

**INTERVIEWEES:** John Todd & Olga Taussky Todd

**INTERVIEWER:** Henry S. Tropp

**DATE OF INTERVIEW:** July 12, 1973

**Tropp:**

This is a discussion with Doctor and Mrs. Todd in their apartment at the University of Michigan on July 2nd, 1973. This question that I asked you earlier, Mrs. Todd, about your early meetings with Von Neumann, I think are just worth recording for when you first met him and when you first saw him.

**Olga Tauskky Todd:**

Well, I first met him and saw him at that time. I actually met him at that location, he was lecturing in the apartment of Menger to a private little set.

**Tropp:**

This was Karl Menger's apartment in Vienna?

**Olga Tauskky Todd:**

In Vienna, and he was on his honeymoon. And he lectured--I've forgotten what it was about, I am ashamed to say. It would come back, you know. It would come back, but I cannot recall it at this moment. It had nothing to do with game theory. I don't know, something in....

**John Todd:**

She has a very good memory. It will come back.

**Tropp:**

Right. Approximately when was this? Before 1930?

**Olga Tauskky Todd:**

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No. I think it may have been in 1932 or something like that.

**Tropp:**

In '32. Then you said you saw him again at Goettingen, after the--

**Olga Tauskky Todd:**

I saw him at Goettingen. I saw him then. He had proved one of the Hilbert's--he had solved one of the Hilbert problems and there was a lot of clamor attached to that.

**Tropp:**

There still is. [LAUGH]. Right.

**Olga Tauskky Todd:**

There still is, yes. It's a great thing. But it was completely new, and he was invited to come there and lecture about it.

**Tropp:**

I still remember the great uproar three years ago when the Russian professor solved the, one of Hilbert's problems. I think it was three years ago.

**Olga Tauskky Todd:**

Yes, it was about three years ago, that's right.

**John Todd:**

Mateushevich.

**Tropp:**

Yes. Within two weeks there were two other solutions around.

[LAUGH]. At least approaches.

Professor Todd, I wanted to ask you about your Cambridge period in 1931 to '33. I take it you had just finished your work at Belfast. And were you doing graduate work, or were you a research fellow?

**John Todd:**

I was doing graduate work there on a research fellowship. I was, at that time, interested in the real variable theory, not in computers at all.

**Tropp:**

Well, who did you work with if you--

**John Todd:**

With Littlewood.

**Tropp:**

Oh. That's right, Littlewood was there, Hardy was there

**John Todd:**

Hardy was there, yes.

**Tropp:**

Ah, Bes--

**John Todd:**

Besicovich.

**Tropp:**

Besicovich was there.

So, you did your work then with Littlewood? Through '33. And then you mention that you were at the University of London in Kings College. You go there directly from Cambridge?

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**John Todd:**

No, I went to Ireland first, to Belfast.

**Tropp:**

Oh, to Belfast?

**John Todd:**

Yes. I was there for four years.

**Tropp:**

At the university?

**John Todd:**

At the University of Belfast, then I came to London in '37.

**Tropp:**

Were you teaching mathematics at Queens University?

**John Todd:**

I was teaching mathematics there.

**Tropp:**

Real variable theory?

**John Todd:**

Gen--yes, in the whole, analysis, yes. Then in London there was a modernization of the syllabus. At that time I was called to London to help at Kings College as, with analysis, vectors. Then I met her.

**Tropp:**

Was it at the University of London that the two of you met? Well, let's go back in your career period,

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because that isn't on the tape that Doctor Mertz did with your husband. Where did you start your mathematical training?

**Olga Tauskky Todd:**

In Vienna.

**Tropp:**

In Vienna? Under whom?

**Olga Tauskky Todd:**

Under a very famous man called Furtwangler.

**Tropp:**

Oh, almost like the conductor?

**Olga Tauskky Todd:**

He was a cousin.

**Tropp:**

A cousin of the conductor.

**Olga Tauskky Todd:**

He was a German.

**Tropp:**

There's also a historian or a historical writer by the same name.

**Olga Tauskky Todd:**

He came from a family of organ makers. So maybe the music was--

**Tropp:**

[LAUGHTER].

You were at Vienna then during this period when Von Neumann visited. You were still there?

**Olga Tauskky Todd:**

I think I was at my Doctorate Degree then, I'm not even completely sure. I'm not completely sure of the nature of it.

**Tropp:**

Then you came to England when?

**Olga Tauskky Todd:**

I came to England in '35.

**John Todd:**

She came to America first.

**Tropp:**

You came to America first?

**Olga Tauskky Todd:**

I came to America first. I was at Bryn Mawr College.

**Tropp:**

Oh. There were some rather distinguished mathematicians there at one time or another.

**Olga Tauskky Todd:**

Emmy Noether was there. Yes, unfortunately she also died that year.

**Tropp:**

Is that the same year that you were there?

**Olga Tauskky Todd:**

The same year that I was there. It was her second year. Then, during that year I actually saw Von Neumann several times again, because she went to Princeton every week, and I went with her.

**Tropp:**

That was the same time that Turing was at Princeton, wasn't it? Or was it a year later that Turing came?

**Olga Tauskky Todd:**

I certainly did not, but I was only there as a visitor, once a week, occasionally.

**Tropp:**

Was Von Neumann's main interest during that period mathematical logic or did he have other areas--

**Olga Tauskky Todd:**

No. I would think he was interested in functional analysis.

**John Todd:**

Yes, ...at that period, yes.

**Tropp:**

Functional analysis.

**John Todd:**

Yes, von Neumann--yes, I think that was the prime interest.

**Olga Tauskky Todd:**

I don't think he even thought he would ever be interested in--

**Tropp:**

He seems to have gone fairly heavily by the time Turing is there. Maybe shortly after Turing, but Turing came to work with Church, with Alonzo Church, as I remember,

**John Todd:**

Yes.

**Tropp:**

And--

**Olga Tauskky Todd:**

He may have been there, but--

**Tropp:**

Yea. I'm sorry.



**John Todd:**

I think at that time Turing was not interested in computing machines, in real ones.

**Tropp:**

You mean Von Neumann, not--

**John Todd:**

Turing, Turing, too, you see. I think both, I mean everybody, Von Neumann and Turing and most of us got interested in actual hardware and real, during the War. There's no doubt about that.

**Tropp:**

Did you have any association at all with the electronic machine that Turing was associated with during the War, the crypto analytic machine?

**John Todd:**

No, no. I had no contact with that at all.

**Tropp:**

That's still heavily classified.

**John Todd:**

Yes.

**Tropp:**

I guess one of my curiosities is the technology that came out of that because so many of the people like Newman and Flowers and others ended up in the machine building projects, as did Turing.

**John Todd:**

Yes, yes.

**Tropp:**

And I guess what the question is: What were the characteristics of that machine? But that's still classified. Anyway, you came to the United States and you were at Bryn Mawr; and then you came back to England when?

**Olga Tauskky Todd:**

Then I went, in '35 I went to Cambridge with a fellowship, and then in '37 the same year as he did, although we didn't know each other, I went to London University.

**Tropp:**

The same at Kings College also?

**Olga Tauskky Todd:**

No, not at Kings College, no. I was at a woman's college called Westfield College.

**Tropp:**

That's right. The University of London was really the first English university that began to begin to break all kinds of barriers, wasn't it? Away from the traditions of Oxford and Cambridge?

**John Todd:**

Well, this is true, I mean this is true.

**Tropp:**

They had a woman's college long before either of them.

**John Todd:**

They first of all started with the University College, because at one time in order to get into Oxford or Cambridge, you had to be, subscribe to the 39 articles. This, the University College was started so that

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there was no religious entrance, and as a counter to this here, the College to which I was attached, Kings College, was set up with a very strong, originally, a very strong religious background, to University College in London, you see. But the only trace of that that remains to this day is that there is one sacred hour of the week at which no lectures must be given apart from a theology lecture. So, everybody is free to attend if he would.

**Tropp:**

[Laughter].

**John Todd:**

This is ten o'clock on Mondays, you see, so that everybody can have an extra hour to ...

**Tropp:**

[LAUGHTER].

Didn't, there was quite a to do, this isn't, I guess, appropriate to this tape, but there was quite a to do during Sylvester's period. Wasn't he at the University College?.

**John Todd:**

This I don't, this I just don't know.

**Tropp:**

Well, that's very much of a side issue. Anyway, you met in '37 and you were still at University College, and what was the name of the women's college?

**Olga Tauskky Todd:**

Westfield College.

**Tropp:**

Westfield?

**Olga Tauskky Todd:**

Westfield College. There were three women's colleges then.

**John Todd:**

There are about seventeen colleges there.

**Tropp:**

Then when the War broke out, you mentioned that you were separated and you went to the Nautical,

**John Todd:**

The Admiralty.

**Tropp:**

The Admiralty at Portsmouth. And you joined the Air Force, is that right?

**Olga Tauskky Todd:**

[Inaudible]

**Tropp:**

[Laughter].

**John Todd:**

It was what was called the Ministry of Aircraft Production.

**Olga Tauskky Todd:**

Yes, Aircraft Production.

**Tropp:**

Oh, Aircraft Production.

**Olga Tauskky Todd:**

That was what it was called.

**Tropp:**

Doing what?

**Olga Tauskky Todd:**

I was actually stationed at the NPL, where actually later Turing came. Later.

**Tropp:**

Right, yes after the War.

**Olga Tauskky Todd:**

After the War.

**Tropp:**

Right. So, you were at the National Physical Laboratory.

**Olga Tauskky Todd:**

That's right, I was working there, but paid and employed by the Ministry.

**Tropp:**

Oh. Were you doing computational oriented problems there?

**Olga Tauskky Todd:**

Actually not. Actually not. Most of my colleagues did, but I did not. I was working on differential equations, boundary value problems with differential equations.

**Tropp:**

Theoretical work then? Strictly theoretical.

**Olga Tauskky Todd:**

Theoretical, and very hard; but I finally did it. [Laugh].

**Tropp:**

Well, that's interesting, because we looked at the two environments, the American and the English environment, during the War and the slowness with which they came to utilize the scientific communities in theoretical work, in really both environments. Is it then, essentially you were doing this kind of work from the beginning?

**Olga Tauskky Todd:**

Yes, I was really.

**John Todd:**

No, No. You were at Westfield.

**Olga Tauskky Todd:**

No, I'm sorry.

**John Todd:**

You were not doing it from the beginning.

**Olga Tauskky Todd:**

I'm sorry, I'm just confused.

I went to Oxford, my college left London and went to Oxford, and I stayed there for about three years.

**Tropp:**

So, it was in the early forties then that you joined NPL under the--

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**Olga Tauskky Todd:**

Later. That's right.

**Tropp:**

Under the...

**John Todd:**

Ministry of Aircraft Production.

**Tropp:**

Aircraft Production?

So, then the timing is about right. This is about when everybody woke up to the fact that there were other, other things in applied instantaneous needs. I say both countries were a little slow getting there, but once they did, it went rather, it became rather large. Everybody had to get into something that was of instant need when the War first broke out. I guess I would like to talk about Comrie. Did you have close association or any association with Comrie during the thirties?

**John Todd:**

I think I had. In fact, I think that it was he who first taught me to use a computing machine.

**Tropp:**

You mean a desk calculator?

**John Todd:**

A desk Brunsviga, in Cambridge.

**Olga Tauskky Todd:**

I did not--at that meeting?

**John Todd:**

At the meeting of the British Association.

**Olga Tauskky Todd:**

At that display.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

I see.

**John Todd:**

Yes.

**Tropp:**

This would have been about '37?

**John Todd:**

'38.

**Tropp:**'38.

**John Todd:**

'38, I think, yes. The British Association had a meeting, this is like the AAAS, but there was one mathematics subsection, and they had a meeting in Cambridge, and there was quite an activity. I think this was run by Wishard who was a statistician wasn't he, or Neville?

**Tropp:**

Neville is a name I'm familiar with, the other I don't know.

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**John Todd:**

Wishart was quite a famous statistician.

**Tropp:**

How do you spell his name?

**Olga Tauskky Todd:**

W-I-S-H-A-R-T.

**John Todd:**

He was one of the first people really concerned with the Monte Carlo, only without the name.

**Tropp:**

Without--the name came much later.

**John Todd:**

Yes.

**Tropp:**

When did his early publications appear on this kind of thing, or was it mostly verbal and internal communication?

**Olga Tauskky Todd:**

Cambridge Proceedings, no?

**John Todd:**

I don't know. They must be in some of John Curtiss' writings on Monte Carlo. The history is given quite well.

**Tropp:**

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He gave me some copies of papers that I haven't had a chance to look at.

**John Todd:**

Yes. He has the dates that I couldn't remember.

**Olga Tauskky Todd:**

I would like to tell an episode

**Tropp:**

Great.

**Olga Tauskky Todd:**

about that. When he was--he looks frightening

**John Todd:**

Yes.

**Olga Tauskky Todd:**

When he was explaining to you the machine, you asked such clever questions that he suddenly stopped and said, "Now listen, are you teasing me, and know all about it and letting me explain it to you?"

**Tropp:**

[LAUGHTER].

**John Todd:**

That's true. Yes, I know.

**Tropp:**

This is Comrie?

**John Todd:**

This is Comrie. Yes.

**Olga Tauskky Todd:**

That is true.

**John Todd:**

That's true, yes. But I had never seen a, I mean, I was really, at that time, interested in very abstract mathematics.

**John Todd:**

Well, when you were with the Admiralty service, though, with the Nautical Almanac Section, when you had moved from Portsmouth back to London, then you must have been associated fairly closely with him.

**John Todd:**

Well, you see, the story is that Comrie left. He had fights with the Admiralty and left, because they wouldn't pay him enough or allow him to have consulting jobs or something. I don't know the exact history. But he had a violent fight with the Admiralty.

**Tropp:**

I knew about them. Yeah. I don't know what they were about.

**John Todd:**

So, he set up his Scientific Computing Service.

**Tropp:**

That was during the War?

**John Todd:**

Before the War.

**Tropp:**

Oh, before the War.

**John Todd:**

That was before the War.

**Tropp:**

So it would have been '38 or '39?

**John Todd:**

Something like that.

**Tropp:**

Early '39.

**John Todd:**

I can't tell you exactly, the dates and this again...

**Tropp:**

I agree it's a matter of record. It's easy to check.

**John Todd:**

It's easy to find this out. So, there was no love lost between Comrie and our group, you see.

Because he thought we would be taking away some of the work from him.

**Tropp:**

Yours was Government and his was private.

**John Todd:**

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Yes. But finally, we made peace with one another, and this was a very dramatic episode. I don't think it was put down in the tapes.

**Tropp:**

No.

**John Todd:**

We agreed to have lunch and settle our differences.

**Tropp:**

[LAUGH].

**John Todd:**

We had just got to a restaurant in Soho and ordered lunch, and the V 1 came and the whole building came down on top of us.

All:

[LAUGHTER].

**Tropp:**

I gather that both of you survived?

**John Todd:**

We survived. It really was, it was a, it was a glass, it was a glass back room with a glass roof on it, and they had linen pasted all over the glass. And so, we just were draped, so to speak, ...

**Tropp:**

It's funny only thirty years later. At the time it isn't funny at all. Did Turing take this--[I mean] did Comrie take this as an omen that peace was not to be? [LAUGHTER].

**John Todd:**

No, no, no. I still remember then, you see this was very close to his office, and he had a lot of girl computers, and so as soon as we shook the dust out of ourselves, we went, I went with him to collect his girls so to speak. They were having lunch in a less expensive restaurant.

So, he made sure they were all there and took some brandy out of his safe and gave them some brandy and sent them home. And I never got my lunch that day.

**Tropp:**

[LAUGHTER].

**John Todd:**

I got some brandy.

**Tropp:**

[LAUGHTER].

**Tropp:**

The V I, I guess devastated a pretty wide area then,

**John Todd:**

Yes, yes.

**Tropp:**

When he was really worried about the safety of the--

**John Todd:**

Yes. Of course, there's glass and that sort of thing. So, since then I met him various times, since then, but that was meant for our reconciliation. [LAUGHTER].

**Tropp:**

Well, while you were at the Nautical Almanac Office, what kinds of problems were you working on primarily?

**John Todd:**

Oh, these were miscellaneous. This is described in detail in our articles in MTAC.

**Tropp:**

Math tables, okay.

**John Todd:**

And so--

**Tropp:**

You refer to one of them in the paper that you just showed me?

**John Todd:**

Yes, yes. So that's pretty well documented now, so I've forgotten.

**Tropp:**

Let me ask Mrs. Todd the, some of the people that you were working with, connected with your theoretical problems, who were some of the mathematicians?

**Olga Tauskky Todd:**

Well, the chairman of our group was called Fraser, he worked in IEEE [?]. He was one of the flutter experts, theoretical flutter. He had written a big book on matrix theory. It was one of the first leading books of practical use in matrix theory. It was published by three authors, but he was the main author. Fraser, Duncan, and Collier.

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**John Todd:**

That's, so to speak, the father of Wilkinson's book, so to speak.

**Tropp:**

Yes.

**John Todd:**

Yes, but that was written about 1937,

**Olga Tauskky Todd:**

It is still a very good book.

**John Todd and Olga Tauskky Todd:**

But for hand computing.

**Tropp:**

Hand computing, hand calculating. Because this was the only kind of calculation or approximating method you could use, were hand methods. Machines didn't do much good. You were dealing primarily with partial differential equations, weren't you?

**Olga Tauskky Todd:**

Well, for my own work actually there was no computation carried out. During most of my time. Only during my very last month there did I do some practical work on finding bounds for eigenvalues of matrices; then I did some computational work. but for my boundary value problems there was no computation carried out.

**John Todd:**

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What she did was--you know this question of flutter?

**Tropp:**

Sure.

**John Todd:**

She wrote one of the first papers on the flutter of supersonic airplanes.

**Tropp:**

This was when everybody was talking about what would happen if you broke the sound barrier.

**Olga Tauskky Todd and John Todd:**

Yes, yes.

**Tropp:**

That was a closely related problem.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

That was very close.

**John Todd:**

This was published in the Courant

**Olga Tauskky Todd:**

60th Birthday Report.

**Tropp:**

The Festschrift.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

That's right. And Courant liked it.

**Tropp:**

And that was published in the late, in the latter half of the forties, 194-?

**Olga Tauskky Todd:**

That was published in '48.

**Tropp:**'48.

**John Todd:**

Yes. We were at his birthday parties.

**Tropp:**

In New York?

**John Todd:**

Yes.

**Tropp:**

Oh, that's great.

How about Max Newman? Did you have any contact with Max Newman during the War?

**John Todd:**

I think the answer is no. You see, he was with the cryptography place and we had no, they were more or less isolated at Bletchley, you see. We had no real contact with him. We had known him before and

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after, but during that time we had no, no, that's right, we had no contact with him.

**Tropp:**

Then the same would hold for Turing during the same period then?

**John Todd:**

That's correct, yes, yes.

**Tropp:**

Now, even though you have written this paper about Von Neumann's visit to England in 1943 I would still enjoy very much a very short expository account of that visit. That 1943 one, if it's not too lengthy or too tedious. You said the purpose of his visit?

**John Todd:**

I think he, at that time he was working on, for the Navy Department in connection with shape charges. Focusing explosions. And I was with the Admiralty then. So, it was natural that he would make contact with the Admiralty. So, I more or less arranged that I would be a sort of guide to him through the Admiralty mathematical establishments.

So, we travelled to various places together. We went to Edinburgh, because there was a big naval establishment on the Firth of Forth. Then, we went to my own place, where my own computing was done at the Nautical Almanac Office, which was in Bristol--in Bath. And he went to see Barron and Darrier.

**Tropp:**

Were they in England then?

**John Todd:**

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They were in England then, yes.

**Tropp:**

I thought they were here.

**John Todd:**

No. Derrier was working as a consultant for the, for our operations at the Admiralty. Barron had some contacts with, not my group, but with another group. He had developed our Fourier transform--I suppose it was an electronic Fourier analyzer which is also described in the literature, too, and I think it's mentioned in some of these papers, which I have written about the Admiralty themselves.

The material in this paper which I wrote to you and which I have spoken about, was termed the following. The National Accounting Machine was the most advanced machine which we had, then.

That had been used for various purposes, differencing. This was really due to Comrie and is described in Comrie's famous paper.

**Tropp:**

I get confused about some of the machines, because it's in another country. Is that the one that some people also call the Hollerith because of its--

**John Todd:**

No. The Hollerith is a punched card machine.

**Tropp:**

The Hollerith is strictly the punched card in the English use?

**John Todd:**

Yes. The National Accounting Machine—

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**Tropp:**

Was a posting machine the--

**John Todd:**

Was a posting machine where there were six registers, and you could juggle about with them.

**Tropp:**

Then there were successive differences?

**John Todd:**

Yes. So, the Nautical Almanac people were very anxious to use this machine for subtabulating of a function to halves. Given a value at the ends justifying it at the halves and then at the quarters and so on.

They had a very convenient formula for doing this. ... They were now able to derive a scheme like what Comrie had for differencing. And so, we were shown, Von Neumann had never seen such a machine before, I think.

So, in the train coming back from Bath we talked over this problem and formulated it as a matrix problem and solved it, on the way back from Bath, which is about 100 miles I would say from London. As I say, I do have the paper which we worked on, and this was the very bad paper which we got in the British Government during the War time and it was also just a blackout and the carriages had very bad lighting, and it was going across the various crossings. So it is a very, very badly written but still quite decipherable.

So, this was, as I say, one of the first contacts Von Neumann had.

**Tropp:**

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And you actually solved the problem? Which enabled you then to use the posting equipment to do various evaluations at places during an interval?

**John Todd:**

Yes, yes.

**Tropp:**

At different points.

Did you see Von Neumann during that visit?

**Olga Tauskky Todd:**

Yes, a little.

**Tropp:**

Other than the reason for his coming to England in terms of his wartime research, did you get a chance to talk to him and find out the other things that he was working on himself and interested in?

**Olga Tauskky Todd:**

No, I did not talk to him about wartime research.

**Tropp:**

I mean mathematics. I'm thinking more of his other mathematical interests.

**Olga Tauskky Todd:**

Yes. He talked to me about other...

**Tropp:**

What kinds of things was he interested in at that time?

**Olga Tauskky Todd:**

No. He asked me what I was working on and I told him about it and he made some comments. That was all.

**John Todd:**

He had made also contacts with other mathematicians, and he arranged meetings with other people who were in London at the time.

**Tropp:**

How long was he there?

**John Todd:**

I would have to say several weeks.

**Tropp:**

Several weeks?

**Olga Tauskky Todd:**

I don't think so.

**John Todd:**

I don't think it was much...I know we talked about at that time, about some, about the axiom of choice. There had been some new developments just before the War in Warsaw in connection with implications about the axiom of choice.

**Tropp:**

Some of the equivalents probably.

**John Todd:**

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Yes. I remember talking about it on the way to Bath, but on the way back from Bath we were doing practical mathematics. [LAUGHTER].

**Tropp:**

You know, the stories that I've heard about Von Neumann. The incredible mind and his ability to work in almost any branch where there was an interesting problem. It's just hard to imagine him settling for any great length of time on just one thing, especially in conversation.

But you did have contact with him during that period?

**Olga Tauskky Todd:**

Yes, a little bit.

**Tropp:**

Did Howard Aiken get there during the War? Because he was also connected with the Navy.

**John Todd:**

Yes. Not that I know of. I have no knowledge that he came to--

**Tropp:**

Were there any other major people from the American scene that you remember seeing during the course of this work?

**John Todd:**

Well, I mean a lot of people, but none who were especially concerned with computing, you see. H. P. Robertson we saw, and the various lea--there were a lot of the operational analysts who began to work with the Air Force. Synge was there you see.

**Tropp:**

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Yes.

**John Todd:**

Bohnenblust. Who else? Price, Bailey Price. Stoker and McNeille.

**Olga Tauskky Todd:**

Yes.

**Tropp:**

But in terms of people interested in computation?

**John Todd:**

This was too early for that in some respects.

**Tropp:**

I gather that, although after the War they became fairly close, during the War the two computational environments were pretty separated. I guess Aiken is the only other one I can think of who was interested in computation, who was also in the Navy who might have shown up there.

**John Todd:**

Well this, I mean, this I probably would have known, you see, but I certainly have no recollection.

**Tropp:**

When did you begin to get word of some of the larger computational devices that were being built in the United States, like the Bell Laboratory Machine or Aiken's Machine or the proposed electronic machine at the Moore School?

**John Todd:**

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This I just couldn't say.

**Tropp:**

I don't think Von Neumann knew about them at that time.

**Olga Tauskky Todd:**

No, no. I don't think he knew anything about these at all, you see.

**Tropp:**

I think your statement that this was his first introduction to computation other than in his head or on a piece of paper.

**John Todd:**

Yes. I think the point was that at this time he was, he had more or less formulated these explosion problems, theoretically. He had realized that they were not going to be capable of theoretical solution and that computation had to be done. I think that was the period which we are talking about.

**Tropp:**

I guess one of the reasons I keep bothering people about that Princeton period is Turing's work is well known through his publication. What Von Neumann was thinking about in terms of Turing's paper we only know about later, in the sense that when people talked to him in the post-war period who wanted to know about computation, he kind of said, "well, first read Turing's paper." That he considered this essentially a very important beginning point, but the open question of what kind of contact occurred between these two men during the, that short period is, probably never will be answered.

**John Todd:**

No.

**Tropp:**

At least from a theoretical point of view in terms of computation. Oh, what kind of connections or associations did either of you have with Professor Hartree before 1947 during the early, early era, before you came to the United States?

**John Todd:**

Well, I knew him during the War. I think he was

**Olga Tauskky Todd:**

Hartree?

**Tropp:**

Hartree, yes.

**John Todd:**

During the War he was a consultant or something with the Ministry of Supply or something?

**Olga Tauskky Todd:**

He seemed to turn up occasionally at--

**John Todd:**

Yes. Well he was also with the explosives people, too, you see.

I suppose my first real contact with him. Was he in charge of the Mathematical Lab at Cambridge?

**Tropp:**

No.

**John Todd:**

No, no. Yes, it was the other man, Leonard Jones, who was in charge.

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**Tropp:**

Leonard Jones actually founded the Mathematical Laboratory.

**John Todd:**

That's right. Because I knew we had gone to Cambridge, and we had seen these people and they, what was the machine?

**Tropp:**

They had a Bush Differential Analyser. They earlier had had a Meccano version of this, a mechanical...

**John Todd:**

Yes. That was what Hartree had developed, a Meccano.

**Tropp:**

Right, right, and that was in the thirties. Then when the War broke out shortly after the War broke out they got a regular Bush Differential Analyser. They had some desk calculators and I think that was about all they had.

**John Todd:**

No, I had met Hartree casually before, I think he came to Belfast to lecture Massey ..[voice fades out.]

So, I had, but I had very little contact with him during the actual war, as far as I remember. But then, as I described in this SIAM paper, with the comparative success of this Admiralty Computing Service for which I was responsible, we decided to try to organize a National Mathematical Laboratory or something--I have forgotten what the exact thing was.

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**Olga Tauskky Todd:**

Institute.

**John Todd:**

Institute, I've forgotten exactly what it was--

**Olga Tauskky Todd:**

I think you called it an Institute.

**John Todd:**

That would be a central place for applied mathematics for various Government organizations. And we got the Admiralty, our bosses, our Admirals, to suggest the, that such a place should exist or be set up. And we suggested it should be set up under the Department of Scientific and Industrial Research. That was, of course, the host of the Institute for the National Physical Laboratory. We wanted a parallel operation, National Mathematical Laboratory. Well naturally, this didn't get through, you see. And it was absorbed as part, taken up as part of the National--

**Tropp:**

Essentially became a division or a section within it, yes.

**John Todd:**

Divion, yes. During the negotiations which were concerned with that, I had a lot of arguments with Hartree about this, and he was also an applied mathematician, you see, who had more experience in that he had been computing for a long time, you see, in his electronic, his quantum theory.

So, I had various contacts with him then, and then finally he was at the, came out to the Institute for Numerical Analysis for six months.

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**Tropp:**

I guess he was the first official...

**John Todd:**

He was the first official Director.

**Tropp:**

I had the feeling that that was more honorary, was that not so?

**John Todd:**

Yes. This was true. And I don't think his attitude and Curtiss' attitude were the same. Curtiss was a pure mathematician. Hartree was an applied mathematician and..

**Tropp:**

One can almost do a book on just the conflicts within the Bureau of Standards between individuals.

[LAUGHTER].

**John Todd:**

Yes, yes.

**Tropp:**

Could you characterize some of Hartree's attitudes in the discussions you had about a National Applied Mathematics Center?

**John Todd:**

Again, it's almost too long ago. I have a, I have a--and I don't know--I have a copy of the original statement which he made about this. Which was I think, probably forwarded by the Admiralty to the Department. This I have in Pasadena

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**Tropp:**

Oh wonderful.

**John Todd:**

And there are several articles which Sadler and I wrote and which Erdelyi and I wrote about this.

I think these are all referenced

**Tropp:**

They are all referenced.

**John Todd:**

And listed and this is all documented.

**Tropp:**

Very good.

**John Todd:**

But, any of the detailed arguments at this inter-departmental meeting about the formation of this National Math--this got too much, to diffuse, you see. There were people brought in from the Agriculture Department who thought this was counting the number of turnips or something, you see.

**Tropp:**

[LAUGH].

**John Todd:**

Something of that kind.

**Tropp:**

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Well, it's taken us most of the last two or three decades to really change the computational environment.

People still think of it in terms of that attitude. It's just gradually changing.

One of the questions I wanted to ask you, Mrs. Todd, was this period of yours at the National Physical Laboratory. When Turing joined it and began to work on an automatic computational or calculating engine and later Jim Wilkinson, joined him. I know you were in a different section,

**Olga Tauskky Todd:**

I was in a different area, yes.

**Tropp:**

But I just wondered if you had any memories of conversations and things that were going on at that time?

**Olga Tauskky Todd:**

I heard at lunch time, I had not even met Turing yet, but he was sitting near me at lunch time once and he was talking violently about a chess playing machine.

**Tropp:**

[LAUGHTER].

**Olga Tauskky Todd:**

I don't know to whom he was talking. Then I talked to Fox occasionally.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

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I talked to Fox. I, you know, I sort of knew already quite a bit of matrix theory at that time. It's one of my major subjects now. And, I don't know, I think I had views, problems ...

**John Todd:**

Turing came to our house.

**Olga Tauskky Todd:**

That was, it was a little later.

**John Todd:**

A little later, yes.

**Olga Tauskky Todd:**

He came down to our house, and he was very happy there.

**John Todd:**

And he talked, when he talked to you particularly, he talked about non-computing things. He was, during the day he was highly immersed in computing, but I know he was talking about continuous groups and things of that kind.

**Olga Tauskky Todd:**

Yes, yes, that's right.

**Tropp:**

I've got the feeling and Jim Wilkinson brought this out beautifully in my recent conversation, something that is not in the literature, and that is how broad Turing was in his interests and capabilities and general breadth.

**Olga Tauskky Todd:**

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I'm sure that's true.

**Tropp:**

Because he published so little formally, and because people tend to think of him in only one light in terms of, you know, computation, that Jim felt that this was an important thing about Turing that isn't generally known.

**John Todd:**

Well, his last work on biological matters, what's the name, oh, I've forgotten the name of the...

**Tropp:**

Not cryogenics?

**John Todd:**

Not cryo--no, no, no. This was published, this was published in the biological proceedings of the Royal Society.

**Tropp:**

I guess I don't know that.

**John Todd:**

Well this was, I mean he spoke to us, we spoke about this the last time we saw him in Manchester. When we were in Manchester at some meeting.

**Olga Tauskky Todd:**

Oh, I do remember, yes.

**John Todd:**

It's some horrible Latin name which I just can't remember now.

But, this was really his latest work really was on the--I remember he said, why is a horse the shape it is?

**Tropp:**

Oh that kind of thing?

**John Todd:**

Yes. Morphogenesis. And he had this one very big paper and he had left manuscripts which apparently were not intelligible. Then we also know that he had a paper, again a manuscript, on the Riemann hypothesis.

**Tropp:**

That was something he'd worked on even very early.

**John Todd:**

Early. But this was, and people are still trying, I mean this was your friend, Stein,

**Olga Tauskky Todd:**

Mhm. Oh, he's ... with that.

**Olga Tauskky Todd:**

Trying to understand this manuscript of Turing.

**Tropp:**

Somebody mentioned that he had had a very early interest, while still at Cambridge,

**John Todd:**

Yeah, on the zeta function.

**Tropp:**

On the zeta function.

**John Todd:**

On the zeta function, yes. He had been concerned with the computation.

**Tropp:**

Isn't his very first paper on that subject, or am I wrong again?

**John Todd:**

I don't know. She wrote, I think, the obituary notice of Turing in MTAC. I think probably that gives a bibliography, but again, we don't have it here.

**Tropp:**

I guess I would love to have the two of you just, let me turn the tape over and get a fresh side of tape and just have you talk about Alan Turing.

[End of side 1]

**Tropp:**

I'll just let you talk about Alan Turing as you saw him and stories you remember about him. Things you want to say about him that you can think of.

**John Todd:**

Well, you know the stories about him being quite a distinguished long distance runner?

**Tropp:**

Mhm.

**John Todd:**

We were living near the National Physical Laboratory in, from--when was it? '45, '46 - '45 until '49 I

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believe it was.

**Olga Tauskky Todd:**

The War was still on.

**John Todd:**

Yes, '45.

**Olga Tauskky Todd:**

We still had air raids, so it must have been.

**John Todd:**

When I was in Germany, yes, when I was in Germany.

**Olga Tauskky Todd:**

'45 to '49.

**John Todd:**

Yes. We would often see Turing running on his practice runs in front of us on the street.

**Tropp:**

I remember a story Harry Huskey told me about some place that they were going, which was 20 or 30 miles away.

**Olga Tauskky Todd:**

That was [?]

**John Todd:**

Right.

**Olga Tauskky Todd:**

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The Post Office Station, yes.

**Tropp:**

Right. Turing ran and he gave Harry Huskey a change of clothes and Harry Huskey took the train and Turing beat him. [LAUGHTER]. I gather he had great hopes at one time and then got ill and wasn't able to compete.

**John Todd:**

Well I don't think, he was almost Olympic standing, but not quite. But I know, as I say, we lived there, and he came to our house and ate bread and cheese and beer I suppose.

**Olga Tauskky Todd:**

He didn't want to drink more beer, because he felt it might interfere with his effectiveness.

**Tropp:**

[Laugh].

**Olga Tauskky Todd:**

Because he was doing all this, I don't know

**John Todd:**

He was training for

**Olga Tauskky Todd:**

He was training for some particular competition and so he said it might interfere. Maybe it was some other alcohol.

**John Todd:**

Well, ok.

**Olga Tauskky Todd:**

I don't know, but he wouldn't drink it.

**Tropp:**

One of the things that Jim wasn't sure about was that he remembered, by the time he got to the National Physical Laboratory, that Turing was already on the fourth or fifth or sixth version of his calculating engine. And it went through a series of successive developments. Do you have any idea how many different levels he went through in that?

**Olga Tauskky Todd:**

I don't know, but I remember that there came a phase when he was told that only his ideas would be used, he was not allowed himself to, what they say, tinker with it. And he--that was the word which was used--and he was apparently very annoyed about that and I think he probably quit.

**John Todd:**

Yes. He went, he was given leave to go to Manchester.

**Olga Tauskky Todd:**

Yes, he was given leave to go to Manchester. You see they wanted to use his ideas alright, but he was not to supervise it or be in at every phase.

**Tropp:**

This was the, I gather he had a big personal clash with the man who was then the Director of that section.

**Olga Tauskky Todd:**

I think so.

**John Todd:**

Womersley?

**Tropp:**

Womersley, yes.

**John Todd:**

Yes. Well, I think the true fact of the matter probably was this and you have already said that Turing really was a very distinguished and broad man. He could not, the people who were asked to wire up the circuits for him could not follow his instructions as quick as he could do it himself. So, this really was part of the difficulty. It was amazing how much he knew about the actual tubes.

**Olga Tauskky Todd:**

That's what it was. You see, he actually knew the hardware.

**John Todd:**

The characteristics of the tubes. The electronic char--

**Tropp:**

This is, of course, the thing that we just can't get to and that's finding out his role in this electronic crypto analytic device that was built during the War and completed in 1943.

And there was electronic circuitry involved.

**John Todd:**

Well, presumably he learned well there, because I think this was really part of the difficulties.

**Tropp:**

Because when you look at the machine developments, the actual machines that were built in England

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after the War, and at one point there were more going, successful ones, there than in the United States, actually on the air at least, at some early point.

The people had come either out of radar with a good deal of experience in delay line technology or some of them had come out of that particular project that Turing was associated with.

Wilkes, I think, was unusual, in that he came out of a totally different field. No, I guess Wilkes was in radar too.

**John Todd:**

He was in radar, yes.

**Tropp:**

That's right, that's right. One of the things about Turing, we've talked about Von Neumann and I keep linking their names. The more I talk to people like yourself and Wilkinson, is I get the feeling that both of their minds ranged over an incredibly wide field.

I guess I wanted to ask you how you would compare them intellectually in terms of the way they operated, in their breadth of interest. Von Neumann, all the stories are around about Von Neumann's quickness and rapidity, but he seemed to be in almost everything, that was, you know.

You sort of have the feeling he knew everything.

**Olga Tauskky Todd:**

Well, Von Neumann was a good bit older than Turing was at the time we knew Turing.

**Tropp:**

Because Turing was very, very young when....

**Olga Tauskky Todd:**

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Yes, he died very young so naturally he couldn't have achieved so much.

**Tropp:**

That's right.

**Olga Tauskky Todd:**

Apart from the machine work in which they were both interested, they were both, they both wrote these very fundamental articles on solving linear equations.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

Both of them. They were very parallel.

**John Todd:**

Well, the difference was that, you see the Turing thesis on the Turing machine. There's no--

**Tropp:**

The whole concept of solvability which was really the important aspect of that paper.

**John Todd:**

And then, as you said, these two parallel papers, this Von Neumann-Goldstine paper, '57 paper.

**Tropp:**

'47.

**John Todd:**

I'm sorry, '47 paper. And there was a parallel one by Turing published in England, you see.

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**Olga Tauskky Todd:**

I think in the Oxford Quarterly Journals.

**John Todd:**

No, the new, the Quarterly Journal of Applied Mechanics.

**Olga Tauskky Todd:**

The new, that's right, it just looks almost the same.

**John Todd:**

And these are really very, very parallel.

**Olga Tauskky Todd:**

They're very basic papers in that sort of thing.

**Tropp:**

Did Turing ever get interested in areas like game theory or linear analysis, linear programming or any of these, the other areas that were hot during that post-war period?

**John Todd:**

No. I mean, I think this biological thing, this morphogenesis,

**Tropp:**

This was where he was going.

**John Todd:**

This was where he was going, you see, and this was--In my last, our last, was that in '48 or '49?

**Olga Tauskky Todd:**

That Manchester meeting? The Manchester meeting must have been in '49.

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**John Todd:**

In '49, yes. There was a meeting,

**Olga Tauskky Todd:**

In the Bates [?] Library [?],

**John Todd:**

of the British Mathematical Colloquium, was it?

**Olga Tauskky Todd:**

Yes, yes. I think the first one.

**John Todd:**

The British Mathematical Colloquium.

**Olga Tauskky Todd:**

Possibly the first one.

**John Todd:**

Yes, in Manchester, and we were there. We had been to America for a year/

**Tropp:**

Right, you had been at the

**John Todd:**

And went back, at the Bureau, we had been...

**Tropp:**

With the bureau, at the Institute and then you had come back.

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**John Todd:**

We had come back, and then we were there for, just before we came to Washington, more or less permanently. We had some talks with Turing in Manchester, and this was the, this morphogenesis, And this was the main thing he was talking about.

**Olga Tauskky Todd:**

But I told him at that time, that was that little paper I wrote on the condition number, do you remember that? He was very pleased that without specifying which condition number I was using I could prove something about it. He was very nice. He listened to every detail. The square, the symmetrizing

**John Todd:**

The symmetrizing was bad, yes.

**Olga Tauskky Todd:**

Was bad. Yes, I remember that he was very friendly.

**John Todd:**

It was he really, in some respects who started the, who used the word condition number first, in his paper.

**Tropp:**

In the paper of '47?

**John Todd:**

In the paper of '47 or '48. I'm not sure of the exact dates but--

**Tropp:**

The one that's listed in your, the one that's similar to the Goldstine--

**John Todd:**

The one parallel to the Goldstine paper.

**Tropp:**

Was he concerned with the same problem of inversion?

**John Todd:**

Exactly the same. Well this is about the first problem which anybody who has a computing machine must be concerned with.

**Tropp:**

I'm going to digress for a minute, because I'm looking for a paper, it's not really a formal paper, it's more of a letter Von Neumann wrote as a consultant. My guess is May, June, first half somewhere of 1951 to, I think it's Northrop Aircraft after he had seen the MADDIDA and he suggested to them a machine, but only on paper, for solving a large system of equations.

And as the paper is described to me, he gives an example of a 100 by 100 system in his mathematical analysis. That's very early for something of that order of magnitude and for a special purpose, essentially peripheral device to the magnetic drum digit differential analyzer. [LAUGHTER].

**John Todd:**

Digit differential analyzer. Yes, yes.

**Tropp:**

But I have not been able to find it. I've talked to two people who claim to have seen it at Northrop and one of them remembers, or a third one remembers, Von Neumann getting up at a meeting that year and mentioning it. So, it's not a total myth and I wonder if you had had any memory of that? That would be

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about mid '51 and any other thing would have come later than that.

**John Todd:**

Yes.

**Tropp:**

But it seems to have died and been lost. It seems one of those things that got into a few hands and then vanished.

**John Todd:**

No, I don't

**Olga Tauskky Todd:**

Is this the report of Von Neumann, Montgomery and Bargmann?

**John Todd:**

No, that was earlier.

**Tropp:**

You haven't run into this at all? I've got people looking for that document and it's probably lost, as I've gathered most of the Northrop documents of that era have now been destroyed. So, unless somebody saved it, it's absolutely vanished.

One other area on Turing. You mentioned that he came to your home during the period that you were in the National Physical Laboratory. I gather that when the conflict occurred, and he decided to leave, that he had a choice of going back to Cambridge or going to Manchester. We all know the choice he made. Did he talk to you at all about thoughts of either one and how he happened to choose Manchester? You

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know, looking at his background, I would have predicted he would have chosen to go back to Cambridge.

**Olga Tauskky Todd:**

I didn't actually know that he had that choice.

**John Todd:**

Yes, this I knew. Now, it's awfully difficult for me to know what the source of my, shall we say, information is just now. My, I mean, it was just general conversation with Wilkinson and other people. But I think that he thought that he would have more opportunities in the computing area at Manchester, because Newman was there.

**Tropp:**

Newman was there, Williams was there, Kilburn was there.

**John Todd:**

Yes, Kilburn. So, I think...

**Olga Tauskky Todd:**

He would have been quite isolated

**John Todd:**

At Cambridge, you see. I mean, there was Wilkes there.

**Tropp:**

But that was a very small operation.



**John Todd:**

And Wilkes was quite a different background, you see, from Turing.

**Tropp:**

His idea of a machine was very different,

**John Todd:**

Yes, yes.

**Tropp:**

His whole concept.

**John Todd:**

So that--I, I mean where, I don't think this comes directly from Turing and I think it may have come from a conversation with Max Newman or, or somebody else.

**Olga Tauskky Todd:**

Perhaps it was Newman.

**John Todd:**

So I think this was the, this was probably the reason why he chose to go.

**Tropp:**

Now, it's interesting some of the stories that I hear about Turing make it difficult for me to guess as to the kind of person he was. Because some people talk about him as being very quiet, others, like Jim Wilkinson, talk about the arguments that they had, often very loud, but never affecting their friendship. They always remained very close friends.

**Olga Tauskky Todd:**

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That's a good sign.

**Tropp:**

I just wonder if you could characterize him as a person?

**Olga Tauskky Todd:**

Well, the first time I heard about Turing was the following thing. He came from Kings College, Cambridge, and there was a group theory expert there called Philip Hall,

**Tropp:**

Philip Hall, that's right.

**Olga Tauskky Todd:**

Philip Hall. And Philip and the other people in Kings College, you know, whom I occasionally run into, said, oh, we know that there is a Philip Hall, but he's a completely, I don't remember what word was used.

**John Todd:**

A recluse, a hermit?

**Olga Tauskky Todd:**

A sort of hidden man.

**Tropp:**

He was the only one there in algebra, too, there was nobody else. [LAUGHTER].

**Olga Tauskky Todd:**

That's quite true, but it wasn't only that, but as a member of the college, I suppose he never turned up at meals or ate in his room, you know. He was a member, but nobody ever saw him. I don't know, but for

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some reason I mentioned that to Philip Hall, and he said, oh, he said, there is a man who is far more hidden, and he said: Turing. It was the first time I ever heard his name. [LAUGHTER].

**Tropp:**

Well, you were at Cambridge very near to the time Wilkinson was there, because he took work under Hardy and Littlewood and he mentioned taking a course under Philip Hall and I think Besicovich was his major.. professor, supervisor.

**John Todd:**

Supervisor, yes.

**Tropp:**

Were you there at the same time or were you there, you were there earlier.

**John Todd:**

I was there earlier, yes, yes, yes. But I had taken a course from Besicovich, Hardy and Littlewood.

**Tropp:**

That was an interesting period, it was a very exciting period.

**John Todd:**

Yes, yes.

**Tropp:**

But you didn't know Turing during that--

**John Todd:**

No. No. Now you see I--

**Tropp:**

He might have been there as an undergraduate.

**John Todd:**

Undergraduate.

**Olga Tauskky Todd:**

He would have been an undergraduate, I think so.

**John Todd:**

No, the people whom I remember in this general context, what we're talking about, attending courses, was Garrett Birkhoff. He and Marshal Hall were there at the same time, and I was with them and we took lectures from Besicovich on Lebesgue and Denjoy integration.

I knew these people, these were two obvious Americans.

**Tropp:**

[LAUGHTER].

I would say that Birkhoff's another man whose interests ranged over a wide, wide area.

**Olga Tauskky Todd:**

Tremendous, really tremendous.

**Tropp:**

Of course, Marshal Hall, I know of primarily in algebra.

I say, that was an exciting period. The Hardy stories of that era are marvelous.

Well, back to Turing. I keep digressing because--[pause]

**Olga Tauskky Todd:**

Well, I remember something you know, that I said to him on one of those evenings. I don't know if I

can put it in the right words, but I, something that I guessed at that time which really came true in a way. Namely that in some physical phenomena, sometimes integral values matter. I talked about, do you remember?

**John Todd:**

I don't remember. You mean some sort of quantum theory, eigenvalues?

**Olga Tauskky Todd:**

No.

**John Todd:**

No?

**Olga Tauskky Todd:**

No, no, maybe even boundary value problems or things like that. I have forgotten what I quoted to him, and he was interested in it; and I don't know how the conversation came to me. And then this new work of Jurgen Moser. There's really number theory actually enters. I mean, usually in applied work only approximations matter, but there are some things where integral values matter, and I remember that I had a conversation, because it interested him very much. That's what I remember about it, but I can't put in into, into real ...

**Tropp:**

Who was the name that you just mentioned?

**John Todd:**

Jurgen Moser.

**Olga Tauskky Todd:**

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Jurgen Moser.

**John Todd:**

He's at

**Olga Tauskky Todd:**

At the Courant.

**Tropp:**

Courant, yes.

**John Todd:**

He's the Head of, was the head of the Courant Institute, yes.

**Olga Tauskky Todd:**

He's the son-in-law of Courant, actually.

**Tropp:**

But he's no relation to Leo and

**Olga Tauskky Todd:**

No, I don't think so.

**John Todd:**

No, no.

**Tropp:**

The other Moser?

**Olga Tauskky Todd:**

No, I don't think so. No, I've not been acquainted that well, but in this, in the Gibbs Lecture, for instance, which Jurgen Moser gave, he had something of that. But I haven't explained it well, because it is making my mind--

**John Todd:**

Maybe this will stimulate you to think more about it and it will come back later.

**Olga Tauskky Todd:**

We had very lively and very pleasant conversations.

**John Todd:**

But mostly not about computing, you see.

**Tropp:**

I guess, that's what I'm interested in, more Turing the man.

**John Todd:**

Yes, I mean it was, there were no particularly well-trained mathematicians, I think, at NPL. Wilkinson, you see, was a young man who just came. Really his, instead of post-doctoral work, I mean his doctoral work, his graduate work, he went into War work you see.

**Tropp:**

Right, right.

**John Todd:**

You see, all these people were comparatively--Turing was older, you see, and had this brawl and he had nobody to talk to. We also were older, and so we talked about general mathematical problems, not just the day to day work which he was concerned with in building and designing a computing machine.

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**Tropp:**

What were your main mathematical interests at that point in time?

**John Todd:**

Well, at that time, I was really undecided, you see. My prewar work had been on abstract analysis and then I had a changeover, you see, and I spent six years or more on this, and I had to make a decision, you see, on whether I would go back to my earlier work or carry on with the numerical work.

And this was really quite undecided, you see, so, I was tidying up things in numerical analysis at that time, but I had not made up my mind to switch to this computing.

**Tropp:**

In terms of your own career, of both of you, you came to the United States during the year '47/'48, at the Bureau of Standards in both Washington and Los Angeles, and you were also at Princeton during that period, then you came back to England for a year before you came back to the United States for, essentially permanently.

**John Todd:**

Yes.

**Tropp:**

By the time you came back during '48, '49 there were a number of large-scale computers compared to what there had been in the process of being built. There was the machine at Manchester, the Physical Laboratory at Cambridge at Birbeck

**John Todd:**

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Birkbeck.

**Tropp:**

Birkbeck, under Booth.

**John Todd:**

Yes.

**Tropp:**

And, I guess I'm curious as to what you were seeing then and what your impressions were during that year when you returned. Because nothing was completed.

**John Todd:**

No, nothing was completed.

**Tropp:**

Except Wilkinson insists, and this is contrary to the literature, but he said he saw it and I believe that he saw essentially a bench model of a digital computer, electronic computer at Manchester, actually work. Functioning reasonably well in 1948.

Now, the first supposedly internally stored program, digital computer was, that ran, was the Cambridge machine in the first half of 1949.

**John Todd:**

It's quite possible that this is true.

**Tropp:**

Well, I believe it. [Laugh].

**John Todd:**

Yes, because I think they did some number theory like Lehmer's sieve.

**Tropp:**

It was either Lehmer's sieve or some kind of a generating function or they were decomposing numbers or searching for primes. It was something of that sort.

**John Todd:**

It was something, a special purpose machine.

**Tropp:**

Right.

**John Todd:**

This, I think, I heard talk of this here, you see. Do you remember that Symposium we went to in Cambridge, a computer...

**Tropp:**

But that wasn't until '49.

**Olga Tauskky Todd:**

'49.

**John Todd:**

Yes, but we may have heard about that at that time. Is there nothing on record about it?

**Tropp:**

I have the record of that Proceeding at the symposium there, and I don't remember anything except the larger machine that they were building. I could be wrong, I could go back through that. Since I've talked to Jim, I'm going to go back through it, but I hadn't, I don't remember it. Because the

Cambridge machine was just barely running. It wasn't doing much, but it was on the air.

**John Todd:**

No, again, I've, I seem to have memories of something of this kind.

**Tropp:**

And, according to Jim, it was an internally stored, programmed, digital computer. Not on a large scale.

**John Todd:**

This I may have heard, you see, at this meeting. Turing was there and Hartree was there and all the people were there. But I can look back, when I look back at the Proceedings and see if this may remind me of something.

**Tropp:**

It's interesting. I was having great difficulty finding a copy of the Proceedings any place in the United States, even the Library of Congress couldn't find one for me. Now they may have it, but Wilkes finally xeroxed a copy for me and sent it to me. [LAUGHTER].

**John Todd:**

I have a copy at home.

**Tropp:**

And you know the Bureau of Standards published his bibliography. You know the two volume permutation, title permutation, and of the volumes that they used, one of them was that Proceeding that they referenced, but they didn't have a copy, at least they couldn't find one.

**John Todd:**

I see, yes.

**Tropp:**

But they obviously had had one when they published the first volume of this bibliography.

**John Todd:**

Well, as I say, at that time we were uncertain, you see, what to do, and I was trying to get again the University to set up a mathematical, applied mathematics institute. Erdelyi and I had written about this and had some of the things which you see here. Then this was turned down, you see, and in England you know that the, at that time the university grants were given for five-year periods, and if you got nothing in a five-year period you had to wait for five years.

So, when this was turned down, this was one of the things which encouraged us to come to this country.

**Tropp:**

But you were back at University College for that one year?

**John Todd:**

Kings College.

**Tropp:**

At Kings College. Did you go back to the University College?

**Olga Tauskky Todd:**

No. I was at that Westfield College.

**Tropp:**

Westfield College.

**Olga Tauskky Todd:**

When I joined my War job, I actually terminated the job. I wouldn't say that I terminated, they did not

at that time guarantee they would take me back. They were against my leaving for my War job. They needed staff and they thought my first loyalty was with them.

**Tropp:**

Oh, I see.

**Olga Tauskky Todd:**

So, since I did not have tenure, they actually terminated my job.

**Tropp:**

What, did you go back to teaching that year?

**Olga Tauskky Todd:**

I had a grant from DSIR at that time.

**John Todd:**

That's the Department of Scientific and Industrial Research. So she had an NSF fellowship.

**Olga Tauskky Todd:**

It's just like an NSF fellowship. I had that during one year. Then we came over to this country in '47. I had this after I left my War job from '46 to '47, I left my War job in '46 and I had this DSIR grant. Then we came over here for a year and I was at the Bureau of Standards.

He was originally only asked, but when I came here, Curtiss immediately put me in too [Chuckle].

**Tropp:**

Of course. [LAUGHTER].

**Olga Tauskky Todd:**

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And then, then I came back and I lost my DSIR, it was a three year grant, and I had lost it, you see. So I actually, for a year I was working on my own.

**John Todd:**

But you had a grant from the Royal Society for travel.

**Olga Tauskky Todd:**

A tiny grant from the Royal Society for making, for going to meetings and things like that.

**Tropp:**

Is this the period when you began to get involved in the matrix theory?

**Olga Tauskky Todd:**

No. I got involved in the matrix theory because really my chief in that in my War job was a great matrix expert, he was a great matrix expert, but he decided I was not to work on matrix theory.

**John Todd:**

He wanted to keep the matrix theory to himself.

**Olga Tauskky Todd:**

To himself. And when I--I'm an algebraist, I'm an algebraist and

**Tropp:**

Who was that?

**John Todd:**

Fraser.

**Tropp:**

Fraser. Oh, is that the same Fraser that you've been...

**John Todd:**

That's right.

**Olga Tauskky Todd:**

I worked on these boundary value problems. Only in my last half year he let me work on the matrix theory, and much of my work to this day is really based on what I did in those six months. I picked up an enormous lot of the problems which I learned there. Because I learned the basic problems these people have in flutter work is to test the matrix, whether it is stable. But it is still, a practical test is still not done, to this day not done.

**Tropp:**

In fact, I listened, when I told you this seminar of Wilkinson's that I sat in on the afternoon I was there, the same subject kept coming up, this problem of instability.

**Olga Tauskky Todd:**

The problem is not solved to this day. Now Wilkinson is a genius. He can compute all the eigenvalues, so he doesn't have to test the matrix itself, but these people still want to have a test on the matrix without computing the eigenvalues and much of the theoretical work that I do even nowadays is still in that, you see.

**Tropp:**

They use the terms, in terms of computation, I guess, of conditioned or ill-conditioned, rather than the stability characteristics, which has another meaning in the computational aspect.

**Olga Tauskky Todd:**

It has another meaning in the computational aspect from the aerodynamics, basically.

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So then, anyhow, we, I did not try even harder to find any suitable jobs and we were, anyhow, scheduled to come over here and we were already at the Bureau of Standards.

**Tropp:**

Did Turing ever come to the United States after that period. I know he made a trip, again, classified, but during the War on crypto analytic work. I know he visited Dayton, Ohio which was the center in the United States for that work. Do you know of any trips that he might have made during the period when you were in America?

**John Todd:**

I don't think so, I don't think so.

**Olga Tauskky Todd:**

He was not at the Cambridge Congress in 1950.

**Tropp:**

The one at Harvard?

**Olga Tauskky Todd:**

At Harvard, that's right. I don't think he was there. I think we would have noticed.

**John Todd:**

Yes, yes.

**Olga Tauskky Todd:**

I think we would have noticed. We'd gotten all very friendly.

**John Todd:**

Yes, as I say, our last contact with him was at this meeting in Manchester in probably August or

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September of

**Olga Tauskky Todd:**

Late in the summer

**John Todd:**

'49.

**Tropp:**

Then, was the Cambridge meeting, '49 meeting earlier?

**John Todd:**

That was a computer meeting, was a computer meeting.

**Tropp:**

Yes. Turing was at that one.

**John Todd:**

At that one, and then he was also, we also saw him again at the Mathematical Meeting in Manchester.

**Tropp:**

The Manchester Meeting, though, was later?

**Olga Tauskky Todd:**

That was later. In fact, it was really practically a day it was concluded a day before our departure. In fact, we were expecting, you know travel was still very difficult, and we were only promised a passage to this country, and we had our things all ready to leave from the Manchester Meeting right to our boat practically.

Don't you remember we were expecting a phone call from the shipping company? Don't you remember

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that?

**John Todd:**

Yes, yes.

**Olga Tauskky Todd:**

It didn't come until a day or two after we came back.

**Tropp:**

Well during that period then, you were trying to establish something in this area at the University of London and I would assume, maybe it's the wrong assumption, that you were using as part of your ammunition other things that were going on in England that depicted needs for a Center.

**John Todd:**

Well, it was really our War, my wartime observations, you see, that there was a possibility of using mathematicians in operations analysis and I think we made a long list of desirable sections in this sort of institute, you see.

Then finally, I think, to go back, I think probably in the next five-year period, you see, there was started up in the University of London, a University Computing Centre of some sort. I have forgotten the name, Computing Institute or something, in which Buckingham was in charge, or was in charge. This may have started in about 1955 or something.

**Tropp:**

Somewhere in the mid-fifties.

**John Todd:**

About 1955, yes.

**Tropp:**

By then there were some computers around and you could talk about a computer.

**John Todd:**

Yes, yes.

**Tropp:**

Even when you came to the United States there were no machines running, except for the machines at Harvard,

**John Todd:**

And the ENIAC.

**Tropp:**

ENIAC at Aberdeen, and the relay machines at Aberdeen.

**John Todd:**

Yes, the Bell.

**Tropp:**

The Bell machines, and that was about it.

**John Todd:**

That was about it.

**Tropp:**

There were a lot of machines being built.

**John Todd:**

Yes. My first, the first program I ran on a machine was on Good Friday, 1950.

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**Tropp:**

Was this the one on Fibonacci numbers that you mentioned?

**John Todd:**

Yes, on SEAC.

**Tropp:**

On SEAC, but it had something to do with the Fibonacci frequency?

**John Todd:**

Yes. It was finding the highest comm--Euclidean algorithm applied to the Fibonacci numbers, because this gives it the

**Olga Tauskky Todd:**

slowest

**John Todd:**

slowest

**Olga Tauskky Todd:**

Yes, mhm.

**John Todd:**

the slowest

**Tropp:**

You are looking for a factorization

**John Todd:**

Yes. To show that they had no common factor. So that was--but, as I say, we had written programs for

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idealized machines in '47, you see.

**Tropp:**

Idealized machine, essentially, meaning something like a Turing machine?

**John Todd:**

No, I'm sorry, I mean, more or less these were the ones that the Bureau of Standards was, there were specifics-the machines were specified, the Raytheon and the UNIVAC machines.

**Tropp:**

Oh, I see.

**John Todd:**

So, we were playing to see whether the various operation codes which were suggested would apply to other mathematics then what, shall we say, differential equations?

**Tropp:**

Right, kind of a paper simulation of machine coding and as applied to specific branches?

**John Todd:**

Yes, yes.

**Tropp:**

In terms of a particular product. That was interesting in '47. No machines on the horizon and you were already coding problems. [LAUGHTER].

**John Todd:**

Yes, yes.

**Olga Tauskky Todd:**

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It did seem very funny; it did seem exceedingly funny.

**John Todd:**

So we were very excited when we actually got one going.

**Tropp:**

I heard people refer to that and during that period to what they call the Von Neumann concept.

**John Todd:**

Yes.

**Tropp:**

When was the machine going to be completed? [Laugh].

The Von Neumann concept was whatever answer you got which always seemed to be the same, six months or a year and a half. Did you have much contact with Von Neumann while he was building or--

**Olga Tauskky Todd:**

Well, yes, we spent the whole time in Princeton actually in early '48.

**John Todd:**

Yes.

**Olga Tauskky Todd:**

Yes, you see we were, the Institute to which we had been brought over, in '47, we thought that we would immediately travel out to it, which later became the INA. That was not ready yet, so we were hanging about in Washington, and were trying to pick up all the things, that was in '47. But after some time, we realized that we had picked up what we could there in Washington and gave all the help that we could do. So, we, since we still could not go out to the West Coast we asked if we could go to Princeton for a

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term. Isn't that the way?

**John Todd:**

That was

**Tropp:**

That's that letter

**John Todd:**

That's that letter you've seen, yeah.

**Tropp:**

that you showed me from Von Neumann in which he tells you what dates he's going to be around?

**Olga Tauskky Todd:**

That's right, that's right.

**John Todd:**

Yes. And so, we spent then, three months there.

**Tropp:**

What was the state of the Princeton machine at that point? Was it still pretty much on paper?

**John Todd:**

No, no. There was quite a lot of hardware. There was quite a lot of hardware going up, yes, yes. Well, of course, Slutz was one of the people.

**Olga Tauskky Todd:**

Bigelow.

**Tropp:**

Bigelow was the Chief Engineer.

**John Todd:**

Then Slutz came to the Bureau of Standards.

**Olga Tauskky Todd:**

That's right, yes.

**Tropp:**

Oh Slutz, Ralph Slutz.

**John Todd:**

Ralph Slutz, yes. Have you seen him?

**Tropp:**

No, but I know the name and I know I should see him.

**John Todd:**

He is in Boulder, I think. I don't know now, but he moved out about

**Tropp:**

Isn't Dantzig at Boulder?

**John Todd:**

George Dantzig? No, he's at Stanford.

**Tropp:**

Is he at Stanford? Somebody told me they thought he was at Boulder.

**John Todd:**

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No.

**Olga Tauskky Todd:**

We've seen him also.

**Tropp:**

Yes, I'm sure you are right.

**Olga Tauskky Todd:**

I don't think he ever was Dantzig?

**John Todd:**

No, no.

**Tropp:**

Somebody told me they thought he had just gone. Maybe it was for a short period.

**Olga Tauskky Todd:**

Only for a short period, most unlikely. Most unlikely.

**Tropp:**

What was the atmosphere like at Princeton when you were there in terms of the computational aspect.

Princeton seems like a very unlikely place to build a computer. When you look back in time.

**John Todd:**

Well, I think it was.

**Olga Tauskky Todd:**

Von Neumann had said, if they don't give him an institute if you don't give him facilities, he will leave,

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he will go to MIT.

**Tropp:**

[LAUGHTER].

**Olga Tauskky Todd:**

Isn't that what he said? Yes, he would go to MIT, because they would, they offered him full facilities.

So, they gave him a building which was in a good distance from the Institute. He took a bus.

**John Todd:**

No, no.

**Olga Tauskky Todd:**

It was not necessary. But during winter, it was quite a distance.

**Tropp:**

Yes. Well what were some of the attitudes of the people at the Institute who were not connected with the machines?

**John Todd:**

Well, you can say what Hermann Weyl told us.

**Tropp:**

What did Hermann Weyl say?

**Olga Tauskky Todd:**

Hermann Weyl said--well, the first one actually who attacked me terrifically was Lefschetz. Lefschetz, I think used really almost bad language.

**Tropp:**

[LAUGHTER].

**Olga Tauskky Todd:**

He attacked me personally. [Laugh]. Poor me.

**Tropp:**

Oh. [LAUGHTER].

**Olga Tauskky Todd:**

So, no, he was tremendously hostile. I think maybe he was jealous. It is possible.

**Tropp:**

What did Weyl say?

**Olga Tauskky Todd:**

Well, Weyl was very gentle. He also attacked me for associating with it. He really did, and then he said, "well after all, it is your job and it's perfectly okay. Only," he said, "I have a feeling it may be the end of the previous way of working, of," I don't know, I cannot think of the right words, but he felt that it would really bring

**John Todd:**

a change of mathematics

**Olga Tauskky Todd:**

the type of mathematics that he was used to may actually be terminated.

**Tropp:**

Of course, he turned out to be very wrong. [LAUGHTER].

**Olga Tauskky Todd:**

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Very wrong. He finished off by saying, "Whatever happens, Siegel still computes his own logs."

**Tropp:**

[LAUGHTER].

Which Siegel was he referring to?

**Olga Tauskky Todd:**

Carl Ludwig, the famous, the famous.

**Tropp:**

Oh, yes, yes. Did you have a chance to talk to Einstein while you were there? I've heard lots of stories about him, but I've never heard any reaction of his to what Von Neumann was doing. Or whether he even knew about it, I don't.

**John Todd:**

Ernst out in California. Straus might know something about it.

**Olga Tauskky Todd:**

He might.

**John Todd:**

Ernst Straus was his assistant, you see.

**Tropp:**

He's where?

**John Todd:**

He's at UCLA.

**Olga Tauskky Todd:**

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Yes, he might know.

**John Todd:**

Your young lady might call on him.

**Tropp:**Ernst?

**John Todd:**

Ernst, E-R-N-S-T and Straus with one 's'.

**Tropp:**

And he's at UCLA?

**John Todd:**

He was an Einstein assistant during that time.

**Olga Tauskky Todd:**

Yes, I think so.

**Tropp:**

I would just be very curious to hear what kind of comments he made, flip or otherwise. [LAUGHTER].

**Olga Tauskky Todd:**

I think the other people were plain scared. They were sort of scared. Certainly Lefschetz and Hermann Weyl. Hermann Weyl was quite outspoken about it, but in a friendly tone, while Lefschetz--

**Tropp:**

Well, of course, that was a period, too, when Norbert Wiener was going around, giving kind of a scare talk about automatons in the future and our inability to prepare for the change in paradigm that this would bring about. Wasn't that, it was '49, I guess, when he was travelling around giving his speeches.

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All over the World, I think.

**Olga Tauskky Todd:**

I see.

**Tropp:**

So, there were some, I think, some justifiable concern,

**Olga Tauskky Todd:**

There was concern.

**Tropp:**

more of a human, in a human environment, not, I didn't sense a mathematical one. But I was thinking in terms of kind of quality of life or way of life context. At the Institute, I obviously don't know very much about it, but in looking at the various directorates, it's clear that there must have been an almost changing emphasis in area of interest annually. Was this intended from the very beginning? Since you were there at the beginning, was it clearly the intent to keep rotating people sufficiently so that the Institute would never get bogged down in one thing. It would always be at Los Angeles.

**John Todd:**

At Los Angeles.

**Tropp:**

Was that deliberate?

**John Todd:**

I wouldn't have said so. I think it was John Curtiss' idea to get good people and he could not get good people to commit themselves

permanently.

**Tropp:**

I see.

**John Todd:**

And so that was one of the reasons why I think things changed around, you see.

**Tropp:**

I think it's a rather fortunate thing, no matter why it occurred. I was just curious as to whether it was planned.

**John Todd:**

No, I don't think, I don't think that was in the charter. The original document, no.

**Tropp:**

It kind of turned out that way.

**John Todd:**

It turned out that way.

**John Todd:**

Yes, it turned out that way, but I think this was just that people were wise, but there were difficulties enough with people who had no jobs when the place folded, you see. So, they were wise, and so he got first class people, and when he couldn't get anybody, he did it himself.

**Tropp:**

Right, I know that, yes. He was acting Director for...

**John Todd:**

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For the first

**Tropp:**

Commuting for a while.

**John Todd:**

Yes, yes.

**Tropp:**

He's written an interesting history of the Bureau from '48 until '53, that you I'm sure have seen.

**John Todd:**

Yes, this I have.

**Tropp:**

I ran across a document that he can't identify which is a history of computation at the National Bureau of Standards, and it's clearly written in 1949, and it covers the period from 1946 to 1949. It is a twelve-page document, which is very specific in terms of contracts which were let, consultants, their recommendations, specific dates, actual amounts of money spent, literally to the penny. In the case of a contract, the dates of signing, the effective date of implementation.

**John Todd:**

Was this not something that Cannon wrote?

**Tropp:**

Don't know. I've been circulating it to John Curtiss and a number of people.

**John Todd:**

I have got one document, which I think that he asked Cannon to write, a, so to speak, history of more or

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less the contractual activities.

**Tropp:**

Yes. This covers that three-year period.

**John Todd:**

That's very likely. I mean that was my impression that this was--

**John Todd:**

I got it through Franz Alt. I was sitting in his office a few months ago and we were going through his file of documents and he pulled this document out. I say it's twelve pages of exposition, and then it has a three-page chronology, which summarizes the events, like here's when Eckert and Mauchly were contacted as consultants. Here's when we contracted with them and here are the amounts of money involved. Here's George Stibitz as a consultant. You know, very specific. And it's a beautiful document.

**John Todd:**

Yes. I have that, and as I say, I didn't refer it here, you see. I was not concerned.

**Tropp:**

It's unsigned and undated and I guess at 19--

**John Todd:**

As I say, I thought it was possible--

**Tropp:**

I gave it to Margaret Fox and Churchill Eisenhart, whom I happened to see, and they were going to circulate it among people at the Bureau.

**Olga Tauskky Todd:**

You don't have that.

**John Todd:**

Oh, I think I have it, I'm not sure.

**Tropp:**

It's clearly something that John Curtiss did not write. There's no question about his authorship.

**John Todd:**

I know there's something which I have which I think Curtiss asked Cannon to write.

**Tropp:**

Well, that's interesting, because when I sent it to John Curtiss for identification, he wrote back and he gave me a series of names and Ed Cannon's name wasn't in them. Two of the four names he suggested are no longer alive. His thought was that it had been an administrative document for preliminary work for a budget.

**Olga Tauskky Todd:**

Oh, I see.

**Tropp:**

But who wrote it? It would be a beautiful document to publish.

**Olga Tauskky Todd:**

Some of these things were written by people who were excellent writers.

**John Todd:**

It wasn't ... There was a man Bolton who was the Administrative Budget Officer at the Bureau at INA

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for some time, who is now at the Science Foundation.

**Tropp:**

BOLTON?

**John Todd:**

Yes. W. W. Bolton, Junior. He might be, have something to do with it.

**Tropp:**

I'll give him a call. [Laugh]. But it's strange to find something so well done with no name attached to it and no date, no cover. But it is titled: History of Computation at the National Bureau of Standards.

**Olga Tauskky Todd:**

Then, it's most likely neither Franz Alt nor Curtiss.

**Tropp:**

It's not Franz Alt. He gave it to me, and he didn't know who wrote it.

**Olga Tauskky Todd:**

And he did not know who wrote it?

**Tropp:**

He did not know. He didn't even suggest Cannon. I sent it to John Curtiss, and he said, "I didn't write it," and he didn't suggest Cannon. I showed it to Margaret Fox and Churchill Eisenhart, and they had no idea who might have written it.

**John Todd:**

I'll look, I'll look at mine.

**Tropp:**

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It's the kind of thing that should be published, because it's beautifully done. I'll send you a copy, okay, just in case you don't have one. [Pause]. I'll send you a xerox copy when I get back, and maybe you can identify it. He may recognize the phrases and the style. That's the only hope at this point. But some day I would like to publish some of these unpublished documents as you are doing with this material. That one of John Curtiss' that he wrote in '53 or '54 is one that's only been circulated and in a small group of people. There's another famous document that you may have been there for, and that was a report given to Doctor Curtiss by a group of people who were associated with the Office of Scientific Research, I think, by, it's a joint report of Aiken, Von Neumann and Stibitz on the Future of Computation or the Need for Computers. Does that ring any bell? It would have been '49. [Thunderclap] Some storm [LAUGH].

**Olga Tauskky Todd:**

...I think.

**John Todd:**

That I don't recognize at all. It may have been a--

**Tropp:**

It may have been a very internal thing. Curtiss remembers it, but it too has vanished.

**John Todd:**

Oh, it has vanished?

**Tropp:**

Yes.

**John Todd:**

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I don't think I have that. The only thing which, again I mention in this: After the battery additive case at the Bureau there was an investigation of the whole Bureau by a Committee appointed by the Academy and the Chairman was Kelly who was, I think, the head of Bell Telephones at the time.

**Tropp:**

Yes, that's right.

**John Todd:**

Mervyn [?] Kelly. It's the Kelly Report. This has got a very good appreciation of the work of the Bureau, of the Mathematics Division.

**Tropp:**

Franz Alt gave me a synthesis of the Kelly Report, and then a very long letter that he wrote after it was issued. So, I've got some documents on the Kelly Report.

**John Todd:**

Yes, well, as I say, I have the Kelly Report.

**Tropp:**

I have never seen the complete Report, though.

**John Todd:**

No, this is a somewhat complete set [?]. Yes, we had some trouble about that. You see, a Committee was appointed to investigate the Bureau, and no mathematicians were on this, so we kicked up trouble and finally, we got a mathematician added to it.

**Tropp:**

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Who was it?

**John Todd:**

It was Rosser.

**Tropp:**

Oh, Barkley Rosser.

**John Todd:**

He had left the Bureau at that time.

**Tropp:**

This would be '52, '53?

**John Todd:**

This was '53, I think, you see.

**Tropp:**

That's been cited as one of the reasons for the demise of the Institute as part of the Bureau.

**John Todd:**

Well, that, as a matter of fact, I mention this here in my--You see here's what I say in the fair copy, you see, I don't--[pause]

**Tropp:**

Well, one outcome of the Kelly--

**John Todd:**

No, one outcome of the battery, this was the battery, this was the battery additives business.

**Tropp:**

Oh, that's right, Doctor Astin was asked to resign, was reinstated, and they were fully supported by the Nationa--

**[End of Tape]**