ashamed. One of them is the president of a great university. Another is an important professor of mathematics. I do know of one who was with us [and] definitely doesn't want her name mentioned at all in connection with the [MTP.] So [please] ask Gertrude or ask Pfefferman, whether those men [who] were there before I came were the kind that would not mind being mentioned.

TROPP:

Well, what we could do is, you could give me their names on a piece of paper. We could keep it privileged; and I could contact them individually and see if they want to talk about it.

RHODES:

I would prefer that Gertrude, who is very discreet - not like me - tell you. If Gertrude tells you, then it's all right because she is the most discreet woman in the whole world. And if you [put] dynamite under her, she would never say anything that she felt would hurt anybody. So if she wants to talk about that, fine. They didn't stay long because, I suppose, they didn't like that type of work and looked for something else.

[The MTP] pioneers did a job that should be, I think, described as [truly outstanding.] I suppose all WPAs did wonderful work, because I see some people on TV, artists, some [actors] like Lee Cobb and [others] who were originally on WPA, and some of the —

TROPP:

Some of our top writers started off on WPA writing projects.

RHODES:

Top writers, top painters. It's remarkable what the WPA did. And why people still think that [WPA] was [detrimental to] the United States, I cannot understand. If I were a Catholic, I would burn a candle to Hopkins. I think he was a saint, and he saved not only the lives, but the sanity and the self respect of thousands of people. So I am all for him.

Dr. Lowan had a great deal of difficulty in getting mathematicians to run the Project. It seems that he applied to many universities, and whenever the professors would approach some of their bright students and tell them about it, the answer was, "Oh, join a boondoggling [agency?] No." They didn't want to be connected with WPA. So he had [to] get permission from the National Bureau of Standards to receive funds — you will have to ask Gertrude where those funds came from, they were not from WPA — to hire mathematicians.

In 1940 I was working in Albany at the [New York State] Unemployment Insurance [Agency.] When I was in [its] New York office, my job was to examine the applications, because we had written to many manufacturers and storekeepers, begging them, "Please, find some kind of a job for these poor people who just haven't enough to live on." And we had sent them forms to fill out if they needed anybody. And my job was to look at these forms every day and to try to match [them up] with the [myriad applications for employment.]

When I left to go to Albany, this [task] was taken over by a dear friend of mine who [is] no longer alive, a very brilliant young man, George Cooper, and I begged him particularly to be careful about certain applications from manufacturers who specified that the girls should be around 18, should have certain measurements, should be blue-eyed and blond, and [be] very good to the buyers. And, because I always tried to give a [bit of] advice to those girls before I sent them out on those jobs, I spoke to George and asked him to [scrutinize] those situations, too.

Well, I was delighted one day in Albany when George called me up, using his own money, God bless his soul, to tell me that among the forms they received from possible employers there was a letter from Dr. Lowan asking whether there was anybody in New York City or vicinity who might be interested in becoming a Unit Supervisor of the Mathematical Tables Project. [George] thought it fitted me, and he asked me to come [to New York.]

I had been considered a sort of a prodigy at Cornell and at Columbia, and every professor spoiled me terribly by telling me that I was one of the most outstanding [students;] and they did tremendously wonderful and generous things for me, very often changing completely their schedules so that I would be able to take their courses. I was a hospital nurse. I left [school] at one, and worked for twelve hours and, therefore, could not take any courses in the afternoon. So if I showed an interest in [one] they would ask the other students to come in, look at their schedules, [and rearrange them,] so that I could take the course. That was the reason I couldn't do much in physics and chemistry, because they required laboratories, and at the beginning I couldn't [manage] that.

So I came out feeling that I was one of the world's greatest, most able, most magnificent mathematicians. When I entered the Mathematical Tables Project, I discovered that I was one of the biggest nuts, idiots, and ignorami that ever existed. I knew absolutely nothing about numerical analysis. I had never heard that there was such a thing as numerical analysis. Cornell never mentioned numerical analysis, Columbia never mentioned numerical analysis, and I suppose if they had, I would have [scorned] to take [it.]

[Perhaps the excellent mathematicians] I mentioned before left [the MTP] because they hated being connected with applied mathematics. I don't know. But pure mathematics is something so divine even today to me, that I am sort of sorry for those people that had to lower themselves to do applied mathematics.

TROPP:

I don't even remember there being a good text book in that time period on numerical analysis.

RHODES:

Yes; I did later buy Scarborough's [book,] and when I met Scarborough I hugged him and kissed him because he —

TROPP:

That was published in the thirties.

RHODES:

Yes. They didn't teach anything like that, and I knew nothing about it. And when I came, the other people who saw another greenhorn decided [to] have some fun with me. This was really funny, Henry. They gave me a tiny, unbelievably simple [set of three equations in x, y, z to solve. Suspecting that they expected me to actually go through the traditional process, I gave them the obvious answers at once.] They said, "And what other answers are there?" And I said, "What do you mean, what other answers are there? You know darned well that there is only one set of answers that would satisfy [these equations."] And everybody roared because that's exactly what they expected me to say.

You see, I had been so certain that all numbers were as they were written, that is exact numbers. But in applied mathematics you never deal with exact numbers, or very, very rarely. The numbers are approximate, and, therefore, you can have all kinds of answers, oh, millions of answers. It also has a great deal to do with [the condition of] the determinant, and oh well, I don't have to go into that [here.] But the joke is that every greenhorn that came in, had to undergo this sort of test.

TROPP:

[Laughter]

RHODES:

Well, it didn't take me long to find out that, far from being the great prodigy that everybody made me believe I was, I was really extremely stupid, extremely ignorant. And God bless Gertrude Blanch. She was so patient with me. She was so sweet. She taught me. She worked with me. She did that with everybody, but especially with me, until I really began to understand something about the use of approximate numbers, and the horrible things that approximate numbers can do. And the difference between the divine Eden-begotten concepts of pure mathematics, and the mundane [notions] of

applied mathematics. It took me a little time to learn, but she was very patient with me, and so were the others.

[Thus,] I became, I think, fairly [proficient] in applied mathematics. However, at the beginning, because I had been a nurse, I had other things to do. We had epileptics. We had many cases of arrested tuberculosis. We had dipsos. And they needed a little special attention. So in the daytime, a great percentage of my time was given over to taking care of these cases. Gertrude and I would begin our work in the evening, when everybody left. It was nice and quiet, and telephone didn't jangle, and people didn't need our attention.

We had to do a great deal of work. It consisted of two [types.] First of all, we had to look over all these hundreds of sheets to test them for consistency, because each individual [checker] could only see [one set of] sheets, but he didn't see the rest of them. We had to see that everything was consistent.

One of our Tables, the Table on Bessel Functions, had undergone 22 checks, and on the 22nd check we still found two mistakes. That just shows how careful we were. That was our first job: to test the completed work for the day. And the other was even more important: the preparation of worksheets. It might interest you to know that Dr. Lanczos wrote to me, a short while before his 80th birthday, asking me why did we [fail] to include [in our Zeitschrift article] a few worksheets, because they were so important. I went through all my papers and found a couple of them and [air] mailed them [to Ireland,] because he was going to deliver a lecture and he wanted to make slides of those worksheets. They were really remarkable [productions,] and it is one of the great accomplishments of Gertrude Blanch that she could write out a worksheet so that people who knew nothing about mathematics could [do advanced functions] by just following one step at a time.

TROPP:

You were doing these Tables by using a Taylor expansion.

RHODES:

Usually yes. [But] not all of them needed expansion. For those that needed expansions, we used the Taylor theorem because it was easiest. Once you taught them how to take a derivative, they just continued taking derivatives one after another.

TROPP:

I got the feeling you used something up to the 50th derivative.

RHODES:

55 derivatives. Other methods, of course, existed, but it would have been too difficult to teach [them] and to [prepare the worksheets. They followed the] simple way. After all, [they] had these people sitting there making all of fifty-seven dollars a month, [so] they had to keep them occupied.

The first Table didn't require any derivatives. It was the powers of e, and all you had to do was just keep on multiplying. They began with key values — the better workers would [compute] them, and these [functions] were checked and rechecked and [triple]-checked. [Other workers calculated the values] in between. Say, if they began [with arguments] at a tenth, did two-tenths, three-tenths, and so on, [and finally reached the value of the function] at 1, then they had something to compare [it] with. The chances of them having made a mistake and [obtaining the correct value] at 1, was practically nil, you see. [To meet the urgent need of the key-values computers,] Dr. Lowan began to beg [again,] "Please, send me some machines, we need key values." Our key values were made to 32 significant places.

TROPP:

Wow.

RHODES:

The [WPA] must have gone to the city dump and found 60 of the most broken down, the most ancient [contraptions] — I won't mention the name of the company because it's a good company, but at that time they were making manual [desk] machines that weren't geared to the [foremost] place, [and] they had eight banks. The modern machines have ten banks [and,] of course, they are geared all the way out. The only [disaster] that can [occur] in [mechanical] computation is [an] over [flow in the foremost] place, [and] you need a gear to indicate [the extra unit.] So if you had 8 banks (as we had on these terrible machines) you had to have a gear for the 9th place, to show that 1. But they didn't have that gear, and that 1 got lost.

Well, a mathematician would know that when you add [two numbers] beginning with [say] a 5 [and] a 7, you would have that 1 and, therefore, he or she would not be bothered too much, they would just write down the 1 — add it on from their brain. But these poor people knew [little] about mathematics and, besides, were not that much interested. So if the 1 wasn't there, it wasn't written. Well, if it were just an 8-place affair, that would be no great trouble because, when we looked over the sheets, we would add on the 1s, but we were [carrying out quadruple precision operations and] that lack of a 1 was a tremendous handicap to anyone [computing a series of values, each of which depended on the previous one.]

Many a time somebody would be very unhappy because [his result,] when he arrived at the key value, [did not jibe with the pre-computed one. In that case, they would seek the aid of Bill Horenstein, who was a whiz at detecting those missing units.

Let me take this opportunity to pay a tribute to our beloved Bill.] He was a polio victim, and they rigged up for him an Oldsmobile so that he could drive it by hands alone. One tragic day in Corona, California, he was driving his car on a rather narrow street and saw a child dart out of a store. He knew [he might] hurt that child or maybe kill [it,] so he deliberately swerved the car into a blank wall and killed himself. The storekeeper [saw this act of self-sacrifice.]

Later on, when we became really quite important, we used asymptotic expansions [and] did other very interesting work. But that was [after] WPA was no longer in existence.

In the early days then, we had to beg for even those horrible hand machines, [and we cranked them the livelong day.] Oh, how my arm ached by the end of the day.

RHODES & TROPP:

[Laughter]

TROPP:

They're still around.

RHODES:

And this might be interesting. One day a new person came, and I sat as I always did with them, and tried to show them how to do things. We had a very simple worksheet. [The girl] had to first copy from [a] book [the] sines [of the] angles [listed on the sheet] and [I] showed her how to do that. "After you fill these in, then here is a constant." And the constant was written out: K. "All you have to do is take that K, [punch] it in here, [and] multiply it [by the sines."] And I showed her how to multiply. And we did it five or six times [using] different [sets of] numbers. And she understood [the process.] She did a couple of numbers while I was sitting there. She knew how to multiply on the machine. Fine. Then I went on to the next one. I used to [visit] one after another, [asking,] "Any questions?" "Are you doing all right?" "Trouble?" Those were the good people. Those that were doing key values, mind you, the key people.

I came back again to the first girl that I had just begun teaching, and she sits there with the most woebegone expression you ever saw on her face. "Mrs. Rhodes, I did just what you told me, and I still got no answer." I said, "What do you mean, dear?" Well, you see, she had copied the sine of 0, and it was 00000, and she had multiplied it by the constant just as I told her —

TROPP:

[Laughter] She was shocked when she got zero.

RHODES:

No, she didn't get zero. She got nothing, [from her point of view.] She was supposed to copy down a number, and there wasn't anything to copy.

TROPP:

[Laughter]

RHODES:

So this just gives you an idea of the sort of thing we had to contend with.

END OF SIDE ONE SIDE II RHODES:

We had impressed upon our workers over and over and over again that we were not watching them. We were not counting their output. The only thing we asked of them is complete accuracy. Now, in order to insure that accuracy, Gertrude Blanch and the rest of us would make out worksheets, in which every operation had to be done at least twice. And we tried to hide the fact [as far as possible.] For example, if we added a and b we wouldn't immediately say: add b and a. But some time later we saw to it that b got added to a, and we had arrows connecting the answers saying that these two answers should agree to, say one or two [units in] the last place. If they did not get such an agreement, then they were to [erase the pertinent portion] and [re-compute it.] We were in no hurry. They had to do it absolutely correctly, and not to worry if they did not get it the first time, or the second time, or the third time. And if they needed to, they could just get a fresh sheet, tear up this one and try another one. We were obsessed — especially Gertrude, who had fallen in love with the marvelous Tables of the British — with the idea that nothing but accuracy counts. And for this reason we had made it very clear to everybody that it was all [we] asked of them - complete accuracy.

One day a girl came to me from another Project, weeping bitterly [and] saying that because she's colored she was being discriminated against. She heard that we were such wonderful people, that we treated our workers with respect and dignity, and would we give her a chance? [Being] a softy, [I swallowed her story.] I should have checked with [her] boss and found out why she was not liked. But I didn't. And so I asked Gertrude's permission and she said, "All right, let's give her a chance." [And] she started working for us.

Well, she hadn't been with us long enough apparently to absorb that feeling of accuracy, although, of course, we also gave her the [same] lecture that we gave everybody else. She must have thought that the more she produces, the more we will think of her and the more anxious we will be to keep her. [Her checker] reported to us that the girl was a whiz, she handed in many more sheets than anyone else; and I began to feel very proud of myself, thinking, oh, I got [me a] good girl, working so hard.

You see, all that the [checker did was to examine the values, connected by the] arrows and if they agreed within one or two [units,] he was satisfied. In her case he once mentioned, "It's remarkable, they agree to the very last place." That should have given me an idea, but I was too busy with other things. Well, one evening Gertrude and I sat down to do our regular job of checking the sheets, and [when] we got [to] hers, [no values] differenced, absolutely nothing differenced. That was something we couldn't believe. How could [they] not difference? The arrows showed perfect agreement — too perfect, as a matter of fact.

Well, lots of things can happen. First of all, the formula can be wrong. [Or we] could have made a mistake [in breaking down] the formula [while preparing] the worksheet. [Or] we could have made a mistake in [a sign.] We could have made a mistake in a constant. It happened to be my worksheet, so I checked [it] over: no mistake there. [She had to] copy certain information from other Tables. Maybe [I] gave her the wrong tables. [An examination showed] that she copied the correct Tables. What else could have happened? The point [is] that we were so innocent and so trusting, it never occurred to us that what really happened [could have occurred.] What had happened was that she would get the first answer, and then when she got to [it] the second time — where the arrows showed that they had to agree — and [they] didn't agree, she merely erased the [second] answer and copied down the first [one.] We found that out [when] Gertrude and I recomputed all her sheets.

[Next] morning, Gertrude took her into the office and gave her a nice talking to. We didn't fire people because Dr. Lowan used to say, "Where will we send them? Back to the Welfare Rolls? I haven't [the] heart to do that. Just explain to [them] what they should do, and let's forget all the incidents." He was such a dear man. He knew what it was to be miserable and poor, and he had a heart of gold. So Gertrude [merely] gave her a pretty good lecture. She knows how to use words very effectively, Gertrude does. [And] the next day the girl disappeared.

At first we thought maybe she was upset about what had happened. Maybe she was ashamed. We'll wait a couple of days. [But] instead of her coming back, one of her friends, that she had made during the short time she was with us, told us she had received a letter from her saying that she had gone to Washington and obtained a job at the Treasury Department. Well, all — except one — made pretty caustic remarks about the Treasury Department and the sort of people they hired.

TROPP:

[Laughter]

RHODES:

But Herbert Salzer, our wit, and [incidentally, author of some 200 papers], said, "What's the matter with you? Don't you realize what a perfectly suitable, marvelous appointment

that is, [her] being at the Treasury Department? Who else in the whole wide world would be able to balance the United States budget but that girl."

TROPP:

[Laughter] [Recorder off]

RHODES:

The fame of the Mathematical Tables Project spread far and wide, and [that] is all the more remarkable, because we were the last big nation to start; and yet we outstripped every other nation. I mentioned to you the Italian Istitutto per el Calculo which had [been] started 25 years before us by the [brilliant] Mauro Picone. And there was also a very fine organization, as I told you, in England. And

TROPP:

There was a Japanese group, too.

RHODES:

And the Japanese and the Germans and the Russians and the French. And we were the very last of the big, believe it or not. And yet we outstripped them all and became extremely famous, so that we received requests from all over [the country] to do special jobs, and we always obliged. Of course, we were delighted when the greatest mathematicians and scientists in this country began to send their requests in. Every university, every great man that you can think of sooner or later came - so to speak - with hat in hand asking us to do [a] job for him. And we were so proud to be able to say that we did work for Courant, and for Philip Morse and for Julius Stratton and for Bateman and Jerzy Neyman and Harold Hotelling. It was just a wonderful feeling and we would get magnificent letters from them. Dr. Lowan would have the habit of standing at the door of his little cubby-hole — he had a little office, [the rest] were all in one room — and tell his secretary (he had a secretary by that time) "Show Ida the letter," and then he would stand there and watch me as I read it. And the minute I would notice what they would say, I would get so excited —

TROPP:

[Laughter]

RHODES:

and be so happy and so thrilled. And he would say to the secretary, "We never have to pay Ida any salary. All we have to do is show her those letters." Really, Henry, they were so appreciative and [gave us] such a happy feeling. It didn't matter that we were only making $1600 a year. Even Gertrude. Dr. Lowan was getting [the] magnificent sum of $3200.

TROPP:

Has all of that correspondence vanished? Is it all destroyed?

RHODES:

It's all [gone.]

TROPP:

Do you have some or does Gertrude have any?

RHODES:

Every bit of it is destroyed.

We felt that we were doing a pretty good job, and naturally that raised our esprit de corps. Because the minute I read this letter, I would rush around and tell everybody, "Oh, we got a letter from so-and-so." They may not have known who that person was, but then I would tell them, "Oh, he's a very, very important man." And I would tell them what he said, and everybody was happy.

Dr. Lowan also had the habit of giving little parties. Dr. and Mrs. Lowan would bring in a lot of food and we would have beautiful little [banquets.]

TROPP:

What was his wife's name? You talked about her earlier, what was her name?

RHODES:

Bertha Lowan.

TROPP:

Bertha.

RHODES:

Oh, she was a wonderful woman.

We had such a feeling of brotherhood and pride in our work. And it's true that we expected absolute accuracy. We were like Aiken in that way. We would not have allowed anybody not to, [chuckle] not to be accurate. But we also had tremendous sympathy and understanding of our workers, and they loved us and we loved them.

It was, therefore, not surprising that a certain, shall we say cockiness, would become part of our attitude. So when we received [word] that the WPA was to be closed, we were unhappy, because our work was staggered. We did not start a Table and finish it [before beginning a new one.] That would [have been] impossible, because we had so many workers, we didn't need [them all] for each Table. So we would always be starting new [ones.] And at that time, I believe, there were around 15 Tables in progress at various stages. And it just hurt us terribly to think that we would have to give up finishing those Tables. Dr. Lowan [figured,] after all we had all of this marvelous [appreciation,] all these letters; people would come to our office and just praise us to the sky; surely if he wrote to them and told them to please let us continue until we finish these Tables — we won't start any new ones — but just let us finish those that we started, then an extension would be [granted.]

So he sat there and wrote letters to each one of those men, all those great men, begging them to please intercede with the WPA to allow the Project to continue until we finished the Tables. They all answered and they all praised [us] again. But everybody said the same thing in different words: It's impossible for them to do anything. They can't fight the United States. This was decided by Congress - or whoever decided it - and they are powerless, they just haven't got that much authority to stop the [ouster.] We certainly didn't have to worry because there were now plenty of jobs opening up; the War was on, and [there] would be [no] difficulty [in] getting jobs for [our] people.

At the same time Comrie, who was practically entirely deaf, who had only one leg, and who was already in the advanced stage of debility on account of his trouble with the kidneys, was sitting late at night in front of his radio in London, and he thought he heard the terrible news that the WPA [was] going to close up. He was getting ready for bed, so he had taken off his wooden leg, and he only had his robe on. Nevertheless, without stopping to strap on his leg or to dress, he hopped across the street to the telephone office and sent a very strong cable to President Roosevelt stating that under no circumstances should the Mathematical Tables Project be dispersed. We, of course, knew nothing about it [until almost a year later, when he visited us in New York.]

So we were very sadly busy cleaning out our desks, and especially wrapping up our unfinished Tables and writing down very carefully detailed information as to how they should be completed. It was a vain hope. I'm quite certain that they would have been thrown into the waste paper basket. But still we had to do our duty, so on each of the Tables we wrote down how they should be handled.

[One afternoon,] a little middle-aged lady opened the door and asked, "Is Dr. Lowan in?" [She told us] she was sent from Washington to find out what sort of work we were doing down here. So we brightened up; Gertrude and I grabbed her and we took her into Dr. Lowan's office and we bent that woman's ears. [We must have] made a [good] impression, because it didn't take long before a committee came from the NDRC, including, by the way, an old professor of mine, Marston Morse, and [our friend] Hotelling, and they decided that we should be taken over by the NDRC. Vannevar Bush, Warren —

TROPP:

Warren Weaver.

RHODES:

Warren Weaver, and Mina Rees was working there.

By that time, [most] of [our] people had already [found better-paying employment.] We were left with about 60 people at the time the NDRC took us over. And then life began. Oh, beautiful quarters, no longer that awful stable. Wonderful Marchant machines, geared all the way.

TROPP:

[Laughter]

RHODES:

Electric machines [with] ten banks, and brand new. And later we got a complete set of IBM electromagnetic equipment. Milton Abramowitz was put in charge of that. He had his own floor for [his machines.]

TROPP:

This was still in New York?

RHODES:

That [was] still in New York. And we began to live high.

TROPP:

[Laughter]

RHODES:

We began to put out books, one after another, one after another. I think 42, before I went to Washington.

One day when we were feeling absolutely on top of the world, Dr. Lowan received a telephone call to come to see [the] members of the NDRC. They wanted to give him a certain problem, to find out how long it would take. He suggested that the problem be given [over the telephone, so] he would be able to give them an answer when he [went] to see them.

[It was] a very simple [anti-aircraft] problem, and he happened to assign it to me.

At that time I was in charge of the IBM equipment for the following reason. Dr. Lowan had been invited to the Moore School of Electronic Engineering, and had been [told] what the ENIAC would do. The NDRC was very anxious for us to get acquainted [with the potentialities of] electronic machines, [so Dr. Lowan] assigned Milton and Jack Laderman to study everything that they could find on electronics. The job Milton had — taking care of the IBM equipment — was given to me, and everything that Jack Laderman did and a lot of what Milton did was put on poor Gertrude's shoulders. I don't know how she carried it [all.] She's a tiny little thing. The amount of work that woman performed is [incredible.] Atlas is a pigmy compared to her.

TROPP:

[Laughter]

RHODES:

So we were both doing the work of those two gentlemen, while they [repaired to the] 42nd Street Library and studied very hard about electronics.

Thus, this problem came to me, and I made up a lot of fictitious values for the parameters, and ran 20 or so sets through the machines, averaged up the time, and went down — I say down because Dr. Lowan was on a lower floor — [and told him] we [could] run one of the cases every four minutes. And he thought [that was] pretty good. The next morning, full of pride, Dr. Lowan walks into the NDRC and he [gives them our estimate.] And they laughed at him. They just laughed at him.

This was something that Dr. Lowan never had experienced before. They explained that it had to be done in something like four seconds. And he said, "Four seconds? Could Mrs. Rhodes make such a mistake? Let me go back and discuss it." They said, "No, no, Mrs. Rhodes didn't make any mistake. We knew very well that you couldn't do it in four seconds. The reason we asked you is just to prove to everyone around here that the present type of equipment that you have is completely inadequate for the sort of work we need for [the] War. As a matter of fact, we have already made some contact with the Bell Telephone Company to prepare a relay machine which Dr. George Stibitz is going to

supervise, and eventually this machine when completed will go to you." Because, you see, they realized that he was terribly depressed at the thought that we were no longer the big shots.

So when he came back — of course I don't have to tell you this — he was quite unhappy. And he said, "Imagine the difference, it has to be done in four seconds." And then he asked me, "Are you sure about those four minutes? Are you sure?" I said, "Dr. Lowan, I'm very sure."

So that was [how] the Bell Telephone Company started to [build] its relay machine. Mr. Andrews of the Bell Telephone Company, the engineer, was very charming. Dr. Stibitz was very [informative.] Everybody was very helpful. We would go there [often.] We would watch [and] learn what they were doing. And we were dreaming of the day when we would get [the machine.] Unfortunately, we couldn't get it for two reasons. First, because the type of current that was needed was different from the one we had in our building. We were at that time on Nassau Street katycornered from City Hall. [Moreover, the machine was too tall for our elevators. Consequently, it] was sent to the NRL [here in] Washington.

[Now] we began to feel that we [were] not the only cock on the walk. Especially this electronic business bothered Dr. Lowan a lot. When the ENIAC was finished, he was invited to watch it. [He] came back and said, "We're finished. They don't need us anymore. Do you know," he said, "what they do? They don't look up Tables. They actually compute each value ab ovo." And to me that sounded so impossible, so incredible, that I said, "Dr. Lowan, are you sure you heard right?" And you know, he began to [waver;] he [answered,] "I think that's what they said." Even to him it sounded absurd. To compute each value ab ovo. Not to have to look up one of our marvelous Tables. That sounded like [the] death knell. We were [quite] unhappy about such a possibility.

In the meantime, Jack and Milton became quite expert at this business, and in 1947 a telephone [call] came through from Washington. What had happened was the following: The Secretary of Commerce, Henry Wallace, had decided that he wanted a younger man to be the head of the National Bureau of Standards. I think he appreciated our magnificent Dr. Briggs, but Dr. Briggs was getting old. [The] recommended Dr. Condon had just had some difficulty with [General] Groves on the Manhattan Project and left, and so this was a very good spot for him to come to. And he wanted very much [for] the Bureau [to] have closer connections with computation than merely be the sponsor. So he came to visit Dr. Lowan and said something about wanting to transfer the whole Project to Washington. Dr. Lowan was very much opposed to it, for he had, by that time, become professor of physics at the Yeshiva University, loved his work there and hated to give it up to [go] to Washington. Besides, he felt we were very comfortably placed in New York, and there were many [other] reasons why he [thought] we shouldn't be going [to Washington.] That was the beginning of [the] difficulties between the Washington part of the National Bureau of Standards and the Mathematical Tables Project. [Therefore,] Dr.

Condon began to look for [someone else] who would head a not yet formed Division of Mathematics.

During the War, Dr. John H. Curtiss was Commander of a ship and one of his Lieutenant Commanders was Dr. Edward W. Cannon, and another one was Demming — I forgot his first name — who was with the Budget Bureau. Dr. Demming mentioned to Dr. Curtiss that Condon was looking for a mathematician and, as a result of that discussion, Dr. Curtiss [became] the Chief of the newly formed Mathematics Division, [with] Dr. Cannon as his [associate.] [This took place] I believe, a year before that telephone [call] came through. Maybe Dr. Blanch knows exactly what year they started a Mathematics Division. I am not certain, but I think it was in 1946.

TROPP:

You're right, you're right about the year it started. Because Dr. Curtiss just gave me a history which runs from '46 to '53.

RHODES:

In 1947, a telephone [call] came through from Washington asking for one of these two experts that had been preparing to help with electronic computation, for the following reason: [While] Mauchly and Eckert were making the ENIAC, they had [conceived some] very brilliant ideas of how a fast and magnificent machine could be made with [an] entirely different type of memory — mercury tanks — but Goldstine, who was in charge, told them that the War was on and, therefore, they could not possibly begin making any other machine. They just had to somehow get [the] machine [they were then constructing] to work. And so they slapped 18,000 tubes together and made the ENIAC, although they were quite certain that a much better and cleverer machine could be made even at that time.

So when the War was over they went around looking for somebody to sponsor them, and the Census got interested and gave them a contract to make the UNIVAC. The Census [Bureau then] decided to ask [Condon] to supervise [the construction] and Condon now had [both a] Mathematics Division [and an Engineering Division in Washington, as well as a computation team] in New York.

This chain [of] events [led him] to [ask for] one of our men to come and help with the UNIVAC. [Recorder off] It just so happened that, at the time when the telephone [call] came through, neither could go. Milton's wife had just given birth, and she developed [a] milk leg, and Jack Laderman, foreseeing something of that nature, decided not to leave his forwarding address when he went off on his honeymoon. So Dr. Lowan called me on the telephone — I was [upstairs] with my IBM equipment — and said, "Come down, there's something important I want to talk with you about." When I came down he said — this was on a Friday, I believe — "Could you go to Washington on Monday?" And I [asked,] "Why, what's happening in Washington?" He said, "Well, you know that we

prepared Milton and Jack for the electronic business. Now they want one of these boys to go down to Washington, and you know that neither of them can go, so I wonder if you mind going down there?"

"You're going to send me?"

TROPP:

[Chuckle]

RHODES:

"You know that I never even knew what electronics meant. I have absolutely no idea about any of it. I [have been doing] a double job, just like Gertrude." I was doing Milton's job on top of my own, and so was Gertrude doing Jack's on top of her own. We had no time to bother with this sort of thing. So we knew absolutely nothing [about their recent work. Yet] there I was going to go to Washington.

I said, "I don't care that they will discover that I am an idiot. Of course, it wouldn't take them very long. But what will they think of you, Dr. Lowan, sending an idiot like me down there? And what will they think of the Mathematical Tables Project? Why, that's an absurd idea sending me down there."

He said, "Well, you tell me, whom can I send? Gertrude, you know, runs the whole place." And [he mentioned] every one of us and indicated how impossible it would be to send anyone else. I was the only expendable person.

I said, "Why can't we wait? Why can't we wait until Jack comes back? Why can't we wait until Milton's wife comes home? Just tell them that at the present time they can't come."

He said, "Oh, you forget that we're no longer the only ones in this field. You forget that if we do not answer this call, we may very well be [left] altogether out in the cold, and that somebody else will be called in, and then what about all these 60 people in our Project that have to make a living?" The way he put it, the fate of 60 people was in my hands.

TROPP:

[Laughter]

RHODES:

He knew exactly how to appeal to me. And he added, "All you have to do is keep your mouth shut and your ears open, and nobody will know that you don't know anything about it."

I said, "No, you better tell them that I don't know anything about it."

He said, "I already explained to Dr. Curtiss that you were not prepared for this, and that I'm only sending you as a substitute for one week, and not to be too surprised if [you] do not know much about this work." And then he added something which got me. "Have you ever been to Washington?" I said, "No." "Well, do you know," he said, "that you will get four dollars and fifty cents per diem for going to Washington in addition to your [salary?"]

Four fifty a day, why that sounded tremendously attractive, and I had never seen Washington. So I went.

On Monday I arrived. And the office girl, DeeDee, meets me and I say, "I am Ida Rhodes, I come from New York and I'd like to see Dr. Curtiss."

"Oh, Dr. Curtiss is not available." "Well, is there anybody else?" "Yes, there is Dr. Cannon." "Can I see Dr. Cannon?" "Dr. Cannon is out of town." "Well, who else is there?" "Churchill Eisenhart." "Can I see Churchill Eisenhart?" "Churchill Eisenhart is busy with the boss, and he will not be available today." "Who else is there?" "Dr. Albert Kahn." "Can I see Dr. Albert Kahn?" "No, Dr. Albert Kahn is in California."

I said, "Oh, how wonderful, the Lord arranged this for me. I did my duty, I came, nobody was there, I'm going home."

TROPP:

[Laugh]

RHODES:

"Will you be good enough to tell your boss that I did come, and that now that there is no one here [to see,] I am returning." And I walked out, feeling perfectly delighted. At the elevator [where] I had to wait a while, DeeDee rushed up to me. "Please, Mrs. Rhodes, please don't leave, I beg you don't leave. Dr. Cannon will be back tomorrow, and when he finds out that you were here, and that I did not detain you, he will be very angry with me. Won't you please do me a favor, stay overnight?"

So I said, "Well, I understand that I am to get four and a half dollars." — Those four and a half dollars were very important to me, [since] I was paying for my hotel room [and restaurant meals.]

She says, "I'll check." She calls up the administration office, and they say "No." No four and a half dollars for me. So there I was. Without four and a half dollars, [and without any knowledge of electronics.] [But] I couldn't disappoint the dear little girl. She was a

sweetheart, DeeDee. So I said, "All right. But if somebody isn't there tomorrow I'll definitely leave."

The next morning there was Dr. Cannon as sweet as he could be, and apologetic, and I told him, "Dr. Cannon, I know nothing about this, Milton and Jack —"

He said, "Don't worry. Here is a booklet. Read it over and you'll know all about it."

And that booklet, Henry, oh, that booklet! It was called *Specifications for the Construction of an Electronic Computer*. I read that book over and over and over again, and black despair mounted in my heart. Oh, there were a few words I understood, like 'but,' 'and,' 'with.' But most of them made absolutely no sense at all. And there was a little Greek letter there which baffled me tremendously. It was the Greek letter mu [μ]

Now we mathematicians are in the habit of assigning a letter to infinite numbers, transcendental numbers, numbers that cannot be expressed exactly. So, it occurred to me that μ must be a transcendental number. Why else would they use that [letter?]

Well, I could have, of course, asked. But I didn't want the whole world to know what a perfect ignoramus I was. And so I thought maybe I'll be able to figure out by [myself] what this μ meant. It said there that the access time of a machine word would be 200μ-seconds. Now I knew the word 'second.' That I was acquainted with. 'Access time,' well, that was not so clear, but I [had heard the expression before.] But what was the access time of μ-seconds?

Could μ be one hundredth, I mean of the order of .01? That would make [the access time] about 2 seconds. Well, that's pretty fast for an access time, but not [spectacular.] I had read an article in the newspaper about the ENIAC, and I thought it said [its] access time was faster than that. And I was almost certain that they wouldn't make a new machine that wouldn't be as fast as the ENIAC. So maybe it was a thousandth. No, that was fantastic. That was much too fast. It couldn't be .001. But μ was a transcendental number, so it must be something between .01 and .001.

Now I felt a little bit better. I began to read on and on. And then I wondered again. Am I right about that? The way it seems, it's a very fast machine. Well, I'm going to ask Dr. Cannon. So I walked [into] Dr. Cannon's [office and asked, "What is μ?" And when he told me, Henry,

TROPP:

[Laugh]

RHODES:

I did not believe him for one minute. I was absolutely aghast. I was stunned. .000001 second? How was that possible? [Of] course I didn't say anything to Dr. Cannon, but I walked out and said to myself, "Huh, those people are just dreamers. They don't know what computation [entails.] They'll find out soon enough. That's just a lot of bunk, and I'm so glad that [on] Friday I'm going home and I'll have nothing to do with this scatterbrained scheme. Let Milton [come] here."

[On Wednesday,] Dr. Cannon said to me, "Tomorrow we're going to Philadelphia, and you will meet Mauchly and Eckert and then you can ask all the questions that are not clear to you,

TROPP:

[Laughter]

RHODES:

that aren't clear to you. And so you will learn [all] about this machine."

Oh, my Heaven, this great expert from New York was going to meet these geniuses. Really one can write a comedy on that, there's no question about it.

TROPP:

It would make a good absurd play.

RHODES:

I think it would break up the whole audience. So here comes this dope to the great Mauchly. I wanted to show him that I knew something, too. I had remembered two words; one of them was oscillator. So I said to him, "Show me your oscillator please." And he looked at me queerly.

[Will] you ask him [about] that? When you [see him,] ask him what he thought of me when I [said] "Show me your oscillator."

He called out to one of the engineers, "Mrs. Rhodes wants to see [our] oscillator." So the engineer brought in the tube, and he shows it to me, and I look at it and I say, "What? It doesn't shake?"

TROPP:

[Laughter]

RHODES:

Well, this then was the kind of an expert that was sent to help the Census Bureau to build the UNIVAC.

This was on a Thursday. I was so embarrassed, Henry, that I decided I wasn't going to work till Friday, oh no. I [realized] that I had just put my foot into my mouth, so when we got back to Washington — you want me to stop?

[End of Tape I, Side II]

[Start Tape II, Side I]

TROPP:

That was a Thursday.

RHODES:

Well, I was so embarrassed by that incident with the shaking oscillator that I decided not to stay till Friday, but bought two boxes of candy — [the Division had only] two offices in those days. I left one with a note for Dr. Cannon and another one for DeeDee and thanked them for their tolerance. [I] didn't say good-bye — I was too embarrassed — and I rushed off.

On Friday morning I [ran] into Dr. Lowan's office, and I was a tigress. I said, "Dr. Lowan, don't ever do that again to me."

He asked, "What happened?"

I said, "I'm too embarrassed to tell you. I made a perfect idiot of myself."

And he said, "Well, they just called me. They want you to come back."

And I said, "They want me to come back?"

TROPP:

[Laughter]

RHODES:

"I don't believe it." He said, "Yes. Yes. They called up and —" I said, "I can't believe [it], Doctor." He said, "Call them up, then."

So I called up and Dr. Cannon [asked] why did I have to run away. After all, nobody knows much about this business. And, since he learned from Dr. Lowan that neither

Milton nor Jack can come — Milton's wife was to be [in the hospital for another] six weeks with the milk leg, and Jack hadn't returned from his [honeymoon] — then he wanted me to come back.

And he [added,] "Don't worry. We have a lot of engineers in the place, and they will all help. [Just] don't be afraid to ask questions." He was very, very kind.

So when I came back, the first man I ran into was Sam Alexander. I [confessed,] "I don't know [the first] thing about [electronics;] they sent me because —" and I told him the whole story. He said, "Don't worry. We will [help you." His] too was [a brand] new organization. There [had been no] engineering at the Bureau, and no [Mathematics Division.] There had been some argument as to who was going to be in charge of looking over the shoulders of Mauchly and Eckert. Originally Chet Page, whom you really ought to see, was the genius in the line of electronics, and I don't know why he didn't want to be the Division Chief. It all happened before I came. Apparently there was some argument as to which one [was] to be [Chief,] either he or Alexander, and Alexander got the job.

Sam sent [to] me — and I am particularly anxious for you to hear the name of the man I'm going to mention — Robert Elbourn, a genius of the first water, who only last week resigned — well, if that's a good word, because of [this routine] they [go through when] funds have been held back. [A] lot of people who have reached the proper age and length of service are sort of given a hint to leave. To me, to tell Elbourn to leave is exactly like telling Einstein not to have any connection with the Institute of Advanced Study. [Bob] is such a genius [and] such a wonderful human being.

So Sam and Elbourn and all the others, I couldn't mention them all, they are all darlings; I considered them simply like my own brothers, every one of them was so good to me. They taught me so much. And for a while I did not know whether I was a member of the Math Division or of the Engineering Division. And they, too, felt that I [should] belong to both of them. And it was very important, because for a while there was bad blood between the two Divisions, since there was no real definition as to what the function of each of them was in connection with the UNIVAC. Condon called himself the midwife, [who] was to deliver the UNIVAC to the Census Bureau. But who was to do what between the mathematicians and the engineers was not clear. And, of course, you know how it is. There is always a little jealousy, each one felt, "This is my function." And I was a sort of liaison officer between the two because I was very fond of Cannon and [also] very fond of Sam, you see.

TROPP:

Had you moved to Washington by this time? Or were you still —

RHODES:

Oh, I told you that I spoke to Cannon and he said he wants me back, and that I have to return, and I returned.

TROPP:

But you returned there permanently then?

RHODES:

I didn't know it would be permanent. I thought only until Milton [or Jack] would be ready to come.

TROPP:

I see.

RHODES:

No. I didn't dream it would be permanent. Oh, my gosh, [no.] I had my parents home. I knew that Milton would not be available for six weeks, but I thought Jack would be back from his honeymoon.

[But] in the meantime, I had to be here, I had to make myself useful; so I began to learn, and everybody was teaching me. I had [rented] a room [but I seldom went back to it.] I couldn't afford the time to travel or to sleep. So slept — if I slept at all — on the top of my desk. I worked all through the night. I cooked [in my office.] I was in one of the buildings that had showers because it was a chemical building and they were afraid of fires and [other] accidents. The guards never opened my door. They knew that I was lying down there sleeping. I only went home to change clothes and to bring in fresh [linen.] Otherwise, I worked day and night. Talk about hard work! Gertrude and I really have given blood to [our job.]

I began little by little to understand what it's all about. And even to learn something about other machines. At that time I went down to see Dick Block and Ellis, and learn about the Hurricane. We were supposed to be also supervising them. And then —

TROPP:

This was the Raytheon?

RHODES:

The Raytheon. Yes.

And then I began to read everything I could get hold of. Not that I understood it, but there was one paper that struck me as very interesting, and that was by Samuel Lubkin. And I remembered that name because he wrote in a very [lucid manner] and I appreciated that.

Imagine my surprise when one day [a man] walked into my office and said, "I am Samuel Lubkin."

And I said, "I've been reading your paper and I think you're just magnificent — it's not difficult to understand — and I think your ideas are superb. Where are you now?"

He said, "I'm nowhere now."

I said, "What do you mean? You are with the Reeves Company?"

"I was with [the] Reeves Company, but I left them."

"You mean you haven't got a job?"

He said, "No, I haven't got a job."

I said, "I'm locking the door. Just stay here. Don't move."

He said, "Don't worry, I'm not moving."

And I rushed up to Alexander and I said, "Guess who is in my office, Samuel Lubkin is in my office!"

And he said, "What about?"

I said, "He hasn't got a job."

"He hasn't got a job? Bring him over, bring him over."

So, of course, they hired him, and [he joined A1 Leiner and the rest of the SEAC crew. The ingenious Ralph Slutz came later.]

The reason that we had to have the SEAC is because — I don't know whether this is good for the tape, but it's the truth — Congress was very angry at Condon. They called him the weakest chain in our security link. He was once seen talking to a Russian and that made him, you know, a dirty bird. And his wife, I think, was a Lithuanian. At any rate, he was in bad graces with Congress. [Recorder off] So they felt obliged to harass him whenever they could.

Mauchly and Eckert had promised the machine in 18 months. 18 months had become a sort of a shibboleth among us, because no matter when you asked them when would the machine be ready it was always in 18 months.

TROPP:

They started calling that the Von Neumann constant.

RHODES & TROPP:

[Laughter]

RHODES:

So [Congress] found a good way to harass Condon as if he were to blame, "You promised to produce the machine in 18 months; it's now 2 years; it's now 2 1/2 years; it's now 3 years. Where is the machine?"

Well, in order to protect himself, it was decided that we should make a machine of our own so that we will know what it's all about, [as] it would be very difficult for Alexander to oversee the work of Mauchly and Eckert if he himself hadn't had closer knowledge of what it's all about. So they, therefore, decided to make a little interim machine. We did not intend originally for the SEAC to be a regular machine. And fortunately we found an angel by the name of [Dr.] [Recorder off] George Dantzig. He supplied the money from the Air Forces, and we began to make the SEAC. I mean, the boys began-to make the SEAC.

And, of course, they had fortunately the help of the UNIVAC people because they learned a great deal from them about the memory and everything else. But they didn't have the money that the UNIVAC would have from [the] Census Bureau, and so they had to have something very simple, very cheap. As far as I remember they allowed only $250,000 for the SEAC. Later it cost more.

I was there every day snooping around, trying to get a word here and a word there. And in the meantime doing coding for the UNIVAC. The UNIVAC had gone through quite a number of sets of codes and I tried each one out. How did I try them? I made up various problems and saw whether I could code them up. Every time I would [run] into some difficulty and Mauchly [visited us,] I would say to [him,] "I don't know how to do this, I think that we need this, we need that, we need the other." I don't know how [many] of my suggestions were accepted, but I like to think I was of some help. Of course, Grace Hopper was there and she knew a great deal more than I ever did. But I believe that they did listen, primarily because I was part of the National Bureau of Standards, and they were beholden to the National Bureau of Standards because, [as I said before,] Condon was the delivery man. So that was my job, to try out all kinds of codes and see whether I would be able to solve the various problems, [by their aid.]

In the meantime, Lubkin and I were discussing the codes for the SEAC. Since we could only allow 4 digits [for the commands,] that meant that the most we could have was 16. So there was the question of what 16 commands should [be introduced,] but it turned out that the [engineers] decided only 14, and those were [very] good [ones.] I simply adored the SEAC. Did you ever read the little story I wrote about the SEAC [in DATAMATION?]

TROPP:

No, I haven't.

RHODES:

I'll let you see it, because it shows my great love and admiration for that machine. Beautiful [instrument!] It had only 512 memory registers, that's all we could afford. And I am so grateful for that period, because it taught me how to utilize the minimum amount of space to get the maximum amount of information out of it. And with a minimum number of commands. I had already had, you remember, the great training of teaching how to do very complicated mathematics to people who knew no mathematics at all. So the machine was really nothing but the [same] sort of [pupil.] You had to explain to the machine very carefully, very thoroughly, step by step, how a problem is to be done. For this reason — and I say it unblushingly — I am the very best coder in the world.

TROPP:

[Laughter]

RHODES:

There is nobody that can beat me. I never use any of these artificial languages. For me, it's so easy to learn a machine language, and it's so much cheaper. There is no comparison. It's at least a thousand to one cheaper to use the machine language. It's faster, it's cheaper, it's more convenient. So that no matter [what] machine you give me — I must have coded for at least three dozen machines — I read over the commands and I am ready to code, [the same day.]

Let me say, in passing, that I am no genius because here is what happened. One day a young man came to my office, Mina Rees had sent him to me. He is legally blind. His name is Nelson Blackman. He had told Mina Rees he had been working [at the] Brookhaven Institute on a very important problem [dealing with] the collision of nuclei. And he found out that it couldn't be done, the computation would take much too long by ordinary methods. He heard about electronic machines, so he came to Washington, and he was sent to the [ONR.] Mina sent him to me. She told him that I worked all the time, and a good [day] to see me would be [on] Saturday, when nobody is around. So he came on a Saturday afternoon and said that he wanted to learn what the SEAC [could] do. And

I said, "I'll be very happy to make an arrangement with you and tell you all about it." Because my heart went out to him immediately. "What is your background?"

"PhD of mathematics from Harvard."

Well, that's not a bad background.

TROPP:

[Chuckle]

RHODES:

And he said, "Have you got the time to tell me about it now?"

And I said, "You don't have your Braille equipment."

He said, "That isn't necessary, just speak slowly, and if there is something that I don't understand I'll interrupt you and ask you."

And I said, "Well, but you'll have to come again. After all, it takes me months to teach people how to code. You don't think that you could learn in one day."

He said, "[Let's] see how much [I] can learn [today."]

Well, Henry, you will not believe it, but in that afternoon he learned all about the SEAC, what it's like, how it is made, and how it codes and everything. Monday morning — I give you my word of honor — he brings me in the whole solution of the collision of the two nuclei. One thing he did ask me when I was through, "You tell me it's a binary machine. Well then, what do you do with all your data which is, of course, in decimal?"

I said, "We have subroutines. We just [feed] in the decimal and the subroutine changes it to binary, and then we have another subroutine, when you get the answer in binary, that changes it back to decimal."

"Oh, oh, I understand."

So I said, "Well, when you're ready to use the machine, we will just put in the two subroutines and you wouldn't have to worry about that."

So he came in on Monday and he said, "I decided not to bother with those subroutines. I changed all my data into the binary."

TROPP:

[Laughter] If he's the gentleman I'm thinking of I've had some correspondence with him and talked to him once [on] the phone.

RHODES:

Nelson Blackman?

TROPP:

He's on the West Coast.

RHODES:

Palo Alto.

TROPP:

Right. Right. And he sent me — it's through him that I got some of Condon's speeches and some documents and early reports and some of the early material on the Bureau before the Mathematics Division was formed.

RHODES:

He is a remarkable young man.

TROPP:

Yes, I've talked to him on the phone.

RHODES:

So you see I cannot, although I consider myself the best coder in the world, beat Nelson Blackman on learning the whole business in one afternoon.

TROPP:

Well, he's apparently very modest because when I was in Palo Alto on one trip I tried to see him and he insisted that the other people I was going to see were much more important. I shouldn't bother to see him until some later date.

RHODES:

Well, no, I think he's quite important, not particularly in this field, but he's quite important because he was the liaison officer for England and for Russia. He is just a genius.

TROPP:

Yeah, well, he wrote these documents that survey all of the machines in Europe.

RHODES:

Oh yes, that's right. He wrote that.

TROPP:

Which is all the documents he sent me.

RHODES:

Oh, he is just marvelous. I adore that boy. And I was so impressed with him that I asked him to live with us. I had another almost blind [pupil] whom you no doubt have heard about, and I hope that you will see, by the name of Sam Genensky.

TROPP:

No.

RHODES:

Well, the story about him appeared in the [Reader's] Digest for January 1, 1968.

TROPP:

Genensky. I'll write it out and the address so that you can see him. He [is] in Los Angeles with RAND. He invented a machine for people who have partial vision like himself. Sam has only a little peripheral vision. And he invented this machine, which makes it possible for people with practically no vision to read and to write normally. I am a member of [an] organization which recently bought one such machine, and if you're interested in seeing it I'll give you the address. It's right here in Washington.

TROPP:

Is it the sensitizing machine so that you — these are the machines that sensitize the written material and you feel it in some part of the body and read it in that —

RHODES:

No, this actually uses the eyes. You have to have vision for that, but the point is that no matter how little vision you have it makes it possible for you to read or write. I don't want

to describe it here because it would take a long time, but I'll send you out there and you will look at it and see what it does.

I am now thinking very hard [about attempting] work with the engineers Jack Rabinow and Izzy Rotkin, [to] see whether we cannot do something for the completely blind. But that's a different story.

All the time that I was at the Bureau I had one dream. And that [was] to teach the handicapped, especially the Helen Keller type, that are both deaf and blind. So Alexander, God bless his soul, called up the Handicapped Division, and they brought over Mr. Kappel who is now dead, a blind man, and I discussed what my dream was, and he said, "How many people do you think there are in the United States that can neither hear nor see?"

And I said, "Well, are there more than one?"

And he said, "10,000. At lease 10,000."

"Oh," I said, "if you could only get me a few, so that I could teach them this because they would be perfect for [it.] They would be absolutely perfect." And he said he would try.

In the meantime, we read in the newspaper that a gentleman [was] coming over from the Netherlands who is the Head of Computation Laboratory of the Postal and Telegraph [Agency] which belongs to the government. He is deaf and blind, and he came to the United States to demonstrate his little machine whereby he communicates [with people and] with the electronic computer. He loves the out of doors. He doesn't want to live in the big city where the machines are, and so he communicates by this machine.

I never got to see him, much as I [would have] loved to, because he was busy with President Eisenhower, and there was a picture of him and [the] President [in the newspapers] talking to each other via this machine, which he brought with him. But the gentleman who came along with him, who invented the electronic [computer] for the Netherlands, came to see us, and he was explaining his wonderful little Gamma 60 to us. I asked him how much [would] it cost, and I think he said something like $300,000 or maybe $600,000, I don't recall. But around that. And I said, "How can you make such a magnificent machine for so little money?"

And his answer was, "You see, Mrs. Rhodes, we are poor in our land, so we have to have brains."

TROPP:

Do you remember his name?

RHODES:

[I think] Van der Pol.

TROPP:

Van der Pol. Because Heinz Zemanek mentioned him if I was ever in the Netherlands, he is someone I ought to see.

RHODES:

That's the guy to see. Oh, I tell you, when I heard about this — and the Head of their Computing Laboratory was this blind-deaf man — that absolutely strengthened my belief, which I always held, that it's very easy to teach these people. So I called Kappel, and he said [that he] found one man who was a mathematician, a PhD, deaf and blind, and they proposed that he come to the Bureau of Standards where he would be taught this new skill. And he said that he was very happy where he was. He loved his job. He had a lovely wife. He had three children and he didn't want to leave. And that was the only thing I could do with deaf and blind.

But I did as much as I could for just the blind and just the deaf, as you probably know. I helped to organize [the Computation Laboratory] to teach, and to get the equipment for the Gallaudet College, and my interest — since I retired — and all my time has been [dedicated] to the handicapped, primarily because I'm deaf myself, and because I've always had a very great sympathy for [them.]

In the meantime, as soon as Lillian Abramowitz got well, it was my hope that Milton would come. Mrs. Laderman, when she came back from her honeymoon told her husband in no doubtful terms that she had no intention to go to Washington. As for Milton, he was also leery about the situation. I think he felt very much the way I did, that it was just a dream, and why should he give up a nice job in New York and come here [for] something which may not turn out [well.] I don't know. I never discussed why he didn't want to come. I went to New York to beg him, and to say, "Look, I only went there as your substitute, please go." And he said he didn't want to. So with great pain in my heart I returned to Washington, this time to stay all these years and years and years.

So, in time, the rumor went around that I knew something about this [business.] Now most of it is not true. I know very little. But they say in a blind man's kingdom a one-eyed man is a king. I was the one-eyed man in those days. There was nobody that knew very much, and therefore, I became an expert. And I was sent everywhere to talk about the UNIVAC and the SEAC and the Hurricane and the SWAC, which we eventually made in our West Coast, and every other machine that [was being made.] As I told you, I only had to read over the manual about [any of] these machines [once, to master it.]

TROPP:

Let me, let me ask you about one of those early machines.

RHODES:

[Please!]

TROPP:

One of the machines that there is very little hard information around on is the BINAC.

RHODES:

Well, I never liked the BINAC. I didn't like it because it was a very poor [copy] of the UNIVAC. It had to be a cheap machine and it had to be done fast and, of course, the UNIVAC to me was such a darling. Oh, it's such a sweet machine. So I could never have liked any machine that wasn't as good as the UNIVAC. So, from the very beginning —

TROPP:

The stories are, you know, some people say it ran. Some people say —

RHODES:

It ran, it ran. Of course it ran. I was there for the demonstration. It ran and it gave [results.]

TROPP:

Did both banks run simultaneously? Or both sides of it —

RHODES:

Yes, yes, it ran the way any machine should run. But I didn't like it because I had been already weaned on the UNIVAC and I loved it, and our little SEAC was [progressing] beautifully, [so] I just didn't like the BINAC, and I told Mauchly, "I don't like the machine." [Laugh]

TROPP:

Were you ever around at Northrup after they delivered it to the West Coast?

RHODES:

No, no. They didn't like it either?

TROPP:

Never ran as far as I know.

RHODES:

It didn't run for them? It ran when I was [in Philadelphia.]

TROPP:

When did it first run that you know of?

RHODES:

Oh, that I can't remember. I'm sure that it was before 1950, because —

TROPP:

It was in 1949, because some time in late '49 it was packed up and delivered to the West Coast.

RHODES:

I thought it was a sort of a hurry-up job that was half finished.

TROPP:

Well, they may have felt the same way. They were under pressure.

RHODES:

Yes. That's right. They were under pressure. But, you know, my feeling is that [one] should never knuckle down to such [situations.] If you cannot make something that is good, don't make it at all.

TROPP:

One of the things I should put on tape is the Hurricane Project that you're talking about,

RHODES:

Oh, the Hurricane. That was a very nice little —

TROPP:

is a machine that — well, that eventually became RAYDAC.

RHODES:

Yes, that was a very nice little machine. But let me tell you something, I don't know whether it should go on tape, but the truth is always a good thing. When I came to this Bureau everybody was exceedingly sweet to me, and then I happened to mention to somebody, why is such and such a person being — well, shall I say persecuted, because he has Communistic points of view. After all, if he's a good engineer or he's a good mathematician or he's a good physicist — I don't want to mention what he was — if he was a good worker, what difference does it make what his opinions are? That should be something private and should not be questioned like religion or sex or anything else. Well, word went around — apparently immediately — that I was to be watched. After all, I was born in Russia. I was speaking with a terrific Russian accent. And who knows what the devil I was?

There was a stamp on the Hurricane machine [specifications] that it was a secret thing. I had, of course, read it and studied it and knew all about it, and had been to see Block and Ellis and everybody [else connected with it.] But suddenly they decided that I should not know anything about it. [Laugh] And they put it away and locked it. You know, that was very funny. That reminded me of the time when the newspaper said, "Now, let's [lock] all the books on relativity so that Einstein can't see them.

RHODES & TROPP:

[Laughter]

TROPP:

It's funny today. But it wasn't - not in that period. That was not funny.

RHODES:

It was certainly not funny then. So I was not allowed to look at that machine. But I liked it very, very much. And Block knows that.

TROPP:

Did you know Lou Fine who worked on that?

RHODES:

Pardon?

TROPP:

Wasn't Lou Fine one of the engineers on that machine?

RHODES:

Yes, Lou Fine was there. Yes, yes indeed. I knew Lou very well. I knew them all, because I was there all the time. I used to travel back and forth between [Philadelphia and] Waltham, Massachusetts. That was my job. I had to be everywhere. I had to know what everybody was doing and supposedly tell them where the weaknesses were. It is unbelievable that a dope like me should be telling geniuses where the weaknesses were. But I did know a great deal about computation. That I don't think anybody can deny, and I could tell whether a machine would help me, or would not help me, when I needed to compute something difficult. And [in] that way I did contribute. But to say that I am an expert in electronic computation, that's absurd. I'm an expert in computational techniques, in knowing what you need in order to compute a function.

TROPP:

Well, I think that's interesting, because as we look at that early period, your Math Tables group and Comrie's group and, I guess, Wallace Eckert at Columbia were about the only people who were interested not only in computation per se, but in computational techniques. And they were all very different.

RHODES:

Well, I should say.

TROPP:

Very, very different approaches.

RHODES:

I think that Gertrude Blanch was probably the earliest. I don't know. Of course I cannot tell because I don't know the early history [concerning the] thinking up those magnificent computational techniques. She is just unbelievable. She is now writing [a] book on it. I don't believe that anybody could have beaten us in thinking up brilliant techniques for computing a function. But we could not always use them until later on when we really had a very seasoned gang. At the beginning we had to use very simple techniques. But later on, as we grew older and became more experienced, and more and more good people came to us — remember, we were no longer in WPA, we were under the NDRC, and we could, therefore, choose a very much higher grade of mathematician. Then we could use quite advanced techniques.

TROPP:

Well, as we look at this, this history of computation, is Dr. Blanch even considering writing up some of the techniques that she used?

RHODES:

Yes, indeed.

TROPP:

And some of the ones that she considered?

RHODES:

Yes, indeed. Yes, indeed. She's writing them up now.

TROPP:

Very good. Because otherwise, with all the documents destroyed, that's all going to be lost, if she doesn't do it.

RHODES:

Oh yes, every time I call her on the telephone I say, "Gertrude, don't disappoint me because the whole world needs those techniques. Don't die on me, and don't stop working."

RHODES & TROPP:

[Laughter]

TROPP:

Well, tell her the next time I'm in Los Angeles I'm going to call her and see her.

RHODES:

Oh yes, you must see; oh, you must see Gertrude Blanch. There is nobody like her. Did you see my little tribute that I paid her? Did you see my paper?

TROPP:

Yeah. This one.

RHODES:

No, not this.

TROPP:

I think we'll end the tape for today, set up, and then talk informally about the things we're going to discuss the next time I come.

[End of Interview]