

AN INTERVIEW WITH JEAN-PIERRE BOURGUIGNON

I am not familiar with the school system in France but from your CV it seems that your first degree was an Engineering one granted by l'École Polytechnique. Is that so? What made you change your mind and realize that you wanted to be a mathematician? An influential teacher?

The higher education system in France is peculiar. It is split between on the one hand *Grandes Écoles* and the so-called *Classes Préparatoires* leading to them, and Universities on the other hand. Most of the *Grandes Écoles* are engineering schools, with the notable exception of the *Écoles Normales Supérieures*. The *École Polytechnique* was created right after the French Revolution to give engineers some time before studying technical subjects to get a more basic training in fundamental sciences. The school has kept this theoretical bias, and at my time its curriculum offered a substantial exposure to mathematics. Being a student at *l'École Polytechnique* was for me a formidable opportunity to meet some exceptional mathematicians: Gustave Choquet, who was my Analysis teacher there, and Laurent Schwartz, with whom I extensively discussed curriculum reform.

I date my definite attraction to mathematics from the time I was preparing the baccalauréat. The math teacher I had then suffered a poor reputation from the point of view of pedagogy but for the first time in my life I was confronted with a real (mathematical) challenge. I should probably say that in my high school years I had the great fortune of having the same (excellent) math teacher for four years out of six. He was very strict and thorough, and had the great inspiration of using quicker students to help slower ones. At no moment though, did he trigger in

me the desire of becoming a mathematician, or even a scientist. At that time I was much more attracted by humanities, or even foreign languages. From this experience, I would be tempted to draw the lesson that it is very important to offer real challenges to young students. A uniform and smooth curriculum is not likely to be what will turn young minds on.



Jean-Pierre Bourguignon

You belong to the Class of 66 at l'École Polytechnique. In the middle of your degree you were caught by the May 68 events. Laurent Schwartz in his "Un mathématicien aux prises avec le siècle" refers to you in a very nice way. Let me quote partially

"Deux élèves de la promotion 66, Jean-Pierre Bourguignon et Yves Bamberger, jouèrent, par les initiatives comme par les contacts qu'ils établirent entre enseignants, élèves et direction de l'École, un rôle considérable pendant et après la période de mai 68."

Would you be willing to share with us some of your recollections of that period ?

This has indeed been a very exciting period, the campus of *l'École Polytechnique* being right in the middle of the *Quartier Latin*, which, in May 1968, became the focus of a lot of attention in France. In fact I think it is worth pointing out that already in 1967 there were signs that the very traditional (and blocked) situation the French society was in had entered a period of major crisis. The *École Polytechnique* itself had reached a stage of deterioration where it was impossible to hide the complete obsolescence of its scientific management. Many professors were cut off from recent developments, and offering out of date courses. The Class of 1966 was the first that did not accept this very degraded situation, and asked for a complete revision of the curriculum. Students were fighting at the same time for more freedom in their movements (the military statute of the school forbade students to leave the school during the week for example) and in their choosing topics of study (the curriculum was uniform and quite scholastic). Students had to endure the sharp contrast between the outside image of the school, supposed to train the elite, and the very deteriorated level of the courses offered inside. This was unbearable to a number of them. The strong feeling of living the end of a world was very present before the May 1968 events, and undoubtedly led to them. Afterwards it had to be interpreted as a premonitory sign. In my opinion, this fact is too seldomly acknowledged with the proper emphasis. In the students' governing body, Yves Bamberger and myself (our duo was actually nicknamed "*le tandem Bambignon*", as quoted by Laurent Schwartz) shared the responsibility of questions connected with teaching, both from a qualitative and a structural point of view. To set the tone, let me recall an amazing fact: in 1967, our fellow students were ready to give up a weekend of free time to put pressure on the administration to get rid of a poor teacher. Is that not an image which fully contrasts that of May 68 "baba-cools" ?

Right in the agitated period, in the military environment of the school, going on strike was quickly identified as a critical step. Thanks to the very intelligent behaviour of the General heading the school, the struggle finally led to a complete restructuration of the courses for the last trimester under the supervision of voluntary professors, such as Louis Leprince-Ringuet and Laurent Schwartz who saw there an opportunity to give a big push to their vigorous claim for reform, and of students who wanted to prove the well-foundedness of their request for a new curriculum. This was of course a time of heated debates, justified fears, and finally important changes in the way some of us chose to conduct the rest of their lives.

For me, the big changes the May 68 riots brought concern the "way of life", and the consideration given to various groups of people in the society. I still vividly recall the way Yves Bamberger and myself were greeted by the President of the Board of the school in late June 1968 when, for the first time, representatives of the students chosen by them were allowed to address the Board: "*You must remember that you represent the future only biologically. Decisions will be ours*". He resigned (or was forced to resign) in July 1968, and the General, who had so skillfully and constructively handled the crisis within the school, was transferred to an unimportant position in Bretagne (in other words sacked !). A *Commission de réforme* worked for the whole summer, and Bambignon was part of it. I must say that, from the point of view of the structure of studies, most of the students' proposals were adopted, and, for the whole academic year 1968-1969, the tandem was associated to their implementation under the supervision of a man with a strong personality, Jean Ferrandon, an engineer who had at the same time built extraordinary dams and harbours and developed a passion for rigorous mathematics. For young students in their early twenties as we were, this was an extraordinary experience, which could in some sense be put in parallel with *l'École de l'an Deux* at the time of the French Revolution.

Several of our friends accused us of being recuperated by the system. Although the question is worthy of consideration, we never accepted this view. I really believe that major changes in complex systems can only be achieved under specific circumstances, and then can go quite far without exerting much pressure after they get started, provided the pressure is exerted in the right direction. It is very important not to miss such opportunities, and in such times personal views must become secondary. The May 1968 events made possible a very successful revitalisation of the scientific life at *l'École Polytechnique*, something Louis Leprince-Ringuet and Laurent Schwartz had been fighting for more than ten years without much success.

You became Docteur ès Sciences Mathématiques having submitted a thesis with the title “Sur l'espace des structures riemanniennes d'une variété” at Paris VII in 1974. I think Marcel Berger was your thesis advisor. Let us talk about it for a while. Space in what sense? Is it possible to give us some idea of the problems you were dealing with?

Before answering your question per se, I would like to set the stage a little bit. I was very lucky to join the profession at a time where, in France, young researchers were given exceptional opportunities to work. I was hired by the *Centre National de la Recherche Scientifique* at age 21, before I had really done anything substantial. This gave me the possibility of considering in a long term perspective the research work I got engaged in. This contrasts with the great pressure under which young researchers are now forced to work on a short time basis.

From a disciplinary point of view, differential geometry, the domain to which Marcel Berger introduced me during long afternoons of very open and extremely informative discussions, was at that time very poorly considered in France. In fact, if you were not working in algebraic geometry, you were not doing “real” mathematics. It took me a year of stay in the US in

1972-1973 to realize that the direction in which Marcel Berger had led me was of great interest to world famous mathematicians such as Shiing Shen Chern. What was really exciting was to be able to participate in, and modestly contribute to, the emergence of a new field, namely “Global analysis”, the blend of analysis and geometry that transformed differential geometry from a specialised, and very computational, subject into a hot and much more center stage topic. Marcel Berger had remarkably foreseen this transformation, and encouraged his geometry students to invest into learning more sophisticated analysis tools, something I had done under the supervision of Gustave Choquet at *l'École Polytechnique*.

A typical question that he liked to consider at this time was to find, on a given manifold, the “best” Riemannian metric. This forces one to consider all Riemannian metrics at once, and to see how one can deform a given metric into more interesting ones. One then has to worry about equivalent metrics, i.e. metrics that are exchanged by the action of a diffeomorphism, in other words by a change of variables. Equivalence classes are called “Riemannian structures”, and the purpose of my thesis was to prove the space they form is stratified because of the possible presence of groups of isometries, i.e. the isotropy groups for the action of diffeomorphisms. This space plays an important role in the so-called ADM-presentation of the General Relativity, where solutions of the Einstein equation are sought as paths in the space of Riemannian metrics on a 3-dimensional spacelike hypersurface of space-time, for which one has to worry about the action of the group of diffeomorphisms. From that time on I kept interest in questions connected to deformations of metrics and the like.

From that moment on you have had a beautiful professional career. President of the European Mathematical Society from 1995 to 1998, Director of IHÉS since 1994, you probably still have some teaching to do. All these must be very time

consuming jobs. How do you still manage to find some time for mathematical research?

It is true that in recent years I assumed several responsibilities that have taken time away from my strictly scientific activities. In fact colleagues usually do not realize how time consuming it is to be in charge of an institute like the IHÉS which is a private foundation, i.e. a place where the director must, besides making scientific choices, cope with real managerial and financial problems.

From the scientific point of view, the a priori attractive side of such jobs is that very international research institutes, such as the IHÉS, are extraordinary observatories of the mathematical life, where one can see new tendencies coming up, and also listen to the latest news about challenging problems. Living in such an environment gives fantastic opportunities to meet extraordinary people in the society at large (and not only in the scientific community), and this is a privilege.

Since my job as director of the IHÉS is limited in time (the term is a priori 8 years, but it is now likely that I will stay a bit longer), even before taking the job, I arranged things so that I could spend three half-days a week at *l'École Polytechnique* in a small office in a remote corridor. There, I try and concentrate on my own mathematical agenda. In fact, since for me keeping contacts with students is very important, I am still teaching a course a year, and I am enjoying it very much.

As part of my duties as director, I have to keep alert on new developments, and for that purpose attend a number of conferences each year. This is an exciting part of the job. In my situation, the main difficulty is to find long enough unperturbed periods of concentration on my own research. I must confess that there are definitely moments when I do not achieve it, but I hope to be forgiven for this.

When Professor Friedrich Hirzebruch asked me

whether I would be willing to run for president of the European Mathematical Society (EMS) – I was not yet in charge of the IHÉS –, I really hesitated. It was evident to me that Europe is an appropriate level to fight for science, but I still had mixed recollections of the constitutional meeting of the EMS in 1990 in Madralin (Poland), in which I took part as President of the *Société Mathématique de France*. There the attention was focused on legal and political issues, when I am much more interested in developing tools to help European colleagues getting conscious of their interdependence, and learning to work together more closely. I could only convince myself that taking on this challenge could be meaningful after I made sure that our Austrian colleague, Peter Michor, accepted to form a ticket with me and run as EMS secretary. I am proud that through the establishment of the very successful EMS server EMIS (European Mathematical Information Service) Peter was given the opportunity of putting his passion for electronic tools at work for colleagues, from Europe and elsewhere. Colleagues will judge whether the actions conducted by the EMS are successful, i.e. whether all people engaged in its committees and its actions are doing a good job. For me it was another fantastic experience, during which I was forced to understand and properly acknowledge different approaches, i.e. to face what building Europe is about. If I had one frustration, it came from the extreme slowness with which the European Commission took up cases made by mathematicians. After some time one really gets impatient. I am very pleased to see that the new EU commissioner for Science, Philippe Busquin, succeeded in getting on its way a much more ambitious agenda, namely the construction of “a European Research Area”, a programme which perfectly fits the EMS goals.

You have been making a number of interviews with great mathematicians (Chern, Hirzebruch, Thurston, Atiyah, Jacques-Louis Lions) which were considered to be of sufficient mathematical importance to be reviewed in Zentralblatt Math

and Mathematical Reviews for instance. How and why did you get started?

Indeed, I devoted time to make a number of interviews of mathematicians. There are some you even did not list, and also some that I could not complete, such as one by Professor Jürgen Moser. I submitted a series of questions to him, and got preliminary answers but his struggle with cancer, which ended his life untimely in December 1999, prevented him from completing them.

Here are my two main motivations: first, I feel that mathematicians do not make enough efforts to collect testimonies of eminent mathematicians; second, the communication in our community has, in my opinion, taken a too formalized form. It now exists mainly through very carefully written articles appearing in refereed journals. Publishing interviews is a way of launching debates in the community on the basis of exchange of opinions. If I fully support the idea that published articles are the final mathematical products, we all know that doing mathematics requires going through many other steps, from identifying a promising area for research to realizing that an attempt to prove a theorem is a failure. If we want that outsiders access to a better understanding of how mathematics functions, we should therefore make also some room for all these steps. To those who fear that such an opening will lower the standards, I would say that this will not be the case if the same strict criteria are applied to this kind of articles.

Having some of these interviews reviewed in the international mathematical databases is not a sure sign of their importance. It nevertheless participates to the movement I was calling for earlier, namely making interviews a natural and significant part of the international mathematical life. You must share this view since you have been even more productive than me on this front.

Shall we talk about your videos? You are mathematical author or co-author of two videos:

“Tambour, que dis-tu?” which won a prize at the Palaiseau International Science Film Festival in 1987 and “The New Shepherd’s Lamp” which you were invited to show now in Coimbra. It seems correct to imply that you attach great importance to the popularisation of Mathematics...

To make a transition between your previous question and this one, the interview with Professor Shiing Shen Chern comes from a video, an idea due to an old friend, Professor Anthony Philips.

In fact I participated in two more films but the two you mention are really the ones of which I am the scientific author. Both of them were conceived with a wide public in mind. It is clear to me that mathematicians have not devoted enough attention to the question of how to communicate with the general public on their achievements and the nature of mathematics. Specialists of other disciplines have come up with useful images for all kinds of objects of importance to them. We have to do the same. This will require efforts and a lot of imagination, something that colleagues who have never been in touch with cinema activities often do not correctly appreciate. Producing movies is not only expensive. It is also time consuming!

The making of these two movies has been enlightened by encounters made on these occasions. François Tisseyre and Claire Weingarten, film directors with whom I worked for both, have become friends. What was critical for the success of the enterprise was their thoroughness in filming only a content they felt comfortable with, and this was achieved through lengthy discussions, and back and forth exchanges. As a consequence the production of *The new shepherd’s lamp* has been a lengthy process during which the initial idea I had was completely transformed into a script based on a much broader historical perspective. This was also an opportunity to see how a professional writer, Romain Weingarten, could turn into a text of literary value the script of the shepherd, the character introduced by the film director structuring the whole movie.

Finding adequate projects where artists and scientists can meet and work together should be a priority in my opinion. In this way mathematicians can get a better acquaintance with the mechanisms through which the media function. Indeed producing videos does not ensure that they will be shown in TV programmes, the only way to gain greater visibility. Some mathematical videos made it, e.g. the video *The Proof on Fermat's last theorem* produced by the BBC which has been shown on the german-french channel ARTE. As far as I am concerned, I have already shown *The new shepherd's lamp* about twenty times to extremely different publics. Its length (28 minutes) allows for a short oral presentation and a debate whose content depends very much on the audience. I always find it very challenging and informative.

You were a member of the panel which in 1999 was responsible for the research assessment exercise in Portugal. I do not want to break any confidentiality which may surround that exercise but could you offer us your overall view of Portuguese mathematics at the end of the century? You do not have to be particularly kind. . .

First some general comments. The Portuguese higher education system is expanding rapidly. Worldwide it is now recognized that quality at this level cannot be achieved without active research teams. Therefore it is natural to try and evaluate the research to make sure that university departments are according enough attention to it. The decision to call systematically upon international teams of experts to do this job in Portugal is courageous on the part of your research agency and of your Minister of Science and Technology, but certainly wise in the long run.

The team traveled to several cities in Portugal to visit all research groups in some ten days. It was always well received, and the presentations prepared for it almost always thoroughly informative. The team was confronted with very diverse situations: some labs were already operating at an international level, others just star-

ting to develop significant research activities. In many universities we could witness unreasonable teaching loads that make it almost impossible to pursue actively research at a good level. What makes matter worse in Portugal is the length of the academic year and the time devoted to exams. Too often university professors do not have the free time indispensable to conduct substantial research work. If the government is really serious about developing a full-fetched higher education system, it must address this issue which, from what I understand, means establishing stricter rules for students, a move which may be politically difficult. Such rules exist in almost all other countries.

From a more qualitative point of view, Portuguese research teams may not be diversified enough topically. Some important areas are not covered. In some cases, to the contrary some topics are overdevelopped, and such a situation can isolate some groups from what is happening elsewhere in the mathematical community worldwide. Again the antidote is to be open enough, to send advanced students for their PhD training outside as often as possible, and to grant active researchers the possibility of visiting other scientific institutions abroad.

The Portuguese system supports quite generously students while they are preparing their PhDs. In particular it allows them to go abroad by granting them decent support for this purpose. But the acceleration of hirings consecutive to the expansion of universities is likely to come to a hold in a not too distant future when the system will stop expanding. This could mean a major blow to the health of the research system in Portugal since younger people are indispensable for the stimulation of the research. Mechanisms should be designed to ensure that positions will remain available at a steady rate in the years to come. Many countries in Western Europe have undergone a similar phenomenon in the 70's, and negative effects consecutive to this short-sightedness have been major. If a lesson could be learned from this recent experience,

Portugal may be able to achieve a smoother development of its mathematical research.

(Questions and picture by F. J. Craveiro de Carvalho)

Jean-Pierre Bourguignon was a student at the *École Polytechnique* in Paris. He went on to become *Docteur ès Sciences Mathématiques* in 1974 having written a thesis under the supervision of Marcel Berger.

Professor Bourguignon was President of the European Mathematical Society from 1995 to 1998 and since 1994 he is the Director of IHÉS - *Institut des Hautes Études Scientifiques* in Bures-sur-Yvette, near Paris.

Professor Bourguignon is also the mathematical author or co-author of the videos *Tambour, que dis-tu?*, which was awarded a prize at the Palaiseau International Science Film Festival in 1987, and *The New Shepherd's Lamp*. That very year he was awarded the *Prix Paul Langevin de l'Académie des Sciences de Paris* and in 1997 he received the *Prix du rayonnement français pour les sciences mathématiques et physiques*.