BORIS VLADIMIROVICH GNEDENKO

Nozer D. Singpurwalla[1] and Richard L. Smith[2]

Boris Vladimirovich Gnedenko, Member of the Academy of Sciences of the Ukranian SSR, and Head of the Department of Probability Theory at the Moscow State University, will be 80 on January 1, 1992. He is internationally acclaimed as one of the outstanding mathematicians in the field of Probability Theory. He was a graduate student under the direction of A. Ya. Khinchin and A. N. Kolmogorov, with whom he also developed a close personal friendship. In the spring of 1991 he visited the George Washington University and the University of North Carolina at Chapel Hill. The following interview, about his life and mathematical work, took place in Washington, DC, on May 25, 1991. Apart from Gnedenko himself, present were Nozer Singpurwalla, of the George Washington University, Richard Smith, from Chapel Hill, Gnedenko's son Dimitri, who is also a probabilist at the Moscow State University, and Igor Ushakov from Moscow, visiting the George Washington University.

The following material on Gnedenko's contributions to statisical science has been abstracted from tributes paid to Gnedenko on his 50th, 60th and 70th birthdays respectively, by Belyaev, Gikhman, Kolmogorov, Korolyuk, and Solov'ev, and published in *Uspekhi Math Nauk* (English translation: *Russian Mathematical Surveys).*

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Under the influence of Khinchin and Kolmogorov, Gnedenko, in 1937 became interested in limit theorems for sums of independent random variables. In the subsequent years, drawing upon results of de Finetti, Kolmogorov, and Levy, for the class of infinitely divisible distributions, he derived a series of results in the above topic that are now regarded as his most important contributions to the theory of probability. Gnedenko's researches into limit theorems were summed up in a (1949) monograph with Kolmogorov, entitled "Limit Distributions for Sums of Independent Random Variables". This monograph was awarded the Chebyshev prize in 1951, and was translated into many languages, English, German, Polish, Hungarian and Chinese, to name a few. This monograph resolved the classic problems of limit theorems for sums of independent randonm variables, begun by Chebyshev, Lyapunov and Markov.

During 1940-1943 he published several papers on limit distributions for the maximum term of a series of random variables, where he obtained the most definitive results on the necessary conditions of convergence and the domains of attraction of each of the possible limit laws. His work was the first mathematically rigorous treatment of the fundamental limit theorems of extreme value theory. In its influence on the probabilistic theory of extremes, the paper set the agenda for the next 30 years.

In 1941 he published a paper on "Geiger-Muller Counters" in the *Journal of Experimental and Theoretical Physics.* This paper is a landmark event in what is now known as the theory of reliability. Gnedenko's contributions to the development of this subject, and his role in evolution of the Soviet school of reliability are covered by Professor Igor Ushakov's postscript at the end of this interview.

In 1950 Gnedenko's interest turned to problems in mathematical statistics. Kolmogorov and Smirnov had proved the first theorems establishing the limit distributions for the maximum deviation of an empirical distribution function from the theoretical and for the maximum difference of empirical distributions from two independent samples. Gnedenko succeeded in developing effective methods for obtaining, in

these and other related problems, the exact distributions in the case of finite samples. This cycle of his work received world-wide recognition, because it served as a basis for compiling tables which are valuable in applied statistics.

During the sixties, Gnedenko's interests turned to a new series of problems, namely those of the theory of queues and the theory of reliability. His books on these topics, "Mathematical Methods in the Theory of Reliability" with Yu. K. Belyaev and A. D. Solov'ev, and "Elements of Queueing Theory" with I. N. Kovalenko, are familiar to anyone having an interest in these subjects.

Besides being an enthusiastic research mathematician, Gnedenko is also a brilliant teacher and popularizer of mathematics. His book "A Course on Probability Theory" has been used with universal success, both in the Soviet Union and abroad; it has been translated into all the major languages of the world. The history and philosophy of mathematics is another sphere of interest of Gnedenko. In 1946, he published his popular "Essays on the History of Mathematics in Russia", the only book of its kind to appear in print at that time. For his service to the development of mathematical science, his passionate support of the mathematization of science, and his years of pedagogical work, Boris Vladimirovich Gnedenko was awarded on his 70th birthday the order of the Friendship of Nations.

THE INTERVIEW

Smith:

Professor Gnedenko, could we please begin by asking you to tell us something about your early life?

Gnedenko:

With great pleasure. I was born in Simbirsk,[1] a city on the Volga River. When I was three, the family moved to Kazan. My father hoped to study at Moscow University, but the First World War intervened, and he lost any chance of studying at the university.

Singpurwalla:

Professor Gnedenko, did your father or mother have any influence on your development as a mathematician?

Gnedenko:

They influenced me in different ways. My father wanted me to be a medical doctor. When I started school I had no interest in arithmetic, but by my seventh year of education I began to study mathematics on my own, solving mathematical problems from economics books. My father wanted to know why I liked mathematics. I finished school when I was 15 and wanted to go to a Technical Institute. They were willing to accept me, but told me I had to wait two years because it was the law that you had to be 17 to go to university.

Smith:

Was it unusual to finish school as young as age 15?

Gnedenko:

Yes. I started school at a private gymnasium when I was 6. This was a very good school, but I was only there for half a year. After the revolution, all the private schools

[1]The name was changed to Ulyanovsk after the Revolution.

were closed and I went to a public school which was not very good. I have good memories of the gymnasium but cannot remember anything good about the public schools. In 1923 we moved to Galich, because my father had been advised to change climates for medical reasons. There I was put in the same class as my brother, who was two years older than me. So I ended up graduating two years earlier than usual.

Smith:

So what did you do then?

Gnedenko:

I went to the University of Saratov in 1927. I was given the opportunity to go there by Lunacharsky[2]. He signed a letter to permit me to enter the university. It was not simple to get. Many people at the university thought he was my uncle! The very first lectures there were wonderful for me, and were a great foundation for the future. There was a very good professor of mathematics by the name of Vladimir Goldebier. He had a big influence and was very popular with the students. I also began to read mathematical literature and philosophy. I graduated after three years' study.

Smith:

Were your studies entirely in mathematics, or did they include other subjects?

Gnedenko:

Only in mathematics. There were lectures in psychology and philosophy as well, but these were too formal for me.

Singpurwalla:

But mathematics is very formal too.

Gnedenko:

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[2]A. Lunacharsky, a famous writer who was Minister of Culture and Education of the USSR.

Oh no! There is much more to it. In mathematics the important thing is the ideas, and only then the formalism.

Smith:

What did you do after graduating?

Gnedenko:

One of the professors from Saratov University had been asked to head a department at the Ivanovo Textile Institute. He asked me to join him, so I went and spent four years there. I gave lectures to the mathematics students. At one time I was the only one there, when the professor of mathematics, Professor Boev, and his assistant were both ill and I had to give their lectures. For about a month I was busy every day from early morning to late night. Once I overheard one of the students say about me "How funny he is!" Many years later I met some of these students again, and they were very pleased to see me. While at Ivanovo, I began to study some mathematical questions arising in the textile industry, and this stimulated my interest in mathematics.

Singpurwalla:

I notice that your first publications were about machine failures, written at the Textile Institute.

Gnedenko:

Yes, they concerned mathematical and statistical problems aboout the workings of machines. After four years, I decided to continue my education. We were working on interesting problems which needed a good mathematical education. We were very close to using stochastic processes to address these questions, and about this time Kolmogorov and Khinchin were giving their first lectures about these types of problems. In 1934 I went to Moscow for two months and met Kolmogorov and Khinchin. After that I wanted to study in Moscow and Khinchin accepted me as his student. However, after half a year Kolmogorov told me that he also wanted to take me as a student. So

after that I had two advisers, Kolmogorov and Khinchin.

Smith:

What were they like?

Gnedenko:

Very different. Khinchin was a wonderful lecturer. His language was very literal, very exact, wonderful. After five minutes the students could understand all his ideas. Although he did not raise his voice you could understand every word that he used. Kolmogorov was quite different. He did not like to lecture, and presented his material in a very difficult manner. The students said that they would not want to hear even the proof of Pythagoras' Theorem if it was presented by Kolmogorov! However, he lectured every week in mathematical statistics and always presented new insights. Once I went to Khinchin and complained that I could not understand more than 50% of Kolmogorov's lecture. Khinchin replied "But that is wonderful! I can never understand more than 30%!"

Smith:

I suppose Khinchin was older than Kolmogorov - was Khinchin head of the department?

Gnedenko:

They had a very good relationship. Kolmogorov was professor of mathematical analysis, and gave lectures in calculus and the theory of functions as well as probabillity and statistics. It was in this area that I did my first mathematical work in Moscow, in 1935. Luzin in 1915 had posed a problem concerned with the existence of an orthogonal function system. Gagaev from Kazan had found a solution, but claimed it was unique. I found a second solution. Soon after that, Khinchin went to Saratov as a visiting professor and I visited him there. He posed the following problem: do there exist two characteristic functions which agree on an interval and differ elsewhere? Khinchin believed the answer was no, but I knew something about quasi-analytic functions and

thought such characteristic functions must exist. However, I could not find an example. After two days we met again and Khinchin again asked me if I had solved the problem. I returned to my room and could not eat or drink. I went to sleep and woke up with the solution in my head. I had found an example of two characteristic functions which were the same in one part and different elsewhere. After this I began to study infinite divisibility.

Singpurwalla:

Was this due to the influence of de Finetti?

Gnedenko:

De Finetti began it. After him, some of the main results were due to Kolmogorov.

Singpurwalla:

And Paul Lévy?

Gnedenko:

Lévy after Kolmogorov.

Singpurwalla:

So infinite divisibility was originally due to de Finetti?

Gnedenko:

Yes. It was a short paper on cosmic particles. By this time I was back in Moscow with Kolmogorov, and I submitted two papers on limit laws. In December, 1937, I went into the army, but after only two weeks I was arrested and put in prison for six months!

Singpurwalla:

Wny were you put in prison?

Gnedenko:

Three people made a report that I was a member of a counter-revolutionary

organization headed by Kolmogorov.

Singpurwalla:

What was this organization?

Gnedenko:

It was 1937 and the condition of the country was very bad.

Ushakov:

It was a time when enormous numbers of people were arrested on absurd manufactured charges.

Singpurwalla:

Was Kolmogorov not in the army? Why?

Gnedenko:

Usually professors were not in the army. My case was different, because everyone knew that war was close and privileges for scientists were removed. In prison I was once interrogated for eight days without sleep. Eventually I decided to write a letter. I had a pencil but no paper, but I stuck cigarette papers together and wrote two letters, one to my parents and the other to the procurator. A warden helped send the letters for me. Both letters reached their destinations, and then my parents started working to publicize my case. After another two months I was released.

Smith:

So how long were you in prison altogether?

Gnedenko:

Six months. I was very weak but I went back to Moscow, where Kolmogorov and Khinchin made my rehabilitation in the department possible, against the opposition of some of the faculty. At that time many of the professors were arrested, including

almost all the specialists in mechanics.

Singpurwalla:

Why was that?

Gnedenko:

Nobody knows. They worked in a special institute with the university.

Singpurwalla:

You said that one of the reasons you were arrested was that you were a member of a counter-revolutionary organization. Does that make you a Czarist?

Gnedenko:

It was enough to be anything. All it took was one person to denounce you as a counter-revolutionary. If I had said anything against Kolmogorov, that would have been enough to arrest him.

Singpurwalla:

And were you a counter-revolutionary?

Gnedenko:

Yes, naturally.

Ushakov:

All Russians are counter-revolutionary in some sense.

Singpurwalla:

Oh I see, it's only a question of which revolution. . .

Ushakov:

I should explain Professor Gnedenko's last remark. If he had made, during these six months, the slightest accusation against Kolmogorov, this would have been enough for Kolmogorov to be arrested and maybe worse.

Singpurwalla:

When you went back to Moscow, was this when you started your work on extreme values?

Gnedenko:

Yes, in 1940.

Singpurwalla:

What got you interested?

Gnedenko:

I was reading a paper about the strength of materials when I realized that the use of extreme values in this area was not very good. I finished my paper in 1941, before the war. It was intended for a special edition to recognize Kolmogorov's work in Moscow. However, with the war starting it was not printed. In 1942 Kolmogorov suggested sending the paper to an American journal.[3] Our country had started to have a very good relationship with the United States.

Smith:

So this was by special invitation from the American journal?

Gnedenko:

Yes. Another of my interests started in 1936 or 1937. At that time every student had to write a paper in history or philosophy. Under Professor Yanovskaya, I wrote a 200 page manuscript on the history of mathematics in Russia. However, after I handed in the manuscript I forgot about it.

In October 1941, the German troops were within 10-20 kilometers of Moscow, and all men were mobilized. However, I was turned down when the officers did not believe I had been released from prison. So I went back to my university work and wrote a

[3]Annals of Mathematics. The paper was published in 1943.

paper on the law of the iterated logarithm. By this time Moscow University had moved to Ashkhabaad, and later Sverdlovsk, because of the war. In Sverdlovsk I began working with industry and quality control, both production control and process control.

Ushakov:

We distinguish two types of problems in quality control.

Gnedenko:

I was interested in both, and solved problems of each type in 1943-44.

Singpurwalla:

Were you aware of the work being done in the United States by Shewhart and Deming?

Gnedenko:

Yes, but not all of it. I like to think that my work contributed something to industry.

Singpurwalla:

Professor Gnedenko, could we go back to extreme value theory? Were you aware of the work by Fisher and Tippett?[4]

Gnedenko:

After, after. Before Gumbel's work, I did not know about it. But later I carefully studied all the papers.

Smith:

[4]Some explanation of the following discussion is needed for readers unfamiliar with Gnedenko's 1943 paper. The paper is concerned with limiting distributions for maxima in an i.i.d. sequence. Gnedenko proved that there are only three types of limiting distributions, and characterized the domain of attraction of each. However, earlier papers by Fréchet (1927), Fisher and Tippett (1928), Gumbel (1935) and von Mises (1936) had also obtained partial results. In particular, Fisher and Tippett also obtained the result about the three types, though without rigorous proof. In a curious footnote to the 1943 paper, Gnedenko mentioned this, but claimed to be unaware of the work when he started his own work. We were therefore interested in establishing how much he knew of the earlier papers. Whatever the truth about that, Gnedenko's contribution to extreme value theory was of fundamental importance. For a translation of and commentary on his paper, see Breakthroughs in Statistics vol. 1 (1991), ed. S. Kotz and N. L. Johnson, published by Springer-Verlag.

And Fréchet, and von Mises?

Gnedenko:

Fréchet, Mises, Tippett, Ronald Fisher, I know.

Smith:

Were these papers available in Moscow at the time?

Gnedenko:

Naturally we had these papers. I knew them very well, before my papers.

Singpurwalla:

Which papers?

Ushakov:

All of them.

Singpurwalla:

Including the Fisher paper?

Gnedenko:

Fisher also.

Smith:

But you said you only became aware of it later.

Gnedenko:

I mentioned that paper in my article, and also discussed it in my lectures.

Singpurwalla:

But when you wrote your papers, were you aware of the paper by Fisher?

Gnedenko:

After.

Singpurwalla:

So you independently discovered the three laws. . .

Gnedenko:

No, no, no, no. All these papers influenced me, the Tippett paper, the Fréchet paper, the Mises paper.

Singpurwalla:

Why was the paper published in French?

Gnedenko:

It was prepared in French for the Moscow version.

Singpurwalla:

Why not Russian?

Gnedenko:

The Bulletin of Moscow University required the following procedure. One version was to be prepared in Russian and the other in French, English or German. I gave it in Russian and French. The Russian was not published, but the French was.

Singpurwalla:

Besides Russian and English, do you also speak French?

Gnedenko:

I thought my French was better than my English.

Singpurwalla:

And German?

Gnedenko:

About the same as French.

Singpurwalla:

Can I ask you more about Kolmogorov? He was trained in Germany, wasn't he?

Gnedenko:

He was in Germany for a short time, in Gottingen. Then he went to France and met Maurice Fréchet. He said that he had two teachers in probability, Khinchin and Fréchet.

Singpurwalla:

And where was Khinchin trained, in Russia?

Gnedenko:

Only in Russia. He was a student of Luzin, and his early work was beautiful work on the theory of functions.

Smith:

We have talked about your work in infinite divisibility and extreme values. At what stage did you complete your doctorate?

Gnedenko:

In 1941, for my work on infinitely divisible distributions. At the thesis defense, my opponents were Bernstein, Kolmogorov and Khinchin.

Singpurwalla:

Who had the biggest influence on your scientific life?

Gnedenko:

I think four professors. First, Boev, whom I worked with in Ivanovo. Second, Goldebier. But most of all, Khinchin and Kolmogorov.

Singpurwalla:

What about your book with Kolmogorov? You had a long scientific relationship with him.

Gnedenko:

It was not only a scientific relationship. We were also friends. Kolmogorov proposed that I address him on a first-name basis.

Ushakov:

Kolmogorov permitted him to use the familiar form of the Russian 'you'. This was a rare privilege, only for him.

Gnedenko:

All my life, after 1934, I was close to Kolmogorov. After being in prison, I lived for some weeks in Kolmogorov's home and started thinking about the book. I discussed it with Kolmogorov, but only started writing it in 1945, by which time I was in the Ukraine.

Smith:

So it was originally your idea to write the book?

Gnedenko:

Kolmogorov read my manuscript and supplemented it.

Smith:

But you initiated it?

Gnedenko:

My skeleton. But many good things in it were due to Kolmogorov. Later I prepared a second Russian edition, and I wanted to send it to the USA, or to England, to David Kendall. There are some details that were not covered in the book. The limit laws for sums of a single sequence of random variables are a subset of all infinitely divisible laws. Kolmogorov called this Class L. The background was as follows. Kolmogorov started to write about limit theorems in 1936, and remarked that this class had not been studied. He wrote a letter to Paul Lévy, and in 10 or 12 days received a reply

completely solving this problem. Then there was a second problem, in which the summands had the same distribution. This produces the class of stable laws. However, between these two classes, there are infinitely many others corresponding to random variables drawn from k different distributions, for fixed k. I was interested in this problem. The first solution was by a student in Kiev, Lebedinskaya. She thought the solution had to be a composition of not more than k different distributions. I pointed out a mistake. Her hypothesis for k=2 was studied by Zolotaryev and by my student, Korolyuk. He proved the result for k=2, but the full solution for any k was obtained by a mathematician in Leningrad.

Singpurwalla:

Professor Gnedenko, you were talking about your students. Who were the best of them?

Gnedenko:

In 1945 I left Moscow to go to the Ukraine. I spent four years in Lvov, and eleven in Kiev. There I got students interested in mathematical statistics. In Kiev I had some very good students, Skorokhod, Korolyuk, Kovalenko and many others.

Smith:

Who were the best from this period?

Gnedenko:

I think I started the probability school in the Ukraine. I wanted to give the same emphasis to statistics, but young men prefer probability. I think this is wrong. Mathematical statistics is very important and interesting for me.

Singpurwalla:

For me too - all of us! But let me come back to the question - who was the best?

Gnedenko (laughing):

No one was best! Now my scientific grandson, Sylvestrov, a student of Skorokhod, has a great interest in problems of mathematical statistics. He organizes laboratories in computational statistics.

Singpurwalla:

Where is he?

Gnedenko:

In Kiev. I think the best of my students were Skorokhod, Kovalenko, Domas Szász. There was also a wonderful mathematician from Egypt, Hossain Fahid. We proved together the transfer theorem. However, scientific conditions in Egypt were not good. In 1946 I started work on my textbook in probability. It was published in 1949 in Moscow and Kiev.

Smith:

This was your well-known work The Theory of Probability.

Gnedenko:

The second edition was published in 1954, and after this there were many editions in different countries. In Germany there were eleven editions. In English I know of four editions.

Smith:

I think there is now a sixth edition?

Gnedenko:

The sixth edition is only in Russian, not in English.

Smith:

I think the fifth edition has been published in English.

Gnedenko:

I don't know. But the sixth edition is better. It has new material about history, and

new scientific material.

In 1944, I met Professor Yanovskaya again. She told me I must publish my manuscript.

Smith:

This is the one you wrote back in 1937?

Gnedenko:

Yes. It was a little book of 200 pages, History of Mathematics in Russia. I think someone should prepare a second edition. Many people have talked to me about this.

In Kiev I started a seminar on queueing theory, and many students were interested, both theoretical and applied topics. I began writing the first book on queueing theory, and later took Kovalenko as co-author.

Smith:

So with this book, as with the one with Kolmogorov, the first version was written by yourself.

Gnedenko:

Yes, but I think now Kovalenko is more of an expert in these topics than I am.

From 1957, I worked with engineers to organize a computer center in the Ukranian Academy. This is now a big center of cybernetics.

Smith:

What sort of computers were available in Kiev in the 1950's?

Gnedenko:

In Kiev, there was a wonderful engineer named Lebedev. He built the first Russian computer.

Smith:

The first in the whole Soviet Union?

Gnedenko:

Yes. He had the computer working by 1951. However, in 1956 he moved from Kiev to Moscow and the work of this group was halted.

Singpurwalla:

Professor Gnedenko, have you had a lot of administrative responsibility?

Gnedenko:

I don't like administration.

Singpurwalla:

But you have done a lot of it?

Gnedenko:

For many years I was director of the Institute. I was also academic secretary of the Mathematics Division of the Academy of Mathematical, Physical and Chemical Sciences.

Singpurwalla:

And you are still the head of the Laboratory of Probability? Is that an administrative position?

Gnedenko:

Not much. I prefer scientific work, lecturing and writing. I enjoy working with students. I have had over a hundred doctoral students, of whom thirty are professors in my country or in other countries, and seven of them have the title of Academician. They include Skorohod, Korolyuk, Mihalovich, Grigelionis, Kovalenko and Yustchenko .

Smith:

Professor Gnedenko, in 1960 you moved from Kiev to Moscow. Several years later you published a famous monograph on reliability with Belyaev and Solovyev. How did you start working with them?

Gnedenko:

In Kiev I was working with a group of engineers on medical diagnosis by computer. We had one case in which a heart-lung medicine failed and the patient died. After that I became interested in problems of reliability. In 1959 Belyaev came to me from Moscow.

Singpurwalla:

Was Belyaev your student?

Gnedenko:

No, Kolmogorov's. In August 1960 I moved to Moscow and in 1963 we began our book Mathematical Methods of Reliability.

Smith:

Yourself and Belyaev?

Gnedenko:

And Sovolyev.

Singpurwalla:

Was Sovolyev your student?

Gnedenko:

No, he was a student of a good specialist in complex analysis and number theory, Gelfond. So he has a good reputation in analysis. In 1964 we finished the first draft, and in 1965 it was published in Russian. From 1961 to 1968 I was working on queueing theory and reliability theory. In 1968 I shifted my interest to limit theorems for sums of a random number of random variables. This was motivated by problems in physics, economics and reliability. I first solved a practical problem and then solved theoretical problems. For me, that is the usual way.

Singpurwalla:

You mean, solve a practical problem first and then develop the theoretical.

Gnedenko:

Yes. After this, about 1981, my interest turned to the history of probability. I wrote a little brochure on the subject, and I had a student working on it.

Singpurwalla:

What was the student's name?

Gnedenko:

From Cuba. Perez. Maria Perez.

Singpurwalla:

And she was interested in history?

Gnedenko:

She had no scientific interest. She was interested only in receiving the degree. But she helped my education.

Smith:

Have you written a book about that?

Gnedenko:

In the sixth edition of my book there are some sections on the history of probability.

Singpurwalla:

The sixth edition? Is it only available in Russian?

Gnedenko:

And Arabic.

Singpurwalla:

But not English?

Smith:

I believe the sixth edition was only published in 1988, and has not yet been translated

into English. Professor Gnedenko, you are still very active and writing a number of books. Could you tell us about some of the others?

Gnedenko:

For the past several years I have written one book per year.

Singpurwalla:

For how many hours do you work every day?

Gnedenko:

Now, very few. Four hours a day.

Singpurwalla:

I see your son disagrees with you. (Laughter) He says more than four.

Dmitri Gnedenko:

From five or six in the morning, and during the whole day, he is thinking or working.

Gnedenko:

This year, I wrote a new book for students. It is about what a mathematician is. First, I discussed the place of mathematics in science and society. The second chapter gave some examples of mathematical problems with very limited solutions. The third gave some impressions about contemporary applications. And then about mathematical research, what direction is possible, and some views about pure mathematics, applied mathematics, history and philosophy, and teaching. Without creativity, good teaching is impossible. This year I have also written a short book for school children on mathematics and life.

Smith:

What are your plans for future books?

Gnedenko:

I have big plans. More than I am capable of, I think. Now I am working on three

books. The first is about limit distributions for the sum of a random number of random variables. However, there are some unsolved problems that have held up the work. The manuscript is half completed, and I hope to finish it this year. The second book will be with Ushakov and about reliability. Let me explain why such a book is needed. Our book Mathematical Methods in Reliability Theory is not for engineers. It is a mathematical book and too difficult for engineers.

Smith:

So the book with Ushakov will be more elementary?

Gnedenko:

Yes. More elementary and more practical. The style is to begin with one paragraph about the results, focusing on practical aspects of the problem. I give the solution without proof and discuss the practical consequences. Only after this do I present a mathematical supplement. There are also many tables. I think this is important for putting the results into practice. The third book is also begun, and I want to finish it quickly. It is a textbook on random processes with contributions from Belyaev, Dimitrov from Bulgaria, myself, and Yanev from Bulgaria. Yanev's chapter is good. Some of the other chapters are not good. They will have to be rewritten. I have plans for two more books. The first is a book of memoirs of my life.

Singpurwalla:

So perhaps we should not be conducting this interview and should wait for the memoirs?

Gnedenko:

In my life I have met many remarkable scientists, not just mathematicians but others as well. I worked in Moscow with many fine mathematicians. Almost all of them are now dead. It is necessary to conserve memories about these people.

Smith:

I am sure it is a book that many people will be very interested to read.

Gnedenko:

The second book I plan is for school children - a trip into a mathematical country. The third is a textbook on mathematical statistics. I want to give an informal description of the methods. Here in the USA there are many good books, but they are formal, with a lot of theoretical results without application. I think a practical book should also give an idea of the mathematical conception.

Singpurwalla:

Am I correct in interpreting you to be saying that a very theoretical book is not desirable, but a very practical book with no motivation or intuition is not good either?

Gnedenko:

There are many books in the USA that are not practical. They are too formal, and do not give general mathematical conceptions. But there are many bad books in Russian too.

Singpurwalla:

Can you name any bad American Books?

Gnedenko:

I forget the names! (Laughter)

Singpurwalla:

Is it a countable set?

Smith:

What about good American books? Are there any you particularly like?

Gnedenko:

Gnedenko:

There are many good books. In England there are wonderful books, for example, the books by Cox, I like very much. But these books need good preparation, mathematical and statistical.

I would like to prepare some volumes of Khinchin's work. I prepared for the Steklov Institute a Russian translation of some of his works in German, English and French. After this first volume I want to prepare a second volume, on the theory of functions, perhaps information theory, and perhaps the philosophy of mathematics. The third volume will be about the theory of numbers. Here I must ask a colleague to help as I am not an expert in this area.

Singpurwalla:

You have written many books. What is the motivation for writing so many books?

Gnedenko:

I cannot answer.

Singpurwalla:

Do you like writing books?

Gnedenko:

I write quickly, and it is a pleasure for me.

Singpurwala:

Do you use a wordprocessor or computer?

Gnedenko:

No, no, I use a typewriter.

Singpurwalla:

Do you write one draft or many?

Gnedenko:

One draft.

Singpurwalla:

One draft only. No errors in the first draft?

Gnedenko:

It is necessary to think first and only then to write. At this stage I am almost finished.

There is a second reason why I write so many books. The first of January I will be eighty years old. Eighty is not a good age. I have some ideas I must try to express. Without this I cannot rest.

Singpurwalla:

Professor Gnedenko, in Moscow you have an institute where there is a lot of activity in reliability, with a lot of engineers. Can you say something about the interaction between engineers and mathematical statisticians and probabilists? Is it good? Is it active?

Gnedenko:

In 1961, after my return to Moscow, some engineers and I organized a Moscow seminar in reliability. It was a very good group. It included two engineers, Sorin and Shor, and a very good economist, Shukhgalter. All three are dead now. But it was a very successful seminar with 800 participants, engineers, academicians and mathematicians. Many people came from other cities and many consultations with engineers resulted. However, the last five years, the Gorbachev years, were very bad for the seminar.

Singpurwalla:

Why?

Gnedenko:

Now the interest in quality control and reliability is low. Now I think our industry

works only at 60% efficiency. Production is the priority, and quality and reliability are not asked about. This is very bad.

We have wonderful intellectual power, and I am writing a book about complex systems with a group of specialists in the machine industry. This will be analytical material about reliability and quality control, and about ecological problems in industry. These problems are most important for our country.

Singpurwalla:

Professor Gnedenko, you said that you met a lot of mathematicians in your life. Did you meet De Finetti?

Gnedenko:

Yes, in Italy. I remember this with great pleasure. We had a discussion about personal probability.

Singpurwalla:

And what do you think of it?

Gnedenko:

I think he was wrong. Science must not be personalized. Science must be objective. Personality is very important for the development of science, but science itself must be objective. Its results must change when we learn more. I had many discussions about this with De Finetti, and with Professor Savage, a wonderful man. He was very learned and modest. I think De Finetti and Savage were most important.

Smith:

De Finetti's books on the theory of probability were translated into English; were they translated into Russian?

Gnedenko:

No.

Smith:

Are they known in Russia?

Gnedenko:

It is an interesting idea, but impossible at the moment. Paper used to cost 700 roubles for one tonne. Now the price is 11,000 roubles per tonne and the manufacturers demand payment in pounds or dollars. Editors do not have this.

Smith:

Is this creating a major problem for publication in the Soviet Union?

Gnedenko:

Yes. We have very good editors in the Nauka Company in Moscow. I have had good relations with them for 50 years.

Smith:

This particular problem about the shortage of paper; how long has it existed?

Gnedenko:

Always serious, but especially in the last two years.

Singpurwalla:

Professor Gnedenko, since you have difficulty with personal probability, you must have difficulty with Bayesian statistics also.

Gnedenko:

I think every method has its possibilities. But every method its limitations also.

Singpurwalla:

I agree.

Gnedenko:

And the Bayes method has limitations. But in practice, we must solve serious

problems, and it is best that we use all possible methods. I think the Bayes method has good possibilities and this method must develop, but it is not the only one.

Singpurwalla:

So you think that the Bayesian methods with objective probability are acceptable, but Bayesian methods with subjective probability are not.

Gnedenko:

It is always necessary to state the assumptions. Subjective probabilities, if necessary, can be made objective.

Singpurwalla:

Are there Bayesians in the Soviet Union? Belyaev has been writing Bayesian papers.

Gnedenko:

Yes. Many Russian statisticians use Bayesian methods. It is impossible not to use them. They are important methods.

Singpurwalla:

Have you used them?

Gnedenko:

Yes.

Singpurwalla:

Have you written Bayesian papers?

Gnedenko:

No. I have given my students Bayesian lectures, but I give other methods also. Every method has some difficulties.

Singpurwalla:

What about Neyman-Pearson and Fisher methods? Do they have difficulties?

Gnedenko:

Yes.

I would like to make some comments to supplement our discussion. In our country, I think, there is good work in probability and in random processes. We have good investigators in both subjects. But we need to develop mathematical staitstics also. You young men who are interested in statistics, send your graduate students to us. At the moment there are big discussions going on in the Soviet Union. The Soviet Stalinistic state is no good. The United States is better.

Singpurwalla:

One comment I'd like to make. When we started this interview, you said that your father wanted you to be a doctor, but you became a mathematician. Your son is a mathematician. Did you advise him not to do mathematics?

Gnedenko:

He understands applications in psychology very well. It is impossible to do good work in mathematics without applications.

Singpurwalla:

So Dima, you can answer this question. Did your father have an influence on you?

Dmitri Gnedenko:

Yes, of course.

Singpurwalla:

And does he continue to have an influence?

Dmitri Gnedenko:

Yes. He was my first and most important teacher. But I had others of course. Professor Soloviev, and in mechanics, Professor Zhuravlev, because I began my work in mechanics. But first and forement is my father.

Singpurwalla:

Have you and your father written a paper together?

Dmitri Gnedenko:

Yes, we have some articles written together, and we plan further articles and books.

Singpurwalla:

On reliability?

Dmitri Gendenko:

Not only reliability.

Singpurwalla:

If you write a book on reliability, make sure it is Bayesian!

Smith:

How would you view the present state of statistics in the Soviet Union?

Gnedenko:

There are good statisticians. Kagan was very good, but he is now in the USA. Zhurbenko worked in statistics, in time series, but he is more of a probabilist than a statistician. There are many others, for example Orlov. He works now on the committee of standards.

Smith:

What about Chibisov? He is well known in the West.

Gnedenko:

But his work is closer to probability. Statistics is secondary.

Smith:

Is there much applied statistics in the Soviet Union?

Gnedenko:

I don't know good applied statisticians. There are some in Poshkin, Kazan and Leningrad, but they are middle level. I think we need a statistical society to develop practical applications. However, for this it is necessary to have good social conditions. They are not good at the moment. Statisticians can help improve quality in industry. Without statistics it is impossible to make progress in demography, in experimental science, in industry, in economics, and so on. But when all production is accepted immediately without questions about quality; it is not good.

Singpurwalla:

You mean production without good quality is not good.

Gnedenko:

Not good.

Singpurwalla:

But the Japanese have big production and good quality.

Gnedenko:

Yes, it is possible, but difficult. It is necessary to make more and better.

Smith:

Professor Gnedenko, we would like to thank you for talking to us. We hope you enjoy your visit to the United States.

Gnedenko:

I hope we can invite you to Moscow, but now is not a good time. We must change our system, remove the party and construct a new bureaucracy. Without this it is impossible.

Singpurwalla:

Well, our universities are becoming very bureaucratic. They want memos for

everything. Well, Professor Gnedenko and Dima, thank you for making your time available. We hope you like Washington.

Gnedenko:

Thank you very much.

POSTSCRIPT

The following material has been provided by Professor Igor Ushakov, who has been a personal friend of Gnedenko over the last 30 years and has assisted him in many activities of the Committee of Standards of the USSR.

Professor Gnedenko is not only an outstanding mathematician and an excellent teacher but is also an energetic participant in different kinds of public activities. I would like to say a few words about aspects of his personality that have not been covered in the interview.

In the early sixties Professor Gnedenko established a program of seminars in reliability at the Moscow State University. It brought together people from academia and industry who were working on different aspects of reliability and quality control, and gave birth to many a specialist in reliability in the USSR. Professor Gnedenko's wonderful ability to surround himself with persons of different abilities and to inspire them to do research contributed greatly to the success of this endeavor. Later on he established a special Consulting Center in Reliability and Quality Control at the Moscow Polytechnic Museum, a traditional center of enlightenment and intelligencia. This center has been in operation for more than a quarter of a century, and is responsible for developing what one may call the Soviet School of Reliability.

Professor Gnedenko's scientific generosity is reflected in the fact that he has been an adviser to more than 100 PhD's, many of whom have become members of the All-Union and Republican Academics of Sciences. An incident not known to a wide circle of people and briefly touched upon in the interview, pertains to the episode of his imprisonment. Neither Gnedenko nor Kolmogorov talked about it. At a banquet following Solovyev's defense of his dissertation, Kolmogorov raised a toast to Boris Gnedenko as an honest and brave man. When I privately inquired as to the reason behind this toast, Kolmogorov answered with a slight smile: "In a very difficult time

Boris suffered torment to save his friend." At that time I did not know who the friend was. It was only later on that Natalya Gnedenko, Gnedenko's wife, told me that the friend in question was Kolmogorov himself. However, she added, "Please never say this to anybody, because Boris and Andrei don't like to advertise this and show the public their deep feelings for each other."

Gnedenko is a real representative of the Russian intelligencia. He reads a lot of fine literature, and knows much poetry. In his library you can find a great number of the fine pieces of art from all over the world. He does not like modern art but is not offended by others who do. This tolerance is one of his main virtues. His collection of musical recordings is tremendous. He likes "classical classics": Bach, Mozart, Beethoven, Tchaikovsky, Rachmaninov. There is also a collection of Orthodox Russian Church liturgy. And of course splendid Russian songs.

Professor Gnedenko is an excellent storyteller; he is soft spoken. However, he also possesses a wonderful ability to listen to others. All this makes a relationship with him comfortable and simple for anybody. A combination of scientific renown and human qualities makes Professor Gnedenko one of the foremost academicians of recent time.