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A whole new vigor: *About Montel's book "Les mathématiques et la vie" (1947)*

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Abstract. In this paper, we consider a talk presented by the mathematician Paul Montel in Paris in 1944, dedicated to a general presentation of the importance of mathematics in everyday's life. The text of this talk, and the context of its elaboration, allows various inceptions in the French mathematical life in the middle of 20th century. In particular Montel's insistence on applications of mathematics strongly contrasts with the main tendencies of the French mathematical stage after the war under the impulse of the Bourbaki group.

Key words and phrases: Paul Montel. Emile Borel. Paris' Palais de la Découverte. Applied mathematics. Probability.

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Introduction

My work and interests are not specifically about mathematics education and its history. Nevertheless, I had various opportunities to discover with some amazement the strong interest for probability that animated the teaching of mathematics in Hungary during the twentieth century, especially with Varga and I could see strong resonances

with some French pioneers in the transmission of mathematics of chance: I refer above all to the mathematician Emile Borel (1871-1956) who was the main craftsman of this topic in France at the beginning of the 20th century. The subject I discuss in the present contribution has many links with Borel's efforts even though he is not at the center of my presentation. I consider here a beautifully illustrated in quarto book, published in 1947 in Paris, entitled "Mathematics and Life" (Montel, 1947). The text of this book was taken from a talk given by the mathematician Paul Montel (1876-1975) for the reopening of the *Palais de la Découverte* (palace for discovery) in November 1944, three months after the liberation of Paris from the German occupation. Montel's aim was to prove the vital importance of mathematics in modern life. He concluded his talk by a quote from Blaise Pascal: "Between equal spirits and all things alike, the one who knows geometry wins and acquires a whole new vigor."[1] The purpose of my paper is to provide some elements about the historical context of Montel's talk and its contents.

The *Palais de la Découverte* in Paris

As mentioned above, the text was written for a talk at the *Palais de la Découverte* and I would first like to present this original institution in Paris whose project appears as one of the last achievements in France resulting from the spirit of intellectual cooperation born after the Great War. Most information below on the history of the Palais comes from Bergeron et Bigg (2015, 2017). In 1933, the French Commission for Intellectual cooperation and the Confederation of Intellectual Workers, two structures that appeared in the 1920s (the first affiliated to the International Institute of Intellectual Cooperation of the League of Nations) decided to entrust the General Commissariat of the international exhibition planned in Paris in 1937 to the deputy Adrien Berthod (1878-1944) who belonged to the Radical group. Berthod was a close associate of Borel, himself a deputy since 1924 and vice-president of the Confederation of Intellectual Workers (CTI). Another vice-president of the CTI was an original character, André Léveillé (1880-1962), who was both a highly skilled industrial designer and a self-taught painter whose paintings had earned him a real esteem in the arts milieu. Berthod asked

[1] The quote is from Pascal's text *De l'esprit géométrique*. Page 429 of the English edition by C. W. Eliot: Blaise Pascal (1623–1662). Minor Works. The Harvard Classics. Colier & Sons, 1910.

Léveillé to take care of the coordination of the intellectual aspects of the international exhibition. This included a section of Sciences, and in particular a sub-section called "Scientific discoveries in their applications" chaired by the physicist Jean Perrin (1870-1942) with Borel as vice-president. A project was proposed, notably under the influence of the exhibition "A century of progress" presented in Chicago in 1933, which focused on the presentation of technological advances and on the participation of visitors to discover and understand scientific matters by touching objects and participating in real-time experiments. The project for a scientific section inside the 1937 exhibition aimed at presenting the latest scientific breakthroughs in thematic rooms gathering models, explanatory panels, real-time experiments made either by visitors or by scientific mediators. The project was installed in the west wing of the Grand Palais[2] near the Champs-Elysées and the huge success it obtained convinced the government to make the presentation permanent under the form of a museum for science, which was to be called the *Palais de la Découverte* ("palace for discovery"). It should be noted that the initiative was facilitated by the fact that the government in power in 1937 was still the Front Populaire government, in which Jean Perrin was the undersecretary of state for research. In 1938, Léveillé became the first director of the Palais de la Découverte, a position he held for 22 years. The project of the Palais de la Découverte was to present to the public the science being made. The challenge, in terms of mathematics, was not small: unlike the various sciences that can present experiments - some of which such as the Faraday cage or the manipulation of liquid air are still today part of the scientific imagination of many French children who visited the Palais with their teachers - mathematics seems less likely to provide attractive activities... Emile Borel was the coordinator of the section of mathematics and explained the project for the rooms dedicated to mathematics in the Palais in a popular journal. It was decided, writes Borel,

to give in a sensible form some examples, some samples of what mathematics is, so that the public would suspect its complications, immensity, grandeur, and beauty. It was necessary to start from what many know and try to elevate them gradually until they are at a loss with reasonings they can no longer follow but about which they nevertheless realize that others can go further. (Borel, 1937, p. 4)

[2] The Grand Palais (*Great palace*) in Paris is a large historic site located at the Champs-Élysées in Paris. The construction of the building began in 1897 as part of the preparation works for the Universal Exposition of 1900, which also included the creation of the adjacent Petit Palais (Small Palace) and the Alexandre III bridge.

In the previous quotation, it is worth observing Borel's nice solidary and social conception of the intellectual life. For Borel, it was important that those who are not fit for a deep scientific activity should at least have a certain awareness of its importance for the society.

The difficult years of the German occupation (1940-1944)

The French collapse of June 1940, the German occupation of Paris, the fall of the republic and the advent of the Vichy regime, were a great test for the Palais de la Découverte, although it should be noted that it remained more or less open during the whole period thanks to the relentless efforts of Léveillé. An almost normal program of conferences was organized during the first year, but the activities gradually decreased since 1942: there was for example an exhibition on termites in 1941 and one in 1943 on the bicentenary of Lavoisier. Nevertheless, after receiving recurrent requests from various groups close to the new regime (such as those dealing with racist theories) in order to use the place for activities, the management decided to make some amenities unusable such as the projection equipment.

Meanwhile, those who had inspired the project in 1937 were facing bitter days: Jean Perrin, directly threatened by the new regime because of his proximity to the Front Populaire, fled to the United States and died in New York in 1942. (Townsend, 1943) Emile Borel was arrested by the Gestapo in the fall of 1941 but released after a few weeks; in a poor health condition, he decided in early 1942 to live in his hometown of St Affrique in the south of the Massif Central and remained there until 1944. (Mazliak & Shafer, 2011)

In 1940, the government had decided to put the Palais de la Découverte under the authority of the University of Paris. The trajectory of Paris university under the Occupation was quite eventful. From 1941 to 1946, the dean of the Faculty of Science was Paul Montel, a renowned specialist in complex analysis. Montel was however considered as a moderate leftist. During the Vichy regime, deans were appointed, but the education Minister Jérôme Carcopino (1880-1970), a renowned historian close to the regime but concerned with academic independence, skillfully accepted to follow the result of a consultative vote by the members of the Faculty of Science who chose Montel as a dean in 1941. This vote expressed a certain spirit of resistance that did not escape some hateful comments from the collaborationist press:

The election of the dean of the faculty of science was organized according to the republican tradition. At the first selection, an overwhelming majority was given to the noble Darmois, an eminent physicist and mathematician, an opponent of the sad Perrin, remembered as a warm supporter of the front popu! So, in order to have the mixed-blood Montel appointed, Borel, helped by Carcopino's grace [...], was sent to collect the wishes and voices of all the little personnel in the most discreet places of the venerable house. (quoted in Audin, 2011, p. 197)

The Darmois mentioned in this quote was the physicist Eugène Darmois (1884-1958), brother to the mathematician Georges Darmois (1888-1960) who, contrary to his brother, spent the war in London in service of de Gaulle. Montel in fact managed to get through this dark period by avoiding any overly compromising arrangement with the Vichy regime or the occupier, as evidenced by many testimonials of sympathy issued after the Liberation, and above all by the fact that he could continue his mandate as a dean until his retirement in 1946, a quite rare event among those who were in charge of important administrative functions during the German occupation. This also explains why Montel was invited to present mathematics at the solemn reopening of the *Palais de la Découverte* on 25 November 1944. During the fights of the Paris liberation at the end of August 1944, a fire had destroyed part of the exhibition and the November conference was an opportunity to inform the public that the *Palais de la Découverte* would be gradually reconstructed.

Montel's conference

Montel began his lecture by paying a tribute to Jean Perrin and the other initiators of the Palais project. "In the long intellectual night we are coming out of, he wrote, the Palais de la Découverte has continued its destiny as a nave of truth tossed on an ocean of lies, through a thousand pitfalls, in the middle of a hurricane where free thinking was struggling." Montel then came to his topic and recalled a famous joke: mathematicians are the least annoying specialists because they never speak about their specialty. But Montel was there to talk about mathematics, and it is significant to look at the angle he chose for that purpose.

Not surprisingly, Montel first wanted to demonstrate to his listeners that mathematical properties are ubiquitous in everyday life. The commutativity of the

addition is illustrated by the fact that the amount of the bill in a restaurant does not change if one orders the dishes differently; the properties of minimizing the distance between two points is illustrated by the choice that an inhabitant of a city makes for going from one place to another, constrained by the configuration of the streets. An original point is Montel's insistence that an intuitive mathematization is not a human prerogative: animals, he argues, also unconsciously do mathematics, most of the time by implementing basic geometric properties. Such an example is given by the "pursuit curve" which models the trajectory of a dog wanting to catch up with his master while remaining always aligned with him. Another example is the way sheep on a mountain slope graze along the level lines so as to minimize the energy required for altitude change. Another originality, which can hardly be dissociated from the fact that the conference was held in Paris, the world capital of fashion, is that Montel mentions that "it is in the art of clothing that mathematics plays a very important role". This part (almost 6 pages...) is rather technical, at least for people -like me- who know absolutely nothing about these topics...

The manufacture of ordinary fabrics raises many other problems of geometry as well as number theory. It is known that the weft thread passes sometimes above and sometimes below the warp and that the fabrics differ in their "armor" that is to say by the manner in which these entanglements are established. The study of these arrangements of threads belongs to a part of mathematics called the situation geometry. It is the science of combinations of relative places that points, lines, or surfaces can occupy. Ordinary geometry is the study of the properties of bodies that do not change when one moves these bodies without deforming them: situation geometry studies those properties that do not change when one deforms the bodies: the armor of a fabric for example, does not depend on the shaping of this fabric. (Montel, 1947, pp. 25-26)

Another remarkable aspect of the Montel conference is the tribute it gives to Emile Borel through a broad evocation of the scientific approach of randomness. Borel and Montel had a good relationship even though Montel was never part of the first Borelian circle. Montel, unlike Borel, never seems to have shown a particular interest in probabilities. As Emile Borel had been, before the outbreak of the Second World War, the main mathematical referent for the Palais de la Découverte, one can imagine that Montel, in charge of the talk and assuming the role of dean, wanted to pay homage to Borel at least in spirit, by devoting a quite important room (more than 25 pages) to the questions of chance, risk measurement and statistical processing. Borel is also one of the very few contemporary mathematicians explicitly named in the text and Borelian

inspiration of the content is beyond doubt: it seems drawn from the famous book "Chance" or also from the little book of the series *Que-Sais je?*[3] called "Probabilities and life" which Borel had just published during his forced stay in St Affrique in 1943 (Borel, 1943).

Montel mentions by various examples the omnipresence of scientifically calculated randomness in social life. Not without mentioning that in the past there had been dangerous attempts for moral conclusions from probability calculations, as had been the unfortunate case with Condorcet's and Laplace's research on judgments (to them Montel could have deservedly added Poisson) in order to make the courts more equitable. The long section devoted to probabilities ends with a wink, which is the expression of Montel's regret at the development of an over-invasive culture of risk in today's society.

We have just seen what influence the notion of probability exercises in individual life as in social life. States and collective organizations seek to compensate with insurance the different risks that man can face: death, accident, unemployment, sickness, loss or theft. Perhaps this desire to offer the least possible uncertainty to the human condition presents the danger of mitigating the risk appetite that has led to great discoveries and large enterprises and to delay progress by too much complete uniformity. (Montel, 1947, pp. 69-70)

It is worth observing that such a development of the culture of risk was at least partially a sign of the success of the education program Borel began to promote twenty-five years earlier.

Another remarkable homage occurs a little further in the text, when Montel mentions the work of the Italian mathematician Vito Volterra on mathematical biology, especially the prey-predator cycles he had studied during an analysis of fish stocks in the Adriatic after the First World War (Guerraggio & Paoloni, 2013). Volterra, who had been an early anti-fascist and had opposed himself more and more violently against Mussolini's regime, died in 1940 in dramatic isolation. Montel had probably chosen this first public opportunity to greet the memory of a man who for five decades had personified Italian

[3] The series *Que Sais-Je*? (What do I know?), which does still exist today, had been founded in 1941 by Paul Angoulvent, director of the French University Press. The aim of the series of small booklets was to provide an accessible and efficient introduction to a field of study written by an expert in the field. The title "Que sais-je?" had been taken from the French essayist Michel de Montaigne.

science. Already during the 1937 international exhibition, Borel had insisted that Volterra's work on the subject should be presented in the mathematics section because it was one of the most attractive applications of mathematics for the general public.

In 1947, Montel's talk served as a support for the publication of a beautiful book by his friend the photographer and publisher Philippe Tiranty (1883-1973), an old Montel's friend from Nice who was known as a pioneer for the production and dissemination of portable cameras in France. Tiranty appealed to the designer Pierre Collot (?-?) to illustrate the work with stencil drawings. Collot was, according to the catalogues I consulted, quite present in the milieu of the illustrated edition in the middle of the last century, but I must say that I have unfortunately rather little information about him. A noticeable fact is that Collot's drawings, very colorful and realistic but somewhat naive, seem to orient the book in a direction that was not necessarily in line with Montel's original intention, namely closer to a book intended for children. Montel's talk was indeed not specifically oriented towards a school audience. It is singular to see how the Tiranty's edition, illustrated with these brightly coloured paintings, seems instead adapted to such a readership.

Conclusion

Montel's talk provides a good picture of how mathematics was seen in France in the middle of the 20th century before the Bourbaki group reshaped this vision towards a more formalized approach and a strong dislike (to put it mildly) of applied mathematics. On the contrary, Montel, though he was himself a specialist of analytic functions (hence a domain belonging to pure mathematics), emphasized the role of mathematics in ordinary life through its applications in various domains. As I have mentioned, his insistence on probability and statistics for the scientific approach of situations in which it is necessary to take a risk into account is remarkable and obviously inspired by Borel's activity in this direction during the first decades of the century.

One may also observe that Montel's presentation of the omnipresence of mathematics in everyday life fits quite well with other educational developments in Europe at the same time. In Belgium, there was a movement headed by leftist and freemasons scientists of the Brussels *Université libre*. The mathematician Paul Libois (1901-1990), a professor of geometry at that university, was a main figurehead of that movement (see, e.g., Vanpaemel & De Bock, 2017). In post-War Italy, there were

comparable developments, emphasizing the intuitive nature and ubiquity of mathematics, in particular of geometry, both in daily life and in the other sciences (see, e.g., Castelnuovo, 1948). Inspiration was often found in the work of Reform Pedagogues of the first half of the 20th century, such as Ovide Decroly (1871-1932) in Belgium or Maria Montessori (1870-1952) in Italy.

It is significant to compare Montel's text with the book written in the 1980s by the Bourbaki founder Jean Dieudonné (1906-1992) to see the shift that took place in the next years on the French mathematical scene (Dieudonné, 1987). Dieudonné's title is in itself typical: doing mathematics is a tribute due *to the honor of mankind's spirit*, and certainly not primarily a means to participate to the improvement of the material conditions of society. Hence Montel's and Dieudonné's visions appear as rather complementary (more than opposed). In this context, let us observe however to conclude that Montel, at the end of his conference, insisted on the importance of aesthetic in mathematics, and therefore did not focus only on applications. As a mathematician, he was conscious of the necessity of presenting mathematics not as a servant to other disciplines, but also as a science with its own internal criterions and sources. It would be nice to know how the audience, especially mathematicians, reacted to Montel's conference. Maybe in the future some documents would provide information about this question.

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