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SCIENCE LEADERS UNDER FIRE: STORIES ABOUT MATHEMATICIANS KILLED IN WORLD WAR I

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Tomorrow, it will have been a hundred years exactly that Paul Vipple, a young mathematical teacher at the lycée du Mans, received fatal wounds while building a footbridge over the canal des Ardennes. His orders were to transform the temporary walkway built on cork floaters into a more permanent structure. A first projectile was fired at the working crew and injured two soldiers. Their work was coming to an end when another shot was fired and hit a dense group of workers. One was killed, six were injured including Viple.

The next day, in a field hospital, Viple wrote his family: « A slight mishap just happened to me: I was hit in the back by shrapnel which was taken out this morning. Everything is going well ». The recovery however was slow. The Armistice, on November 11, rejoiced him. The next day, he went to surgery once again. On the morning of the 17th, he wrote with a handmade shaky by his silent suffering: « This is a nice Sunday, which opens the occupation of Alsace-Lorraine [by France]. » At midnight on that day, he passed way without a single complaint.

Little of Viple's previous experience had prepared him for this fate. He was born 32 years earlier in a small town of a hilly region in the centre of France. First educated by a devoted mother, he joined the lycée and impressed everyone by his intellectual aptitudes. In 1906, he was accepted both at the École polytechnique and at the École normale supérieure, the two main elite institutions of scientific higher learning in the country at the time.

Three years later, he would succeed in the competitive state exam — *l'agrégation*— that selected future mathematics teachers. After two years of military service, Viple started teaching to small children: « I like the small ones » was he remembered saying.

Meanwhile, he had started to work on a doctoral thesis dealing with functional equations. We don't know much about this work, which was never published in any form. Although we have few details about Viple's mathematical work, we can say that this field of research was rather popular among young *normaliens*. The French tradition of mathematical analysis was very strong then with mathematical luminaries like Henri Poincaré, Jacques Hadamard, and many others exerting a major influence on young would-be researchers. But research opportunities were scarce at the time and Viple instead started working at the lycée du Mans in October 1913.

In the necrology he wrote in 1920, Maurice Gevrey, who was had met him at the Ecole normale, emphasized that only year Viple spent as a teacher at the lycée du Mans. From the memories of his former colleagues, Gevrey drew a vivid portrait of the young mathematical teacher, characterized by simplicity, modesty, patience, and above all great kindness toward his pupils. In July 1914, Viple and a childhood friend of his got married. A happy life seemed in front of them.

The news of the general mobilisation reached Viple in Switzerland where their honeymoon taken the newlyweds. Contrary to many of the students of the Ecole normale, Viple was offered the chance of training in the Engineering Corps. Only in October 1915 did he reach the frontline for the first time. For the next three years, his life is chronicled by the letters he sent his young wife. He took advantage of a few permissions to father two daughters.

Fighting in the Engineer Corps offered a relative protection from the harshest realities of trench warfare. But in July 1916, he took part in the attack of the Somme, where he was commended for his conduct under fire. After a relatively serious bout of illness which took him away from the front for several months, he reached Verdun in August 1917 and then took part in the last offensive of the war starting on September 26, 1918. A few days before he was fatally injured, he wrote to his wife: "I'm feeling well in this interesting, active, but not too dangerous life; I am happy that I was able to reassure you and quiet your worries."

From our perspective, the contrast between Viple's life before the start of the war and on the front is striking. In his obituary, Gevrey likewise emphasized the difference between the innocence of his pre-war days and the constant worry that came with fight a war, even if not on the first line. But in the middle of his testimony, Gevrey introduced a crucial point of continuity when he quoted one of Viple's pupils who although he acknowledged he never had the chance of meeting his former teacher on the front, saw him there "always the same, kind and sweet, always calm, during days of rest as well as in the trenches, days and night, in the wait as well as at the time of the assault, and kind with his men as he had always been with his pupils." We will come back to this.

The first world war has long been recognized as a scientific war, and it is always surprising to realise that so much of the young scientific elite of the belligerent nations was sacrificed in combat. As the US physicist George K. Burgess would write after a visit to Europe in 1917: "*Pretty much the whole curriculum of physical and natural sciences, and their applications, are each of them fundamentally essential in modern warfare. . . . Almost none could be spared and the war carried successfully.*" As far a mathematics is concerned, vital sectors like the use of artillery in the field, relied heavily on the work of some of its practitioners, especially in the field of external ballistics, that is the computation of projectile trajectories in the air, but also in aeronautics, statistics, and various areas of mathematical physics.

A little later, in 1919, Burgess however felt that the war had had but little effect on science itself. "*While hundreds if not thousands of new applications of known principles were due to war work, one would be hard pressed to name even two or three new principles developed because of the war.*" Some of the scientist most involved in the conflict seemed to agree, like Émile Borel, the famous French analyst who had spent two years organizing the whole scientific mobilization of his country. When he presented his candidacy to the Academy of sciences in Paris in 1919, a reviewer wrote: "*The mathematical work of Mr Borel having been interrupted by the war, I only need to add to my report from 1912 a few words relative the period from January 1913 to July 1914.*"

So, when the war is now at all remembered by mathematicians, its impact on their discipline tends to be downplayed. I have always been struck however by the memories produced by members of the famous Bourbaki group about the First World War.

Too young to have fought in it, mathematicians like Jean Dieudonné and André Weil joined the Ecole normale supérieure in the twenties. A decade later, they formed a collective adopting Bourbaki as their pen name with the goal of reforming the general outlook of the discipline, emphasizing abstraction at the expense of applications. In the sixties, when they started to tell the story of their group, they told stories where the First World War played a crucial part. Dieudonné wrote:

> "*In the great conflict of 1914–1918,* […] *the French* […] *considered that everyone should serve on the front, so much so that the young savants, as well as other Frenchmen, did their duty on the frontline. The result was a dreadful hecatomb among young French scientists.*" As for his friend André Weil, he wrote in his autobiography: "*Already when at the* [ÉNS], *I had been deeply struck by the damage wreaked upon mathematics in France by the 1914–18 war. This war had created a vacuum that my own and subsequent generations were hard pressed to fill.*"

What we therefore get here is an accumulation of different perspectives that are at odds with one another. In the history of mathematics, like in all human affairs, diverse viewpoints produce discordant accounts. But in the case of the World War I, the process through which stories themselves were constructed seem to have played a crucial part. This is why we felt it was necessary to re-examine these stories and the way they were produced.

In the collective book I edited with my colleague Catherine Goldstein in 2014, *The War of Guns and Mathematics,* several authors underscored the importance of the various roles played by mathematics and by mathematicians during the First World War. Like their colleagues in the physical or medical sciences, mathematicians, we argued, were mobilized in a variety of ways and helped developing new tools, instruments, weapons, engines, and protocols that proved crucial to the fighting of the war. In France, Britain, Italy and the United States, and also Russia, Germany, and Austria, mathematicians were drafted or volunteered their expertise for defence in a variety of ways. Many examples were developed by our colleagues in the book showing that mathematicians worked on ballistics (that is, the computing of projectile trajectories through air), aviation, statistics, etc. Needs for new computing procedures either numerical or graphical led to many new developments in this area of mathematics, as well as in probability theory and functional analysis.

In *The War of Guns and Mathematics,* the various roles played by mathematicians in the First World War emerged quite clearly. Roughly speaking, we have outlined four different roles where they were extremely active, roughly corresponding to their age: **first**, the youngest ones served on active duty where they often were killed; **second**, slightly older mathematicians were however often able to use the special skills as mathematicians, serving as experts in a variety of ways, including teaching and research and development; **third**, many would also be called to play active roles in the organization of research on local, and, especially, national levels, sowing the seed of large research bodies that would play an enormous part in the development of a truly nationalized form of scientific research ; and, **finally**, many mathematicians also played prominent parts in intellectual debates about the fate of science, culture and society during and after World War I.

Most historical research until now had focused on the later three roles: here I will try to argue that even young scientists who died on the frontline unfortunately without leaving much of a trace deserve to be studied in detail.

In my recent book, published just a few days ago, whose title may be translated as "Science leaders under fire," I focus on the fate of young mathematicians who served and died as soldiers during the First World War. I revisit the apparent contradiction between pre-war training and wartime service and examine some of its long-term effects. As I hinted at by telling Viple's story, the contradiction, which seemed to have been perceived during the conflict, was mostly worked out through writing. Although they are often difficult to read, because of the raw emotions they stirred in the reader, the many stories told about young scientists who were killed during the war seem to provide a crucial insight into the way in which the experience of the war impacted people's conception of science and mathematics. Having analysed at length this type of sources over the last few years, especially in the case of the young mathematicians of the Ecole normale supérieure, I now would like to argue that these stories played an important role in the emergence of a new, more abstract form of mathematics which could be morally detached from wartime uses of mathematics.

It helps to understand the important roles played by mathematicians to understand that the discipline differed from contemporary conceptions of it. Abstract mathematics was a recent invention then: and even though research at a professional level already was extremely technical, most mathematicians were at least partly trained in applied mathematics, having been exposed to descriptive geometry, general and celestial mechanics, as well as technical drawing. And in so far as it was informed by the sciences, military training was more often than not quite mathematical.

In most developed nations, the last decades before the start of World War I had witnessed the strong development of autonomous universities where mathematicians often played prominent roles. While mathematical cultures spread across campuses to several other domains of science and engineering, mathematicians felt more and more entitled to pursue research agenda over which they exerted more and more control. Consequently, the traditional connection between mathematicians and military men had loosened up slightly, but would be quickly re-established once the war was declared.

But at first some mathematicians experienced a form of rejection. Let me take the case of Jules Haag, later to become a great expert in dynamical systems theory. A reader in mathematics at the university of Clermont-Ferrand before the war, he was serving in the Michelin tyre company (transformed in a bomb factory). As late as September 1915, he could still write that in the eyes of his superior, his mathematical skills had very little value. In a letter he wrote to his professor Paul Appell, at the Academy of sciences in Paris, Haag complained: « I am, in their eyes, nothing more than a mathematician, with no practical usefulness, other than occasionally serving as a computing machine ».

In his spare time, Haag had however developed a new approach to estimate computing errors made in approximating some ballistic trajectories, that is the trajectories of projectiles in air. Despite the fact that it might contain sensitive material, the paper he sent Appell was published by the Academy of Sciences. Luckily, the person who was most interested in reading it was General Jules Charbonnier, the head of the Gâvre Commission since 1906.

Now, the Gâvre Commission was, before the start of the war, the main research institution of the French Navy in charge of ballistics. In August 1914, all men and officers serving at Gâvre were sent to active duty, except 5 officers (who had requested another position, but this was refused). But, as we know, after the first weeks of the war, fighting conditions changed drastically. Indeed, the frontline on the Western Front was stabilized from Switzerland to the North See and fighting took the form of siege warfare. This was a form of combat in which the expertise of mathematicians had for several centuries been quite appreciated. New, more powerful artillery guns were produced for which range tables needed to be computed.

Another crucial aspect of ballistics changed at the time. Most tables before the war were computed for long angles of shooting. In trench warfare, guns could be positions further from the front and used to fire at a distance; they could also be used against airplanes and zeppelins. Mathematical methods which worked well at low angles failed for higher ones. At the Gâvre Commission, new personnel were suddenly badly needed. This is why and how Haag was called by Charbonnier to help. Together with a Navy officer Garnier and a drafted mathematics teacher Marcus, Haag developed a new efficient computing procedure (the so-called GHM method), which was used by the French army for several decades afterwards.

The officers at Gâvre produced a narrative of this collaboration that is strikingly at odds with the story often told by scientists. You can see Haag on this photo surrounded by officers, taking a picture of the photograph. This a rather nice way to symbolize the competing accounts produced by the war. While scientists often complained that the army was often not able to take advantage of their unique expertise, officers at Gâvre emphasized the great work of acculturation they successfully carried out: by the end of the war, civilian mathematicians were trained and ready to work side by side with officers.

Contributors to *The War of Guns and Mathematics* – and we have just heard such stories – have shown that mathematicians were indeed often successfully included in military structures, not least as lecturers.

As I said earlier, mathematicians thus played various roles in the war. When science's role in this terrible war was called into question, scientists responded with speeches. Constructing stories about science in the war was a task many members of the older generations felt compelled to take on.

As early as December 1914, the mathematician Paul Appell (to whom Haag would address his letter just a few months later), gave a moving speech at the Academy of Sciences in which he expressed his worries about the fate of science in this trouble times. In his speech, he emphasized his vision of science which encompassed much of what we now call applications. Contrary to Burgess, later, he wished not to delineate too clearly that distinction. To Appell, science truly was a moral good: "the search for scientific truth by a spirit attracted by moral beauty," he said, "was the noblest effort that a human life can undertake." But the first few months of the war had shaken this belief. He underscored that some had hijacked science with overspecialization, will for power and a narrow focus on practical effectiveness. To him, this led to a hard, selfish, materialistic civilization, to some kind of "scientific barbarity" [barbarie savante] like the one that had taken over Germany.

What we need to underscore here is the fact that this expression would have seemed oxymoronic just a few months earlier. Science led to civilization, lack of science was barbarous. Now, a door was opened allowing for the emergence of something unthinkable before. Was science, then, a word without meaning, Appell asked, a hypocritical delusion? "We must answer: No, a thousand times no!"

A response to that threat was to stigmatize German science. The mathematician Émile Picard was especially vocal in this regard.

In 1915, he published a book under the patronage of the Academy titled "The History of Science and the Pretentions of German Science," in which he chastised the scientists of opposing nation for having stolen much of their inventions from France and England. For him, German science somewhat paradoxically suffered from an exacerbated attraction towards abstraction, while at the same time being too informed by applications. "German science," he wrote, "has the tendency to posit *à priori* notions and concepts and to follow indefinitely the consequences, without worrying about their agreement with reality, and even while taking pleasure from distancing itself from common sense." This was one of the roots of its brutal manifestation on the battlefield.

As I already said, the response in France, like in all other belligerent countries, was massive scientific and industrial mobilization.

In 1915, a mathematics professor at the Sorbonne, Paul Painlevé, entered the Government as Minister of Education and Inventions for National Defence.

Painlevé's pupil, the scientific director of the Ecole normale supérieure, Émile Borel whom you may remember as the mathematician whose work was said to have been interrupted by the war, was named Director of Inventions for National Defence and organized a government body to oversee the scientific mobilization. This Direction examined 9120 projects during the war and 781 of them were developed and passed on to the army. After the war, this Direction became the Office for Inventions and Industrial and Scientific Research. In 1939, it would become the National Center for Scientific Research – the CNRS which is still the biggest research institution in France.

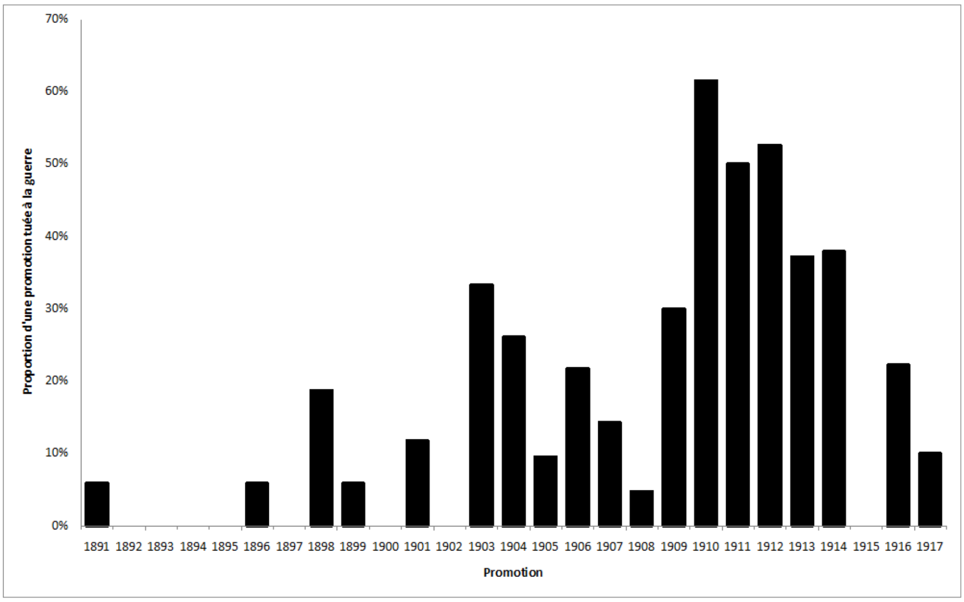
Let's jump to 1918. After the fall of his government, Painlevé served as president of the Academy of sciences. He was in a good position to underline the "lessons" of the war, as people were keen to draw them at the time. In several moving speeches, he went over the experience of the past four years. Significantly, he presented a striking vision of the war as the deadly fight between two conceptions of civilization: "whether science would be for humans the means of their liberation or the instrument of their enslavement". In Painlevé's view, science therefore had ceased in essence to be for the moral good. But contrary to Picard, he did not want to oppose a French to a German science. To him, science was one, and it was morally neutral. Like iron, he said, it could be used for good and evil, to harvest and to kill. For this reason, Painlevé believed that science had to be developed by a superior elite.

We are now left with a new contradiction, of which Painlevé must have been acutely aware. On the one hand, scientific mobilization for defence had proven absolutely essential for the pursuit of war; on the other, the higher conception of science as a means to elevate human spirit was reaffirmed as crucial lessons to taken out from the war.

My latest book therefore aims at untangling this apparent contradiction by focusing on stories told about mathematicians killed in war. It shows how the speeches made at the Academy of Sciences resonated with wider sentiments about the proper place of scientists in war.

As we have seen, the heavy mortality among students and scientists struck imaginations. As early as January 1915, at a meeting of the alumni of the Ecole normale, the director of the school said that of the 195 currently enrolled students who had gone to war, only more than a quarter (55 of them) were safe: already 35 had been killed, 15 had disappeared, 74 were wounded, 21 had been taken prisoners and 9 had fallen ill. The numbers and the speech delivered on that occasion were printed in the press. This was one of the first evidences generally that circulated concerning the toll the war had taken on the French Army during the first disastrous months of fighting.
As far as mathematicians were concerned, already 14 had died at that time. Over the years, 8 more would be killed on the battlefield or because of wounds received there. These 22 mathematicians amount to one and a half time the number of science students admitted at the Ecole normale in a given year at the time. To the French Mathematical Society in 1914, 178 mathematics teachers or professors belonged at the time. The loss of 22 young mathematicians, not counting all the young students who did not have the time to complete their studies, is therefore significant.

To better seize the impact of this loss, we may look more precisely at the proportion of science students and alumni of the Ecole normale killed at war by year of promotion.



From this graph, it is obvious that it was the youngest *normaliens* who were decimated. For the three years 1910 to 1912, more than half of the class died in war. This does not count the wounded, prisoners and other types of casualties. Older promotions, from 1903 onwards, were less but still significantly affected. Alumni who were above 30 years old at the start of the war had however very little chance of being killed while performing their military duty. Comparison with other population have likewise shown that scientists from the Ecole normale suffered greater casualty rate proportionally when they were students, but not afterwards. This difference between generation was somewhat lost in the memories of the conflict and only the great sacrifice of the Ecole would later be remembered.

But numbers alone do not tell a story. As I suggested, it was the stories told about the young men killed in war that in the end informed those memories much more than pure numbers, even if – paradoxically – only the numbers were in the end retained by the memories.

It is a long-held tradition at the Ecole normale supérieure to publish obituaries of deceased classmates. The short notices devoted to students killed in war therefore provide great documentary evidence for their short life and subsequent death. I would like to emphasize the exceptionality of having at our disposal this sort of materials. Young students were given the same treatment as distinguished professors who died at the end of a long career. The documents I analysed therefore provide a very rich, and indeed lively, source about the life and work of young mathematicians at the start of the century.

Joseph Marty's cv shows a typical trajectory followed by the students before they were admitted to the Ecole normale. After a few years in several of France's lycées, they often spent two years in preparatory classes sometimes in Paris.

At the Ecole, they studied hard with some of the world's best mathematicians. Typically, they would pass the teacher's exam [agrégation] after three years. After their military service, they would either get funding for research or would be sent to teach in some provincial lycée.

Some like Marty would do some research and try to publish their results. This manuscript which was sent to the Academy of sciences contains new results about an important topic of functional analysis at the time, call the theory of Fredholm equations.

Of the 22 mathematics student, 2 had already defended a doctorate (one was a university professor; the other working in an observatory); 6 more had published some interesting research; 4 more have been identified as working on a doctorate…

The most famous of them perhaps is René Gateaux (on the left on this picture taken in a room of the Ecole normale). His work on what is now called the Gateaux integral was published by young survivors after he died on the Western front on October 2nd 1914.

Stories told about them are moving and it is sometimes impossible to go over them without being deeply affected by the tragedy of each of these lives. They are however constructed during the war to serve many purposes. They are obvious ways for many writers to grieve the painful loss of a close friend; and they are of course meant to pay tribute to young men who after having been exceptionally successful in their studies had engaged in careers in mathematics either as teachers or as researchers and often both. Together, they also paint a group picture which would significantly shape the meaning of the war, as far as scientists who took part in it were concerned.

To me, once raw emotion is put aside, the most striking aspect of these accounts remained the portrayal of these young men as modest, hard-working family men devoted to their students as well as to their small children and wives. Like in Viple's obituary, with which I started this talk, page after page are devoted to painstaking description of the care with which most of them had embraced a calling as teachers.

In some rare occasions, other sentiments emerged from these stories.

They usually serve to underscore internationalist engagement (like Théophile Rousseau's heavy involvement in the Esperanto movement, here at the Bern International Congress in 1913) or – much less frequently still – their defiance towards German mathematics. A few of them were present at the Cambridge International Congress of Mathematicians in 1912.

Of course, all these qualities translate into great assets once the war is declared. Mostly, they are portrayed as going to battle with resignation; there is little jingoistic enthusiastic, but no hesitation about where their duty lied. Alfred Ballongue took time to pose in front of the photographer before he left, but he pleaded not to be separated from his men when they were sent to the front where he would die. Just like it was pointed out earlier concerning Viple, the *normaliens* appear to have transferred to the men serving under them the mixture of kindness and rigor they had formerly reserved to their pupils.

Some died quickly, like Georges Lery on September 10, 1914, in massive offensives by the German army on badly prepared French regiments.

Some were heroically killed, like Jean Piglowski who died on February 18 1915, at the end of a small machine gun unit, after putting up such a resistance that German soldiers apparently built a stele on his grave.

In public discourses, as well as in the more intimate settings of the obituary, authors betrayed a sense of surprise at witnessing the stoic leadership these men exerted on their troops. A whole new genre of literature emerged around the figure of the *chef*, the leader, who young intellectuals had proven to be. Often criticized before the war, the intellectual seemed to be rehabilitated by this experience. France, after all, had withstood the shock of the invading army.

Slowly, the broken promise of their mathematical career took over. In the case of the young Paul Lambert, barely 21 when he was killed on March 13, 1915, his classmate Gaston Julia – himself heavily wounded in the face two months earlier – felt compelled to compare his fate to Evariste Galois', the young mathematical genius who had died in duel in 1832.

Like for Gateaux, many of the survivors worked at publishing mathematical nachlasses, which would soon fall in relative oblivion. The work of Jean Clairin on Bäcklund transformations would for example only be picked up by a US physicist in the 1970s.

Among the scientists who started to organize the scientific mobilization, like Painlevé, and delivered speeches at the Academy, like Picard, the impression left by the massacre was very strong. The stories picked up from obituaries would receive a wide echo in the press. Prices were given to fallen soldiers at the Academy. More and more, young scientists were relieved from the most dangerous posts and sent to laboratories and teaching centres – for many this came only after they had been injured once, twice or even three times. Many served in sound ranging sections organized by Borel to implement an idea developed by scientists at the Direction of inventions, consisting in locating the enemy's battery by triangulating their position by the sound they made.

Some of them famously located the Pariser Canon with which the Germans bombed Paris in 1917.

By the end of the war, it seemed clear to many that the Ecole normale had paid a heavy tribute to the defence of the nation. While the training they had received had prepared them well to play a crucial part in fighting, their intellectual aptitude had commanded them to authorities. Henceforth, young scientists would serve as scientists, or at least in the artillery, where they would be less exposed.

In ceremonies like this first-time students were readmitted to the school in March 1919 or at the inauguration of the war monument in 1923, postwar memories at the Ecole normale were cultivated on a dual basis. On the one hand, the sacrifice of the Ecole was underscored, as well as the loss to science represented by all these broken lives; on the other, the Ecole was reaffirmed in its mission as the main defender of "free research and disinterested science", of the "pacific and civilizing" mission of postwar France. By contrast, the Ecole Polytechnique represented the adjustments made to these ideals during the war: a heavy investment in the development of new applications of the sciences to industrial and military purposes.

In the twenties, the young men who studied mathematics at the Ecole normale, among whom the ones who would form the Bourbaki group a decade later, encountered such discourses. Interestingly, those who would steadfastly oppose their elders' views of mathematics would in fact pick up rather uncritically the discourse of their alma mater. Mathematics students killed in war were a tragedy pure and simple, the sense of this sacrifice being by and large lost to this generation; their goal now was clear: they should devote themselves to pure mathematical research.

Stories told about mathematicians killed in war, even if the Bourbakis chose not to remember them per se, had fulfilled their role: even while military scientific research was actively promoted by the State, a space for pure, neutral science was opened to them.

To me, this is one of the most lasting consequences of World War I.