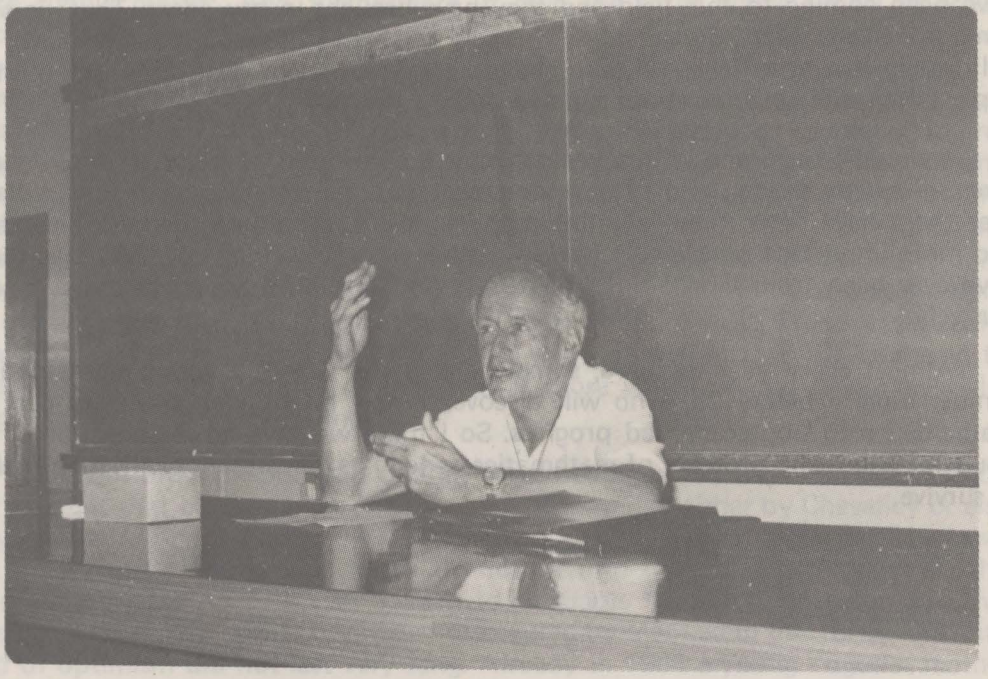

(Courtesy *L. Chen*)

Laurent Schwartz (1915 –), professor at the *Ecole Polytechnique* and University of Paris; contributed to analysis and its applications to mathematical physics; was awarded a Fields Medal in 1950 by IMU (International Mathematical Union) for fundamental work on the theory of distributions.

FRENCH UNIVERSITIES AND GRANDES ÉCOLES

L. Schwartz

The subject is a very difficult one. I think I shall only treat a part of the subject. What is higher mathematical education and, in particular, what is the formation of mathematicians and what is mathematical education for people who will not become mathematicians? These are completely different subjects. I shall try to treat a little of each of them.

In our high schools, there are several type of baccalaureats; some of them are scientific baccalaureats, some are baccalaureats of humanities. I shall only examine the scientific ones because the others do not train mathematicians or those doing science. For the scientific baccalaureats, we now teach more scientific structure, linear algebra and logic than in my time. When I was a student in high school, we heard nothing about modern concepts. You must understand that, for instance, I ended my faculty studies at the age of 22. I did not know what was a group or field or vector space. And, of course, I did not know what was a distribution. Nowadays people in high schools know a little of analysis, a little of exponential and logarithmic functions, and even know something about complex numbers. We did not know complex numbers at that time. We were taught a lot of geometry, geometry of triangles, geometry of quadrics, geometry of tetrahedra and so on; we were very well trained in geometry.

Now they do what is called modern mathematics. By the way, there has been some abuse. Modern mathematics is, in some way, a catastrophe, not only in France but almost everywhere in the world. In the United States, it is the same – many teachers of secondary schools went through modern mathematics very fast. They really believed that modern mathematics is set theory and set theory and set theory. By the way, it is just a modern tool and modern mathematics is not just that. So it shows that we have in France and other countries a crisis in the teaching of mathematics in secondary schools. Now they do not know geometry at all. We knew too much geometry. We used to solve problems which have no real interest in mathematics in general, but we have some intuition in geometry. Now they know the modern structures, they know vector spaces, but they have almost no geometrical examples, so they make fantastic mistakes in geometry. And I think this is universal both in developed countries and under-developed countries. So we have to introduce a little more geometrical intuition in secondary schools. Apart from that, the modern notions of groups, rings, fields and linear spaces are very useful and a good manipulation of set theory is also indispensable. For instance, the quantifier "$\forall x, \exists x$ such that" (for every x there exists an x such that) is a thing which is not completely understood when we were in high school and, of course, it is absolutely indispensable. So we have a novel way of teaching which ends in a baccalaureat, the last baccalaureat being at the age of 18 or 19.

I want to speak about something which is not French but which could be useful to you all here. I have been in the Soviet Union in 1964. They have special high schools for mathematicians and that I found to be a very good idea. It could be

very useful, especially in those countries where there is no tradition. I saw such a special school and there are two or three. In each one, there are about 3000 students. They are selected without examinations, reasonably selected. They have the same problems as those in other high schools for everything but mathematics. In mathematics, their teachers are university lecturers, not teachers of secondary schools. Therefore they teach mathematics at a much higher level, not so much learning more things but solving hard problems. For instance, people like Gelfand and Kolgomorov, in addition to their normal university duties, give lectures every week in such high schools. I attended a two-hour lecture of Gelfand for two or three hundred people from the age of 15 to 18, in which they solve together various hard problems – hard for young people. For instance, how many regions are determined by a triangle in a projective plane? The projective plane is not an ordinary vector space. One has to think about it. What are the commutative fields with at most 10 elements? And they thought about these problems freely. They also gave problems, for instance, to young people of about 15 or 16. They were given the definition of a continuous function. Then they proved that the product of two continuous functions is continuous without any indication. The best student found the solution in eight hours. For that you will have to have new ideas. So I found that extremely remarkable.

We tried to introduce that in France, and university lecturers in the University of Paris gave special courses to students of high schools during their last two years of high school on various subjects; for instance, finite commutative groups, some algebraic number fields, Euclidean division algorithm for algebraic number fields, some analysis, Stirling's formula, Euler's formula for polyhedra. So we gave a lot of lectures of this type and we generated great enthusiasm among two or three hundred young people who attended the lectures during their holidays instead of playing football. It has been very exciting and we did that in a purely voluntary way without any governmental support. But we could not continue and it does not exist anymore, and I regret it very much.

I saw it in other socialist countries, in Cuba and Hanoi. In Hanoi, for instance, it still exists. They have specialists for about 300 people. University professors play the role of teachers for these students from the age of 16, and several of the best mathematicians in the Soviet Union or in Vietnam come from these special schools. Unfortunately, it has been discontinued in the Soviet Union. As you know, there is anti-semitism in the Soviet Union. Practically no youth there can enter the University unless they have exceptional qualifications. Since people in these high schools have quite exceptional quality, a Jewish family will try to push their children into these high schools so that they could enter the university. But because of the anti-semitism, these high schools have been cancelled. And that is probably very bad for Russian universities. But it still exists in Cuba, Vietnam and maybe one or two socialist countries in Eastern Europe. And I do not see any analogous thing in the advanced capitalist countries. I mention these stories because I think here in Southeast Asian countries, it is so difficult to form a mathematical tradition. Maybe you could try by creating such schools which will be under the responsibility of the universities. After all, the universities are for people doing science, I mean people doing physics, chemistry, mathematics, biology.

There are about several hundred thousand students presently in the universities and they normally spend four years there. In the first two years we usually have calculus, even for people who will not be mathematicians. They have to learn convergence, uniform convergent series, limited or unlimited expansion, the formula for $(1 + x)^n$, where n is not necessarily an integer, e^x, log $(1 + x)$, elementary integrals, computations of an integral, just a little topology, I mean something about convergents, maybe a little bit about metric spaces, and something about functions of one complex variable. The course goes much faster than when I was young; I did not even learn complex numbers in high school. Now they learn complex numbers in high school and functions of one complex variable in the two first years of university.

It has been the custom that all university professors, whatever their qualifications, must be able to teach mathematics. So many of the best French mathematicians are teaching in the first two elementary years of university. I did it myself and I think it is a good thing. We have very good mathematicians as teachers in these two years. On the whole, it is quite successful. I shall make two remarks. First of all, the level is going down. The level of people having the baccalaureat and entering the university is going down. Slowly at the beginning, but now very fast. That is a grave problem which is not only French. I was recently in a plane and they also said that high school students entering the university are of a very low level. Well, we do not know exactly why. It is easily said that because of the demographical problem, there are more students coming from middle and lower classes of the population in which the cultural tradition is not the same as that in cultured Paris. That is a simple explanation. But I do not really think it is a good one because in the years '67, '68, '69, they already have this demographical increase and the level still remained the same. The level started to go down several years after the demographical expansion. So I think it does not come from that. Where does it come from? It is slightly the same in the United States. I wonder if you have the same problem here.

It may probably come from the methods of elementary teaching in high schools. I mean the level of teachers in high schools has decreased. It has decreased because the number of people going into engineering or research is increasing and therefore the teaching profession in high schools is taken by people of a lower level. For instance, when I was in high school we have in our school a very brilliant teacher. But now the general level of teachers in secondary schools is lower. So that could be an explanation. Maybe the so-called modern mathematics plays a role in it. You see, they know the definition of a vector space, but they do not know the examples. They know what is a field and the only example they have is the rational field, or the real field, or the complex field. They learn by memory what is a field; they do not know the interesting examples. So they are unable to solve problems.

Another possible explanation is that there is a kind of revolt of students against science. This phenomenon exists everywhere in the world; in particular, France. They do not believe anymore, as they did ten years ago, that science will solve their problems. There is an increase in non-scientific belief so that they are not especially interested in science. We see a strong diminution of motivation for science. However the exceptional people always do science and we do not see any diminution of the level of future mathematicians. When we examine the number of very gifted

mathematicians, we are, as Dieudonné says, full of hope. It is, in fact, increasing, but for the majority of the people the level is going down. We do not exactly know what to do about that. For instance, let me give this example. At the end of the first year of university, the following answer is frequently seen: in order that $ab < 1$, it is necessary and sufficient that $a < 1$ and $b < 1$. And I saw the same thing in California. So there exists a problem. It will be interesting to know whether it is the same here.

The second thing I want to mention is that for gifted people, the way we educate them in mathematics in secondary schools is fantastic. We always give an abstract teaching. French people are abstract people; they like to reason in abstraction. In the past they did humanities and philosophy. Now they are doing mathematics but very little experiments. Our excellent mathematical preparation in high schools for gifted people gives to France one of the highest mathematical levels in the world. But for physics, biology, chemistry, engineering, it is not the same. In high school we neglect our experiments; we have a contempt for them. In British, German and American schools, they are much more practical, much more pragmatic, and they consider experimental results as extremely important. In France, it is not so. I remember, when I was young, in a problem of physics, instead of finding a result of 10.4, I found a result 1.4. And I thought, "The teacher has been very severe with me by giving me a very bad mark for that. He is unjust because my method was correct. There was just a mistake in the calculation." This attitude is quite general among French mathematicians. They have a contempt for practical results. They do not see that if you build a bridge, 10.4 and 1.4 do not give the same result. But I must say that the education in high schools and in the universities is fantastic for future mathematicians. You see the brilliant results in the fact that the French mathematics school is among the best in the world.

It is clear that abstraction is increasing everywhere. It is novel in some ways because all the sciences (physics, chemistry, biology) are becoming more and more abstract. In biology the study of the DNA and the code for reproduction is much more abstract than to just describe what is a cat, what is a lion. So this is novel. In the same way, there seems to be a difficulty in many countries in finding engineers. For instance, in Vietnam, because of the abstract training in the special high schools, mathematicians in the universities have a tendency to teach abstract things to young people so that all of them are doing research in number theory or algebraic geometry and they neglect completely things which have applications.

After their high school students go through two years of university and then a second cycle which leads to the "Licence" or "Masters". This is a more serious stage and there are a lot of licencées for the various professions. If you want to be a mathematician, then you take a Masters in mathematics in the third and fourth years. If you want to be a chemist or engineer, then you take a Masters in applied mathematics or in physics, and so on. Here there is a separation according to your future profession. In mathematics, it will depend on the university; you may have to take 8 units or 4 units. For the mathematics Masters we teach a lot of good and interesting mathematics. We teach general topology, including compact spaces and so on, linear algebra, sometimes multilinear algebra, differential equations, a lot of integration theory, Lebesque integration, distributions, Fourier transform,

convolution, a bit of partial differential equations, maybe a little Banach theory, topological vector spaces. Among the units there are optional units which may be in algebra, geometry, theory of numbers, partial differential equations, and so on. Thus a gifted person who has obtained a Masters will have some good foundation. These last approximately four years – two years of elementary calculus and two years of Licence or Masters.

What happens after this? If you want to become a mathematician, you have to spend approximately five years to obtain a Ph.D. – between four to six years. As you probably know, the level of the French Ph. D. is one of the highest in the world. We have in France between 50 and 80 Ph.D.'s a year and they have between 1200 and 1500 a year in the United States. They are not better than us essentially. Their population is only four times ours, so it means that on the average their Ph.D. is of a lower level. In France our Ph.D. theses are of a very high level. A candidate who is not very gifted sometimes will not complete his thesis. In the United States a lot of mathematics Ph. D's are employed in industry. However, we do not train our Ph. D.'s for industry. Some of them do not become mathematicians and so become lost in the system.

Moreover, I must say that in the United States or the Soviet Union, they are closely supervised. If somebody wants to work with, say Nirenberg or Smale, he must be registered for that. He will be given a subject, and usually the professor has much to do with the subject and he helps the student very much. And this has always been a topic of discussion. Many professors practically do their students' Ph.D.'s. There was even a cartoon in which a student asked his American professor, "Well, at what point are you now?", and the professor answered, "It is sufficient that I do your Ph.D. Please do not torment me by asking me all the time." So they are very closely supervised. They are almost sure to complete their Ph.D. They have been specially selected, but their Ph.D. may be of a very high level or a very low level. There are Ph.D.'s of very low level from mediocre universities. The American Ph.D. system is good for people from the third world. If a country of the third world sends a good mathematician to the United States, he will be sure to get a Ph.D. Maybe the Ph.D. will be very good, maybe not. In any case it will be useful. If you send somebody to do a Ph.D. in France and if the person is gifted, it will give a fantastic result. Maybe better than in the United States. But if he is not gifted, then there will be some three years lost and he will return to his country without a Ph.D. Our system has great advantages in preparing very good mathematicians but at the expense of people who do not become mathematicians. But what about those who just wait in the universities for four years and do not become mathematicians? It is probably the greatest tragedy of our system that there is absolutely no relationship between the university and industry.

The university ignores industry and industry ignores the university. There is a mutual distrust. The university is afraid of industry and we say that we are free people whereas in industry there are no free people, and that if we have a relationship with industry, they will impose their methods on us. This I think is completely false. It is a complete mistake. Although they may introduce more practical methods for professional training, the university is in such a free environment that they need not be afraid of any external influence. Conversely, industry believes that all these

people in the university are radicals or leftists and that it is very dangerous to recruit them and therefore it is better not to have any relationship with them. I think that this is also completely false. It is true that we in the university are very free and liberal. We are trained in very liberal things. However, people who go into industry work and they do not just sit and talk. So there are many congresses or colloquia on industry – university relationships and many good resolutions are passed and carried out. I think, in Germany, England, Japan, United States and Russia, these deficiencies do not exist. It is one of our major problems. Not only do our students have great difficulty in finding jobs; they have no professional training at all. Knowing what is a compact space is not very useful. So they cannot find jobs. There is a lot of unemployment. Even for Ph.D.'s. But in Germany and United States, Ph.D.'s are employed everywhere in industry. Recently in a plane, I met an American industrialist in petroleum engineering. He has a factory of about 30,000 workers and they employ 300 Ph.D.'s. I do not know of any French enterprise which employs 300 Ph.D.'s. Our French Ph.D.'s can only find jobs as university teachers. So we reproduce ourselves and we do not produce for the nation. On the other hand, it is absolutely sure that French industries are not competitive enough. Comparing French industry with German, Japanese and American industries, we have a lot of difficulties concerning competition because our industries do not employ people with a high scientific level. So that is a tremendous problem, a very important problem for the whole nation, and you must know that you should not do the same here. We have excelled in certain things in France but there are also bad things. It is absolutely sure that, whatever the mutual distrust and differences in habits, the university and industry have to be strongly related.

That is the first system, the system of the university. Another different system is called the "great school" (*grande école*). The great schools are selective with competitive examinations. In other countries, entrance into the university is by selection, but not so in France. But entrance into the great schools is based on competitive examinations which are of a high level. You see, for instance, if you take the universities in the United States, they have competitive examinations. If you take Moscow University where they have about 20,000 students, they have a competitive entrance examination. Our universities have no competitive examinations but our great schools are very competitive. There are two supplementary years in high school which are called the "Mathematiques speciales." They are also called "moles" because moles live and work under the earth, and it means that you have to work in this way in order to be able to enter the great schools. These two years of preparation are extremely intensive. Most of the French mathematicians have gone through these two years of preparation which are much more difficult than the first few years of university. Since the university is not selective, the first few years of university have to be modelled on the average level. And the average level is low. On the contrary, the two special years in high school are prepared by very good professors and are very competitive. The level is very high so that you immediately see the difference. If I see a young mathematician in the university, I ask him various things and I can immediately see whether he went through the first few years of university or the two years of Mathematiques speciales. I do not know whether this should be imitated or not. Anyway, in the United States, it corresponds to the first two years of Honours studies. After these two special years they sit for

several competitive examinations according to what they want to do. They may then choose a great school in chemistry, a great school in agronomy, a great school in engineering. There are a lot of great schools and approximately 8000 people enter these great schools every year. Among 150,000 people 8000 have the baccalaureat. For instance, one great school may take in about 70 people, another one 30 people, another one 50 people. You have to be among the best in the competitive examination.

There are two types of great school which deserve special mention. One is the "normal school" and the other is the "polytechnic school". The normal schools used to train secondary school teachers and offered the best preparation for secondary school teaching. This has now changed completely. The normal school now prepares people for research. There are normal schools in mathematics, physics, science and humanities. The number of normal schools is now probably 40. It was 20 when I was young. There were at that time 400 candidates and 20 were selected for mathematics. I was just the twentieth one. They are among 40 people, 20 in mathematics, 20 in physics and biology. These schools depend on the universities for higher education in the sense that students from these schools attend the lectures in the university and they have to pass the examinations of the university for the Licence or Masters. Moreover, there are special courses and special seminars for them. One can say that a person who passes out of a normal school is very well trained and becomes a good mathematician or a good physicist. A majority of French mathematicians come from normal schools. But there are also very brilliant ones who are not from the normal schools. It would have been so in my case because I was the 20th. With a difference of one position I would not have been in the normal school. It is neither necessary nor sufficient, but statistically it is a good thing. The normal school deserves its reputation in that it does the job for which it is meant. It prepares gifted people to become future scientists. Of course, it may happen the other way. They may go through the two years of Mathematiques speciales and then not go into any great school but into the third or fourth year of the university. Among French mathematicians how many are there who had just the four years in the university? Very few. Most of them had the two years of Mathematiques speciales, and then either normal or polytechnic school. But there are exceptions: for instance, Grothendiek, a very good French mathematician, has been to the university only. So there is no rule, of course. And one does not get any privileges. I do not know of any mathematician who is glorified for having been a former student of the normal school. We do not write it on our visiting cards and nobody pays any attention to it.

The second type is the polytechnic school. I am a professor in such a school, and many of you may be much intrigued, very much puzzled, by "what is a polytechnic school?" It is even more difficult to describe a polytechnic school. All the great schools were formed during the French Revolution, or just a little before and just a little after. Normal schools, polytechnic schools, mine and bridge schools, chemical schools and so on were formed mainly by the Convention in 1792. The aim of the great school was the following. Most of the people who became scientists and engineers came from the aristocratic class and it was necessary to have special schools to train the people to become military men, engineers and scientists. For this, they invented a special school with a strong selective process. It was quite an

unusual development among the European countries. So imagine these great schools and polytechnic schools being created in1792 by the Convention of the Republic, and in the beginning they have very funny ideas. Of course, all revolutions do that. They believe that in order to form good people, it was just necessary to take them from the group of revolutionaries, not among people gifted in science. So in the beginning they took into the normal schools and polytechnic schools sons of revolutionaries and it was a complete catastrophe. Later these people were completely ignored and a new recruiting method was established. But no competitive examinations. In the first place, there were professors in normal schools who made a tour of France to pick out gifted people from the high schools.

It is sure that the polytechnic schools gave to France the best engineers in the 19th century, and maybe the best engineer in Europe. So that was a very good system. The normal curriculum for polytechnic schools is the following. You have two years of Mathematiques speciales. After that you have two years in polytechnic school, and then you have two years in a "school of application" which is any school of engineering. So the training of engineers is also theoretical. In the two years in polytechnic school, we only teach the basic sciences. They are very intensively trained. They learn a lot of things. In the polytechnic schools they learn mathematics, physics, chemistry, mechanics and economics. They have a lot of things to do and in a very rapid way. Presently I give a course on Hilbert spaces, which contains definitions of Hilbert spaces, orthonormal bases, the theory of compact operators, the theory of the index of an operator and applications to integral equations and to the Sturm-Liouville theory of equations. All of that in 13 lectures. So it goes very fast. They do quantum mechanics in 13 lectures. So they do a lot of things. In principle, they have a very good foundation. Then they are classified and according to their classification (there are 300 candidates every year), they choose a "school of application" or a profession. I must say that the most difficult task in my life is to give a course to 300 people. I think Lions can give me a confirmation that he can easily give a lecture, but to give a lecture before 300 people among which 20 or 30 people will be speaking together, creating much unbearable noise in the room, is a very difficult task. It is the only difficult task in teaching that I have ever met in my life.

So we give very interesting courses to very gifted people, and among the young polytechnicians, there are some very fantastic people. And a lot of them are doing research. I mean every year there are some polytechnicians who go into research, and many of the good French mathematicians, including some of those who are here, come from the polytechnic school. Others become engineers. If you want to be, for instance, an electrical engineer, then the "school of application" to which you will then go is a school of electricity or electronics. We only give the basics. But we also give seminars in humanities. We teach them things which are not scientific things at all. Humanities mean everything. We have seminars on all the interesting subjects in humanities. We have seminars that make a person aware of, for instance, economic problems, geographical problems; I mean, they have to choose from subjects such as problems of the Third World, modern China, capitalism, socialism, Marxism, Islam and Arab countries, problems of men and women in the world, the history of Venice in the middle ages, the chemical and physical exchanges in the brain, trade unions, the social conflicts in France, the rights and limitations of

enterprise, and so on. So they learn a lot of things which they find very interesting: architecture, musicology, philology, painting, poetry. So they are fantastically trained: the training is one of the best in the world.

There is one tremendous advantage: it leads to a kind of Mandarin system. The training of a Mandarin is very classical here and has a tremendous advantage in that it spreads the culture among the people because there are people everywhere in the country who try to become Mandarins. There are people in the villages who have some knowledge of the sciences, literature and so on, because they are in the neighbourhood of people who try to become Mandarins. In France when a person becomes a Mandarin it is for life, and that is an exorbitant privilege. And when people have privileges, it is usual that they do nothing afterwards. If there is no relationship between the university and industry, there is a very strong relationship between industry and the great schools. During the year students of great schools visit the electronic industry, petroleum industry, nuclear energy industry.At the end of the second year, their training is not finished. They have to spend two years at a "school of application". Then they get their jobs. There is no unemployment among the polytechnicians. And they know it. The people at the university know it. So people work enormously and the competition is fantastic. The title of being a former pupil of the polytechnic gets you a job. There are a lot of industries who just recruit former students of the polytechnic school just to say that they have polytechnicians in their industries. This gives them tremendous advantage. People know that, and the absence of motivation is, I should say, scandalous. We have crises about that; we have problems about that. We give excellent courses to people who are not especially gifted, and these courses have nothing to do with their future jobs. If they learn mechanics, mathematics, physics, chemistry, it should have something to do with their future profession.

In most countries, in France too, administrative jobs offer more money and more prestige than a scientific or technical job. So if industries recruit students from the polytechnic schools, it is not to employ them in manufacturing or engineering, but just in management. So if they practise management, what is the use of a Hilbert space? For instance, some students will come to me and say, "Sir, I don't know what to do because I am not interested in mathematics. What can I do when the courses in mathematics are so heavy?" I say, "Well, maybe you will be interested in physics and neglect a little mathematics, and work in physics." "No, sir, I am not interested at all in the sciences". And it is a scientific school. So what to do? I tell him he has just made a mistake. But it is not true. They will be employed somewhere. And they will be employed in an office or a ministry just to practise management. Another one asked me "What can be the use of Hilbert spaces?" And I say, "Hilbert spaces are used in all the sciences." Maybe not in biology, but in chemistry: the use of the representation of finite groups of Hilbert spaces. They use Hilbert spaces in mechanics, in physics, in applied mathematics, and so on. And I once met two engineers in a train. I was facing two engineers, very practical engineers, reasoning in terms of francs and dollars but they used Hilbert spaces.

"Well, well, well, if I am a future director of the railway in France, what will be the use of Hilbert spaces?" It is true they have this kind of mentality which does not exist at all in the United States, in Germany, or in Japan, where a person who

will become a director in an important industry has to be, for a long time, a worker, an engineer, in these industries and be a very competent one. For instance, an engineer from the United States whom I met in a plane told me that in his factory of 30,000 workers, there were 300 Ph.D.'s. Moreover, he told me he was the deputy director of the enterprise and they had a lot of scientific knowledge. They are doing a lot of mathematics, informatics, mechanics. He solves equations. He starts with particles in porous materials. He had in the plane a computing machine of this size, not a small one, and I saw him solve these equations. He solved equations starting from matter and particles and ending with the dollars. They do that. He told me, "When I solve equations, I go to the field to see when these equations are correct. If they are not correct, of course, I do not solve highly technical problems. But we have 300 people who are Ph.Ds. So I give the problem to them. But I must be competent enough to see what is the problem to be solved."

In France, the director of an enterprise has to know human management, relations between workers and engineers. He has to know something about the sciences and their techniques, but very little. And that is a great defect of our industries, and the organisation of polytechnic schools suffer very much from that. Some people of the polytechnic schools go to science. These are very good people, very well-trained people, and if you compare those who become mathematicians, say people of the university with people of the normal school and people of the polytechnic school, we do not see significant differences between them. But we have a problem.

I have given you the main features of French education which is excellent for the training of mathematicians but which is not as good for the training of engineers and other people. We suffer from some serious problems though we also have very strong advantages. It is sure that France is a country of very old classical culture, and of very strong scientific culture. We have a very high level of culture. We are able to export our culture around the world, and the French people are known throughout the world for their high quality of research in our sciences and our mathematics. But we also have deficiences and we know these deficiences and I think it is good that you know them.