A Tribute to Bernard Morin (1931-2018)

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I have lost a good friend who, as we say in French, had a hard tooth. This is no secret, because no one was spared his uncompromising manner. I flatter myself that I was able to keep his friendship through our last meeting on January 12, 2018, at the retirement home in Chaville, his deathplace, as he referred to it. His family was pained to commit him there as he faced the loss of his cherished autonomy. He had gained weight and was puffing his pipe with a continuous plume of smoke, which undoubtedly contributed to the lung infection which killed him two months later.

He asked, when I had announced my visit by phone: "do you have something to bring me? No, so here are some suggestions: a bar of chocolates with mignonettes of Cointreau or Whiskey, meringues... ." It had become necessary to hide all this at the bottom of a drawer because of the inscription displayed in bold characters on the bathroom door: Monitor the weight of Monsieur Morin every Tuesday morning. His hearty appetite had always caused both admiration and anguish in the hostesses when invited for dinner.

But he had kept his customary sharp mind and insisted on talking to me about the issue of misattribution, resulting so often by accident or from a misunderstanding. Using his own case as example, he began with singularities: "René Thom told me that if one had a differentiable preparation theorem, one could describe the singularities with Boardman symbol containing only 1's. I asked Bernard Malgrange, and he quickly demonstrated the theorem[2]. Then Henri Cartan and his students wrote the notice[3] that I signed. My role was very slight and essentially boiled down to a small generalization. Someone in Orsay decided to call it Morin's Singularity anyway."

"On the other hand" he continued "the central model with four arms of the so-called *Froissart-Morin eversion* is really mine. I made a plasticine model of it that I showed to Marcel Froissart in Seattle[4]. It deserves the name of *Morin surface*.

During dinner the conversation turned to the difficulty of doing mathematics. Bernard evoked St. Augustine, according to whom people accept complicated matters like nature, life, animals, but

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not simple things like God, which is why, he said, it is so difficult to approach mathematics by the axiomatic method. Then he added: "This Paul Valéry is a cretin and Einstein was right to put him in his place with his 'notebook of brilliant ideas'."[1] Valéry exclaimed that Pascal would have done better to invent the infinitesimal calculus instead of sewing scraps of paper into the linings of his coat. He ignores the fact that the infinitesimal calculus is germinally in Pascal's treatise on Roulette, and that this work, like any discovery, is exhausting. It took a new and fresh mind, in this case Leibniz, who was able to read Pascal and extract the theory from it.

From his stay at the Letters section of the *École Normale Supérieure* (ENS) Bernard retained a facility of deprecating others. Moreover, when Louis Althusser, who was preparing students for the Agrégation de Lettres at the time, learned of his desire to switch to the Science section, he warned him that: "you'll see, in mathematics, contrary to philosophy where everyone at every turn dismisses others, there is a generally accepted scale of values." Morin had to climb many rungs on this ladder to insure him the respect of the community.

On first meeting Morin, the five most striking things about him were: First his blindness, of course. And he never tired of flaunting it, for example, by pacing up and down the dais and turning around at the last moment just to hear the sighs of relief from the audience; then his intellectual voraciousness from which stemmed his endless telephone conversations at all hours of the day; the cultured literacy he displayed in any scientific milieu; his remarkable quality of expression; and, above all, his exceptional geometric insights.

Struck with glaucoma, he lost his sight at age of six and retained only three memories from his sighted childhood: a kaleidoscope, a landscape painting, and a bamboo flower that someone put into his hand in Shanghai, where he was born in 1931. Blindness manifests aptitudes as well as inaptitudes, so much so that Morin, who felt himself at a loss with long calculations, developed a geometric intuition more appropriate to his manner of thinking. Nevertheless, blindness remained a handicap for him, and undoubtedly, the only time in his life he resented it less was when he attended the *National Institute for Sightless Youths*.

While some people, faced with the difficulties of their handicap, wall themselves up psychologically, others, with Morin's temperament, develop (possibly latent) qualities which permits them to overcome obstacles and forge a character with little tolerance for pity or forced admiration. No doubt this is the origin of his penchant for throwing down his gauntlet and striking back with bared claws.

It was because his father saw no future for him in the sciences that he steered Bernard towards letters.[2] Endowed with an extraordinary dialectical talent which later won him admiration from Althusser, it was his winning the prize in a philosophical competition[3] that won him admission to

[1] Morin refers to a famous meeting at Collège de France in Paris. After the talk by Einstein, Paul Valéry asks: "Master, I got myself a notebook in which I note everyday my new ideas. How do you proceed yourself?" Einstein answers "I don't need any notebook, since I have got only one idea in my life."

[2] The École Normale has two sections, Letters and Science. The former consists of the humanities, and the latter included mathematics. Admission is based on very competitive written and oral exams.

[3] Prix au concours général de philosophie.

the first year preparatory course for the Letters section[4] of the ENS. The following year he suffered through the lectures of Étienne Borne. This, according to Morin, was the cause of his distaste for philosophy, and so, despite his success on the entrance exam, also for his failure to take the Agrégation de Lettres exam.

He observed that, fundamentally, philosophy poses essential questions about the infinite, the discrete, the continuous, number, space, time, measure, chance, but in the end, is exposed to be impotent even to progress towards, let alone arrive, at the answers. These can come only from the hard sciences, primarily from mathematics, which by its mode of reasoning and the abstractness of its objects, constitutes the closest approximation to philosophy.

Rather than occupy the place left vacant in the philosophy of science by the disappearances of Jean Cavaillès and Albert Lautman,[5] he took the plunge and turned squarely towards mathematics where his keen sense of geometry immediately provoked the enthusiasm of Cartan. In 1974, two years after he defended his dissertation under Cartan, he was attracted to the University of Strasbourg, chiefly on account of the stubborn persistence of Claude Godbillon, but especially by Jean Martinet, who envisioned the possibility of a collaboration with Morin in the theory of singularities.

There he soon learned of the existence of the privately circulated Princeton lecture notes by Bill Thurston. Fall 1978, he organized a seminar to study them. At the suggestion of Michel Coornaert, a corner stone of the seminar from the beginning, he christened it GT_3, for Thurston's course title.[6] Ever after, he steadfastly participated in his seminar, even if he had to be absent for whatever reason, such as foreign travel, by having his taperecorder planted squarely on the table in front of the speaker. On occasion, this led to some gritting of teeth.

The question of turning the sphere inside out while respecting the constraints of what is known as a regular homotopy, gave Morin the opportunity to exercise his considerable talents as a geometer. The subject was at the center of the Batelle meetings in Seattle in 1967, which included Raoul Bott, Stephen Smale, René Thom and physicist Marcel Froissart. Arnold Shapiro had died in 1962, but he had had time to explain to Bernard his version of the flip through a double covering of Boy's surface, as Hopf had suggested to Kuiper[8]. Despite everything, it was still difficult to visualize, even with the help of the drawings of Anthony Phillips.

So, in Seattle, Froissart set out to simplify Phillips's drawings, which had an excess of "heart-shapes and date-pits", as Morin dubbed them for mnemonic purposes. Froissart proposed to replace Boy's surface at the center of the eversion with an object of order four symmetry. Morin, seizing the ball on the jump, visualized this object, now called Morin's surface, as well as how to untwist its many self-intersections to become a round sphere. He also made a series plasticine models of the essential stages, from which everyone could now see the whole eversion, but only from the outside. No one, apart from Morin, could describe, with his disconcerting luxury of detail, those ever mutating internal cavities, starting from the nine chambers of his central model.

[4]The hypokhâgne of Louis-le-Grand.
[5]Both died for their country in the WWII Resistance.
[6]The Geometry and Topology of Three-Manifolds, Princeton.

It is remarkable that Kusner's minimax method[7] of flowing a spherical minimum of the Willmore energy up its gradient to the central model, conceived as an Willmore energy saddle, and then down "the other side" to the now everted sphere. Moreover, *Brakke's Evolver* software, as programmed by John Sullivan, chose the very same minimally complicated set of "catastrophes" along the way that Morin initially imagined. In his mind's eye, Bernard must have kept the everting surface as round as possible, just as the supercomputer did by optimizing the Willmore descent.

Later, many other techniques for everting the sphere were developed, in particular that of William Thurston at the end of the seventies, but especially that of Mikhail Gromov at the end of the eighties, which emerged from the theory of singularities and might have induced Morin to bounce back to this subject.

More precisely, he had difficulty in pursuing long and tortuous algebraic arguments. So much so by his own words, that as a natural form of compensation, he sought to produce the formulas which would prove, even at the cost of considerable effort, the validity of his geometric intuitions. His dissertation was a striking example of this. He reduced the determination of the normal form of a singularity to a calculation by determinants, an approach one hardly would hardly have expected from this quintessentially geometric visionary.

But instead, all the various version of visualizing a sphere eversion are some sort of novel proof of its existence. They do not, however, lead to an explicit algebraic parametrization. Yet only explicitly differentiable parametrizations do, in the end, prove that the deformation does not develop some forbidden singularities. What Morin had hoped to produce is a geometrical description so clear that it would give rise to a deformation through perfectly explicit algebraic varieties.

In this regard, the case of *Boy's surface* deserves special mention. It again required finding appropriate formulas to describe the object. By appropriate, we mean conceptual, in the mathematical sense, that is to say characterizing an algebraic object in a unique way if possible. In other words, as we found out later, by defining a certain rational algebraic surface of the sixth degree with one triple point. What Morin really had in mind here was a parametrization of a sphere eversion. He considered the parametrization of Boy's surface as a first step since one can evert the sphere by untwisting its spherical double cover.

He produced explicit formulas for this in a note[9] to the *Comptes Rendus*, but it had an error right at the start, although this could have been easily corrected. More fatefully, the evolving surfaces become too sharply creased and flattened, and in addition the parametrization was not algebraic, and so proved unsuitable for computing the locations of the self-intersection locus and possible singularities.

It was at this time that the mathematics department of the university of Aix-Marseille invited Morin to give a talk on his work. Morin invited the cartoonist, Jean-Pierre Petit, to draw on the black board as he lectured. This multifaceted personage appeared to also have been gifted with the talents of a scientific draftsman.

This collaboration started off on such good terms, seemingly destined to arrive at the very best: *Morin explains – Petit draws.* In 1979, their collaboration appeared in *Pour la Science*, and later deservedly won the d'Alembert Prize. Nourished by Morin's generous verbal descriptions, Petit fabricated a wire model of Boy's surface. Still friends at the time, they asked the local artist, Max Sauze, to weld a sculpture of it out of some silvery metal. This was eventually exhibited in the Pi Room of the Palais de la Découverte. Here, then, is the substance of how this ended their friendship.

It turns out that the generating curves of the Sauze model were planar ovals while the curves imagined by Morin are non-planar and twisted. From planar ovals it's an easy jump for a geometer to an ellipse, and that had two consequences.

First, Petit asked a programmer to measure the dimensions of the Sauze model, and turned these into an empirical rendering which gave rise to the note[11] in the Comptes Rendues.

Second, it turns out that this generation of the surface by the motion in space of an ellipse (with changing dimensions) is the point of departure for transforming Steiner's *Roman surface* into *Boy's surface*, as a rational surface of degree six, by a generic pairwise elimination of the six Whitney singularities. This was the subject of my dissertation under the direction of Morin in 1984 and published in [12].

Suddenly, the authorship of these ellipses created a misunderstanding that quickly devolved into an exchange of volatile insults. For Morin, it was an unexpected discovery by Sauze, for Petit, it was he himself who told Sauze to use planar ovals. This seemed to be a very thin excuse for a dispute, but, in fact, a misunderstanding had gradually settled between the one who thought like a mathematician, and the other who thought like a popularizer.

Let me take this opportunity to relate an example of Morin's truly breathtaking mastery of spatial intuition. I had used a high resolution graphics computer to visually check the confluence of two Whitney umbrellas, and Morin, who obviously could not see this, asked me if I was content with my observation.

"Absolutely."

"What about Boy's surface?"

"Flawless, maybe a tiny ripple in one spot, but I have to check that it is not a programming bug. "

"Oh well, where is it located?"

"It's barely visible."

"Tell me!"

I then gave an approximate position of the micro-depression. Morin thought about it for a good quarter of an hour, then he concluded. “It is the trace of a desingularization by confluence of umbrella pairs. It must take place exactly in such and such a place, and your bump will be absorbed as you continue the homotopy.”

That was indeed the case!

It was around 1984 that Morin reconciled himself with philosophy through the writings of Jean Beaufret on Heidegger[11], regretting not having attended the Lycée Henri IV where Beaufret taught because his father insisted on enrolling him in Louis-le-Grand. In 1988, this renewed interest gave birth to a conference paper on the verb “to be”, which he presented at the Franco-Japanese House in Tokyo.

From these very dense thirty-four pages emerges something based on Heidegger’s philosophy of the technical sciences, which both tormented and supported Morin, namely religion. “Prior to being political or rational, man is first and foremost a religious animal” he said here, and adds that: “I don’t know if there is salvation through philosophy. As a Christian, I have never doubted that there is salvation through religion.” Indeed, he remained a profound believer, close to the Abbot of Nantes.[7]

Morin often left a indelible mark during his travels, notably at the University of Illinois, where George Francis perpetuates his memory in his writings and computer animations, as well as in Japan where he frequently visited universities at the invitation of Masaaki Yoshida. He even acquired a living memory in his flesh as follows.

One day, as he was walking in the streets of Hiroshima, he asked his guide if there was any risk of residual radioactivity. “The city is one of the safest in world! he was told, just as a car hit him on a pedestrian cross walk. This time, it was more of a scare than injury. But just a few years hence in Fukuota, 1991, while returning on foot from the university, he was hit by a taxi and had both his legs broken. He remained in a local hospital for five months, and ever after, the titanium pins set off the metal detectors.

Anyway, everyone must die one day, even Morin who held onto his Catholic faith without having made any concessions to the modernist tendencies of the post-conciliar church.

[7] Georges de Nantes, a former abbot and founder of the *League for Catholic Counter-Reformation* a conservative and traditionalist cult.

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