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ROBERT E. GREENWOOD

(with ALBERT TUCKER)

This is an interview on 12 July 1984 with Robert E. Greenwood at the University of Texas at Austin. The interview is being conducted over the telephone. The interviewers, located at Princeton University, are Albert Tucker and William Aspray.

Aspray: We were wondering if we could start by your telling us something about your background and how you came to Princeton.

Greenwood: All right. I was an undergraduate at the University of Texas. I spent 1 year at Brown University, and then I came to Princeton to study mathematical physics in 1936. But I soon found out that I was better cut out to be a mathematician than a mathematical physicist, so I switched over to mathematics.

Aspray: How was it that you chose Princeton for mathematical physics?

Greenwood: A large part of it was that I was able to get a small fellowship to Princeton. I had something that was called a Junior Fellowship one year, and the next year I had what I think was called the JSK Fellowship.

Tucker: That's right.

Aspray: What were your first impressions upon arriving in Princeton?

Greenwood: Quite favorable. I enjoyed my stay there.

Tucker: Do you remember people that you got to know in your first year?

Greenwood: Yes. I stayed in the Graduate College, and the entry that I was in had six double rooms—12 people in all. A group of six of us became very friendly. One of them was a chemist, a son of Dr. Otto Haas, and later president of Rohm and Haas; he is retired now. One of them was Howard Richards who studied economics and served as a business consultant. The other four were mathematicians.

Tucker: Who were they?

Greenwood: Ransom Whitney, who later was at Ohio State for many years.

Tucker: That's right.

Greenwood: John H. Giese, who probably studied under Dean Eisenhart. He later worked at Aberdeen Proving Grounds.

Tucker: Yes, and after retiring from Aberdeen Proving Grounds he taught for a while at the University of Delaware. I saw him about a year ago. He's gotten very much interested in computer graphics.

Greenwood: Yes, I could have predicted that. And Joseph Daly, who started out working under T.Y. Thomas, but switched over to statistics. He was a statistician for the U.S. Census Bureau for many years. He lives near Washington D.C. and retired about six or seven years ago. I think he has a son that went to Princeton.

Tucker: Yes, but didn't finish, unfortunately.

Aspray: I interviewed Daly just last Tuesday.

Tucker: Along with Churchill Eisenhart.

Greenwood: Did Daly by any chance mention me?

Aspray: I don't think so. The conversation with him went an entirely different direction because we restricted it to Wilks.

Tucker: We were trying to get into the early history of the statistics group at Princeton.

Greenwood: Did you get Mood, Alexander M. Mood, on that?

Tucker: No, we haven't.

Greenwood: Alexander Mood got a doctorate under Wilks in the early '40s.

Tucker: That's right.

Greenwood: He is in Irvine, California right now; I believe he is retired.

Tucker: I see. Well we'll try to get in touch with Alex Mood.

Greenwood: He was a very good friend of mine. We were not at Princeton together, but we were at Texas and one or two other places together.

Tucker: I knew him quite well when he was here at Princeton, and also later on when he was for a while at the Rand Corporation.

Greenwood: Yes.

Aspray: What do you remember of the courses you took while you were at Princeton?

Greenwood: I took courses both in physics and in mathematics the first year there, and the second year I concentrated on mathematics. I had one course from H.P. Robertson and one course from E.U. Conden, who were both mathematical physicists.

Tucker: That's right.

Greenwood: And one course from a man named Walker Bleakney, who was in the physics department.

Tucker: Later he was chairman of the department, and he is now retired and living in Princeton.

Greenwood: And one course from an elderly gentleman, E.P. Adams. For the course we used, I think, James Jeans's textbook on electricity and magnetism.

Tucker: Yes.

Greenwood: Then in mathematics I had courses from H.F. Bohnenblust and Salomon Bochner, and I attended a topology seminar that I had written Professor Tucker about.

Aspray: Yes, I have seen that.

Greenwood: Some of us took a course under Dean Eisenhart, using one of his books as the textbook.

Tucker: Was that Riemannian geometry?

Greenwood: I believe so.

Tucker: I took his Riemannian geometry course in '29-'30.

Greenwood: It was quite a popular course. There used to be a saying that if Wedderburn says something is true, accept it but don't try to prove it because you won't be able to. If Eisenhart says something is true, get out his book and by using cross references 20 to 30 times you can work up a proof for it. And if Lefschetz says something is true ...

Tucker: It is probably false.

**Greenwood:** ... my apologies to Professor Lefschetz, look for a proof and for a counterexample at the same time.

**Aspray:** Can you tell me something about your experiences with the difference between Texas topology and Princeton topology?

**Greenwood:** They were motivated by two different philosophies. The Texas topology was mostly in the hands of R.L. Moore. He believed in building from the ground up on your own efforts; he did not want a student to do any reading in his book or any other book that dealt with the subject. Professor Lefschetz thought it was all right for the student to talk and work with others as long as he didn't plagiarize, and as long as in picking up techniques he made them his own. So there was a wide difference in the philosophical approach to mathematics between the two people.

**Aspray:** What about the outcome? Judging from your experience, how well were the two groups trained?

**Greenwood:** I'd have to say that both of them were pretty well trained. It happened that I knew I wasn't cut out to be a topologist, so I didn't align myself strongly with either of those two philosophies.

**Aspray:** I see.

**Greenwood:** After I'd served six years in the U.S. Navy doing probability and statistics and combinatorics, I was sort of switched from analysis over to combinatorics. It was the occupational experience that brought that about, but I don't think I'd ever have been a successful topologist.

**Tucker:** You were affected like John Tukey, who switched to statistics as a result of his war work.

**Greenwood:** Yes.

**Tucker:** He was a contemporary of yours as a graduate student, I think.

**Greenwood:** I knew him also very well. I spent a year at Brown University, '35-'36, just before coming to Princeton. I knew John Tukey there. Then Tukey came to Princeton in '37 intending to study chemistry, but Lefschetz convinced him to study mathematics instead.

**Tucker:** Yes, we interviewed John Tukey some time back.

**Aspray:** What do you remember about some of the faculty members you had? Personality, quality of teaching, and such?

**Tucker:** You mentioned Bohnenblust and Bochner. I guess you did your thesis with Bochner.

Greenwood: Yes. They were all very nice, very friendly. I got along with all of them. I knew Condon very well the first year I was there, but I believe he then left to go into some sort of work elsewhere. I even got along with Professor E.P. Adams, who was then quite elderly. I enjoyed my experiences with the faculty there.

Tucker: Did you have any contact with Einstein?

Greenwood: None to speak of. Nor with Hermann Weyl. I didn't have much contact with the members of the Institute for Advanced Study. Although I do remember J. Wallace Givens; I think he was an assistant to Weyl or someone else.

Tucker: I think to Veblen.

Aspray: How did you come to work with Bochner?

Greenwood: I happened to be a little better in mathematical analysis than in, say, mathematical physics or topology. So I went into that, and Bochner was available. Bochner was very nice. He gave me a problem to work on, and by the time I had finished it I could tell that Bochner had already practically gotten most of those results himself—or at least he knew that they were possible—but he let me go ahead and develop the topic.

Aspray: I see. Was he there, ready to help you, whenever you needed help?

Greenwood: Yes, though you had to arrange a conference with him. I think I'm not too far wrong in saying that I didn't go to him for very much help. I'd work something out and complete it and then show it to him. He would say, "Well, that's fine. Now go ahead with the next stage." Or something like that. I don't believe I ran into any great difficulties in writing the thesis, so I believe I did most of that on my own.

Aspray: Did he have other students working with him at the time?

Greenwood: I believe he did, but I don't remember them. His first student was a man named Barnes who wound up as an electrical engineer out in ...

Tucker: UCLA.

Greenwood: Andrew Sobczyk was working with Bohnenblust. Sobczyk and I graduated the same year, I believe.

Tucker: Have you had any recent contact with Sobczyk?

Greenwood: Yes, when he was at Clemson. My wife and I were driving East one summer, and we went through Clemson and saw him. And Andy Sobczyk wrote a paper, and some journal asked me to review it. It dealt with a topic that I was quite interested in and had done

some papers on—it was in combinatorial analysis, evaluating Ramsey numbers—so I corresponded with Sobczyk a little bit. He never did find out that I'd written the referee's report on one of his papers. Sobczyk died two or three years ago.

**Tucker:** I didn't know that.

**Greenwood:** Yes, two or three years ago. But we visited him there for a couple of hours one day on our way North. That must have been 15 or 16 years ago.

**Tucker:** I have a list of 40 Ph.D. theses that were completed at Princeton in the 1930s. About half of them were in geometry and topology. The rest were in a scattering of subjects. But over the long haul, the person who supervised, I think, more theses than anyone else was Salomon Bochner.

**Greenwood:** Well, he was just getting started at the time I worked with him. J.L. Barnes had finished before I started working with him. Bochner of course was from middle Europe somewhere.

**Tucker:** From Poland.

**Greenwood:** And when he worked himself up and got going ... well, he was doing very well.

**Tucker:** Yes, he certainly was. Bob Gunning and others are working on a nice memorial volume for Bochner. Perhaps you have heard about it?

**Greenwood:** Yes, I have. Now Gunning I did not know at all until they had that big retirement party for Bochner 12 or 15 years ago. I met him then, but Gunning is much later than I.

**Tucker:** Another person whose thesis was supervised by Bochner in 1939 was Joe Weyl.

**Greenwood:** I did not know that. We called him Joachim Weyl, but I hardly knew him. I lived at the Graduate College, and I'm sure that he stayed at his parents' home.

**Tucker:** Yes. How is it that your thesis is listed with 1939? Were you here in '38-'39?

**Greenwood:** No, I was not there. I came back about the last of May and stayed in Princeton for a month or so, and that was when I took the final.

**Tucker:** So you were in residence only the two years, '36 through '38?

**Greenwood:** Yes. I finished writing the thesis down here in Austin, Texas, in the late fall of '38. I sent it to Bochner. He liked it and presented it to some committee or other, and they said, "Come take the final orals."

Aspray: Did you get to know Alan Turing?

Greenwood: Reasonably well. Then during World War II it happened that Alan Turing was working for the British government and was sent over as a liaison man, and I met him in Washington, D.C., and renewed acquaintances with him there.

Tucker: Did you also know Shaun Wylie?

Greenwood: Yes, but I've not seen him since the days at Princeton, although I did have occasion to write him a number of years ago. I think that Shaun left the British government to go back to teaching, and later decided he'd prefer to work for the government.

Tucker: Yes, he worked for the government until it was time for him to retire. He is now living in Cambridge and teaching mathematics part-time in a boy's school. I saw him a couple of years ago. His Ph.D. thesis is credited to Lefschetz, but actually it was mainly done with me. In a sense he was my first Ph.D. student, and so there has been a good bond between us over the years.

Greenwood: I've known many of the people who worked at Bletchley Park during the war.

Tucker: Have you by any chance read the biography of Alan Turing?

Greenwood: I don't recall whether I have or not.

Tucker: It's a rather massive volume that came out a year ago.

Greenwood: I've not read it if it came out that late.

Tucker: You would be interested in reading it, because it mentions a great many people that you know. It's called *Alan Turing: the Enigma*. There's a pun on 'enigma', referring to Alan Turing and to the code machine. The man who, I guess you know, was in charge of that mathematical effort was Max Newman. You referred to meeting Max Newman in one of the notes that you wrote, saying he joked about mathematicians that spent their time proving such things as the ham-sandwich theorem.

Greenwood: Yes, though I really didn't know Max Newman. I corresponded once with Turing's mother, however.

Tucker: Yes, she wrote a biography of him, but that biography was largely intended to argue that his death wasn't suicide. She didn't believe it was suicide, but almost everybody else does. The author of this recent biography is a man by the name of Andrew Hogdes.

Greenwood: I'll look for it.

Aspray: You started to say something about Shaun Wylie a couple of minutes ago.



Greenwood: Shaun was one of the nicest fellows I've ever known. I remember at the time that he left he sold all of his possessions there at Princeton. They used to have sort of a garage sale—anybody that was going back to Britain after a few years. I remember going to his garage sale, although I don't think I bought anything.

Tucker: Did you know Maurice Pryce?

Greenwood: Yes, he was one of the mathematical physicists there.

Tucker: Yes, I think he did his Ph.D. thesis with Condon, or was it Robertson?

Greenwood: He was a gifted and brilliant student.

Tucker: He's also mentioned in the Bletchley Park history.

Greenwood: I didn't know that he was connected with Bletchley Park.

Aspray: Were you a frequenter of the teas at the math department?

Greenwood: Yes, also the Sunday-afternoon teas that the Eisenharts gave. I learned to play go and go-mo-ku at the Fine Hall Common Room. I enjoyed both of those very much.

Aspray: Did you talk mathematics there also?

Greenwood: Oh, yes, we talked mathematics a lot. I remember once going in there with someone who had just received a copy of the *American Mathematical Monthly*. He thumbed through it and said, "Hm, I just wasted my 40 cents on this." That was when you could get a subscription to the *Monthly* for one year, ten issues for four dollars. He said, "I just wasted my 40 cents on this issue." Don't tell the editors of the *Monthly* that now, though.

Tucker: It's a very different journal now. Incidentally, I remember the paper by H. Petard very well, because the editor of the *Monthly*, E.J. Moulton at Northwestern University, realizing that the paper had come from Princeton, wrote to me about it. He said that the *Monthly* had a policy against publishing anything from an author who was not known. He suspected that it was a cover name for a group of mathematicians, as it was. He said that if I would assure him that the names of the authors could be determined, if they were required for some legal reasons, that he would go ahead and publish it. I got in touch with John Tukey, whom I knew was one of them, and John Tukey said that the names would be provided if absolutely necessary. So it was published.

Greenwood: Moulton and I both caught onto the hoax there.

Tucker: Of the other people that were in on it, there was the astronomer you mentioned, Lyman Spitzer.

Greenwood: Yes.

Tucker: Also, I think, the mathematical physicist Feynman may have been one of the group.

Greenwood: Some of the things in the paper suggested a knowledge of mathematical physics, so that's quite in order.

Tucker: I think there was a group of them who ate together in the Graduate College dining hall.

Greenwood: Yes. Now this group that I mentioned, we ate together a lot in the Graduate College dining hall. You asked about Thomas Doyle earlier?

Tucker: Yes, he was called "the sailor boy" by Lefschetz because he had been in the merchant marine for a while before he became a graduate student.

Greenwood: Yes, he was a bit older than the fellows just out of college.

Tucker: You say that you know of his death?

Greenwood: I think I remember reading of it.

Tucker: I have completely lost track of him. He taught at Dartmouth after he left Princeton, but I don't know what happened to him after that.

Greenwood: Incidentally, there was a young man studying physics there by the name of Robert Herman. He later went to the General Motors research institute and did a lot of work on automobile-traffic analysis.

Tucker: Isn't he at the University of Texas now?

Greenwood: Yes, he's been down here now for four or 5 years, and he's doing the same sort of work here.

Aspray: Do you remember any anecdotes from that period that you might want to tell us?

Greenwood: Right now I don't recall any, but I'll probably send some items to Professor Tucker later on.

Aspray: Very good.

Tucker: Well, thank you very much.

Greenwood: I enjoyed talking with you.