

8 – CURRENT AFFAIRS

André-Marie Ampère

“Ampère was a man of simple tastes, with his loves and his sadnesses, alternating between religious doubt and profound faith, his dedication to his work and his discouragements, above all his passionate search for the truth, expressed in his heartfelt cry: ‘I only find truths; show me the Truth’” Paul Janet¹

André-Marie Ampère, the French physicist and pioneer of electrodynamics, gave his name to the unit of electric current, the ampere, usually abbreviated to *amp*. His life, however, was full of personal tragedy, and it was perhaps because of this that he devoted himself so single-mindedly to his science.

He was born on 20 January 1775 in Lyon, the great silk manufacturing city and the second largest conurbation in France. Lyon has a long and turbulent history. Situated at the confluence of two major rivers, the Rhône and the Saône, it was a major strategic city in Roman times, then later became the principal city of the Provençal kingdom. Its frontier position on the old borders of France, Provence and Italy ensured the city’s growth as centre of trade, industry and finance. From 1400 it flourished as a centre for silk weaving, and today has a museum containing one of the world’s greatest collections of textiles. Despite efforts by the Revolutionaries in 1793 to destroy the city, it has survived as a major industrial centre. And although nowadays the accent is on metals and chemicals, there is still a thriving textile industry.



Fig. 8.1 Painting of Ampère
(French School, 19thC)

Ampère’s father, Jean-Jacques, was a merchant who prospered from the silk industry, and his mother, Jeanne-Antoinette Desutières-Sarcey, was also from a well-to-do family involved in the silk trade. They were married in 1771, and it was not long before a daughter, Antoinette, was born in 1772, followed by André-Marie three years later. A second sister,

Josephine, was born in 1785. Although ten years younger than him, she was later to become his house-keeper when he moved to Paris. In common with many other bourgeois families, the Ampères had a country retreat at Poleymieux as well as a house in the heart of the old commercial centre of Lyon.

The village of Poleymieux, about 10 km north-west of Lyon, is situated in a small enchanting valley in the Mont d'Or mountains, and it was here at their country home that the Ampère family spent the summer months. It was an idyllic spot, the hills dotted with white villas and, below, the graceful Saône River winding its way through the woods and fields.



Fig. 8.2 The Ampère house at Poleymieux

After Jean-Jacques' semi-retirement in 1782, at the age of 49, the family took up permanent residence there. The tranquil setting of his country home in Poleymieux was the inspiration for André-Marie's formative years, from the age of seven, and left in him a yearning in later life to return to the idyllic scenes of his boyhood. The house today is a national museum of electricity, and contains many historical documents, books and apparatus demonstrating Ampère's experiments and the development of electricity.

There was no school at Poleymieux at that time so, as with many bourgeois families, André-Marie was educated at home by his father. He was given access to his father's library and encouraged to read books on natural history, Greek and Roman history, as well as French and Latin literature. His father being a keen follower of Rousseau's educational philosophy, the young boy was given ample opportunity to explore the terrain around Poleymieux and 'learn from nature'. In his own autobiographical account, in which he refers to himself in the third person, we read:

"His father, who had never ceased to cultivate Latin and French literature, as well as several branches of science, raised him himself in the country near the city where he was born. He never forced him to study anything, but he knew how to inspire in him a desire for knowledge."²



Fig. 8.3 Poleymieux from the terrace of the Ampère house

His country upbringing, however, far from the bustling city life and society of Lyon, had its disadvantage; he was never at ease in society, and for the rest of life he exhibited a certain awkwardness with other people.

Two works which aroused an early interest in natural science were Buffon's *Histoire Naturelle*, with its beautiful, captivating paintings of animals and birds, and Diderot's *Encyclopédie*. He learned entire articles by heart, and apparently in later life could recite pages from memory. The *Encyclopédie*, containing hundreds of articles on science, technology, as well as natural history, music, art and so on, was an attempt to summarise all human knowledge. First published in 1751, it was one of the most important documents of the Enlightenment in France, marking a move away from unquestioning, dogmatic belief towards reason and science. Much of the work sought to popularise the new thinking of Newton as well as other luminaries of the seventeenth century. But its questioning of religious dogma did not please the religious or the civil authorities, and it was banned by the Council of State.

Another important early influence on Ampère was reading the eulogy on René Descartes by Antoine Leonard Thomas. In this book, Descartes is portrayed as a seeker after truth, who turned his back on the mysticism surrounding the science of the Middle Ages and dedicated himself to the pursuit of knowledge. The famous spirit of doubt that pervaded Cartesian philosophy, challenging the dogmatism of traditional teaching, and preferring mathematical reasoning, impressed the young Ampère.

According to Ampère's own autobiographical account, he developed an interest in mathematics at the age of thirteen. Whether or not this was inspired by Thomas' book is not clear, but he had soon mastered the elementary texts on mathematics and gained enough confidence in the subject to submit a memoir to the Académie de Lyon on the geometric

construction of a straight line equal in length to an arc of a circle. In it, he used the concepts of infinitesimals – the stuff of differential calculus – but since he had not studied calculus he stumbled in their application. At about the same time he read an article on calculus in the *Encyclopédie*, but had difficulty understanding it. His father, being no mathematician, was unable to help him, but arranged for lessons in calculus by Abbé Daburon, professor of theology at the Collège de la Trinité in Lyon. (Perhaps there is a subtle connection here – remember that Isaac Newton had developed his early thoughts on calculus whilst at Trinity College in Cambridge!)

Other early influences were the study of the works of other scientists such as Euler and Bernoulli, and by the age of eighteen he had mastered such seminal works as Laplace's *Treatise on Celestial Mechanics* and Lagrange's *Analytical Mechanics*. With his father, he also attended some physics lectures given in Lyon during the winter months. In all, his childhood and education were stimulating and emotionally satisfying. His parents also instilled in him what would be a lifelong devotion to Catholicism.

Soon, however, disaster was to befall the family. Ampère's father, Jean-Jacques, in his position as a bourgeois landowner was responsible for collecting feudal tithes from the local peasants, working for the *seigneur* of Poleymieux, Guillin Dumontet, who had recently taken up residence in the château there. Seeds of discontent were already being sown as Guillin, through his high-handed treatment of the peasants and the enlargement of his manorial property at their expense, had succeeded in alienating them.

The storming of the Bastille in Paris on 14th July 1789 marked the start of the French Revolution – the popular uprising against the old feudal regime. The unrest rapidly spread to the provinces, and groups of peasants took up arms, ostensibly to defend themselves against a backlash from the nobility, but sometimes attacking the châteaux and trying to destroy the land registers that listed the dues owed to their lords. This alarmed the National Assembly, who in August 1789 quickly acted to abolish the feudal society of the *ancien régime*, and issue the famous 'Declaration of the Rights of Man'.

During the first two years of the Revolution, although its effects were felt, Poleymieux had largely escaped the violence and drama which were unfolding elsewhere in France. Jean-Jacques was sympathetic to the aims and ideals of the Revolution, but had lost his administrative post at Poleymieux in 1789. It was just as well to distance himself from Guillin Dumontet, as the *seigneur* of Poleymieux was making himself ever more unpopular with the peasants. Elsewhere, peasants had stormed manorial châteaux, but here in Poleymieux they preferred to use legal methods of challenging their *seigneur's* financial machinations. Following the abortive flight of Louis XVI in 1791, however, tension increased and a large crowd

attacked the château and destroyed it, killing Guillin and parading his dismembered body through the streets of the city.

Up until now, the Ampère family do not appear to have been threatened by the growing unrest. But the civil war that had spread throughout France during 1792 and 1793 now engulfed Lyon, which had traditionally had monarchist sympathies. The Jacobin revolutionists, who were now the ruling party in Paris, set up guillotines in most major cities and ordered the public execution of anyone suspected of treason against the Revolution. Increasing oppression by the revolutionists in Lyon, led by Marie Joseph Chalier, led to a backlash by the royalists, who sacked the revolutionary headquarters and took over the municipal government in May 1792.

The provisional royalist government in Lyon proceeded to issue arrest warrants for prominent revolutionists, including Chalier. It was Jean-Jacques Ampère's job, as a Justice of the Peace, to certify these arrest warrants and initiate legal proceedings. The National Convention in Paris promptly accused the royalists of insurrection and declared anyone helping to carry out the orders of the royalists to be guilty of treason. Thus Jean-Jacques found himself embroiled in the civil war and accused of being a traitor to the Revolution, even though he had only been performing his official duties. Matters worsened when the royalists ignored the threats from Paris and executed Chalier; this triggered a violent reaction from the National Convention who ordered the destruction of the city: "Lyon warred against Liberty; Lyon is no more."³ The siege of Lyon lasted for two months, culminating in the capture of the city in October 1793. Jean-Jacques Ampère was among those imprisoned; he stood trial in November 1793, was found guilty as 'the justice of the peace who had issued the arrest warrant against Chalier', and guillotined. His trial was in fact one of the last occasions when a semblance of law and order prevailed, before the descent into the chaos that marked the Reign of Terror.

The effect of his father's death on the young Ampère, now eighteen years old, was devastating. Already he had suffered the loss of his older sister, Antoinette, who had died, tragically, the previous year at the age of twenty. He went into a state of almost total physical and mental withdrawal, which lasted for nearly a year and a half. During this time there was no question for him of any study. He later recalled that it was a reconnection with nature in the lush countryside around Poleymieux, and a renewed interest in botany, that contributed to his recovery. He also began writing poetry as a therapy to reconcile him to the loss of his father. His concern to find orderly patterns in nature has a direct analogy with his later efforts to discern the mathematical laws behind the electrical phenomena he studied.

It was during one of his botanical excursions in April 1796 that Ampère met Julie Carron who, three years later in August 1799, became his wife.

For Ampère it was love at first sight; he was twenty-four and Julie was almost twenty-six. His diary records the romance with touching simplicity:

“We were in the lane where I climbed the large cherry tree, from which I threw the cherries down to Julie... I sat down on the grass at her side, and ate the cherries which were in her lap... we went into the big garden where she accepted a lily from my hand; we went together to look at the stream; I gave her my hand to jump across the low wall.”⁴

The Carron family had much in common with the Ampères; Julie’s father, like Jean-Jacques Ampère had been a successful silk merchant, and they also maintained a home in Lyon as well as a country retreat at St. Germain-au-Mont d’Or, a few kilometres north of Poleymieux. Socially and intellectually, however, there were differences; Julie enjoyed theatre and dancing and the social whirl of city life in Lyon, while Ampère had few social graces. Julie’s sister, Elise, summed him up: “he has no manners; he is awkward, shy and presents himself poorly.”⁵ Julie’s reading was restricted to literature and history, and she had no inclination to share Ampère’s scientific interests. Their wedding in August 1799 involved a clandestine religious ceremony – Catholic rituals had been banned by the revolutionary government – and civil proceedings the following day.

The marriage included some of the happiest moments of Ampère’s life, but the early years were a struggle to make ends meet. Julie confided to her mother in her first letter home: “The more I know him, the more do I find him kind and sensible. With a little fortune everything would go well.”⁶ As well as financial worries, the early years of the marriage were dogged by continual worries about Julie’s failing health. Their son, Jean-Jacques, named in memory of Ampère’s father, was born in 1800 and gave them both great joy, but the birth had taken its toll on Julie’s health. The Revolution had destroyed the financial independence of Ampère’s family, and so he was forced to earn a living by seeking employment. Encouraged by friends and relatives, he embarked on private tuition of mathematics students in Lyon.

That was not Ampère’s only occupation, however; to make up for his lack of formal education, he determined to prove himself to the academic world by writing a paper on science. He was only too well aware that to get anywhere with an academic career, one needed to be noticed by men of influence and get papers published in respected journals. Thus we see him in 1801 embarking on a grand treatise which tackled the whole range of topics from electricity and magnetism to gravitation, and attempted to reconcile the different theories in vogue at the time. He presented an outline of his work at the Académie de Lyon in December 1801 before a distinguished audience which included Alessandro Volta. The treatise was never completed, but here we catch a glimpse of his fertile mind struggling to make sense of the mechanisms behind electricity, magnetism, heat and

light, subjects that would preoccupy his thinking for the rest of his life.

Teacher of Mathematics

In 1802, on the strength of his reputation as a tutor, Ampère was appointed as professor of mathematics at the Ecole Centrale for the department of Ain in Bourg-en-Bresse, about 60 kilometres north-east of Lyon. This school had a long and prestigious history, dating back to 1391. With the inspiration of the famous astronomer, Joseph Jérôme Lalande, who was born in Bourg, it had become the centre of intellectual life in the mid-eighteenth century, and was eventually renamed Lycée Lalande. Despite lacking any experience of formal education himself, Ampère held his own there, teaching mathematics, physics and chemistry. At that time, the journey from Lyon to Bourg would have been a one and a half days, and his wife's ailing health would not permit her to travel. So he had to live in private lodgings while his wife and young son stayed with her family in Lyon and Poleymieux.

Ampère's letters to Julie during their enforced separation express his deep affection for her, telling her where he kisses the pages of his messages to her, and that her replies would be treasured for ever. But the year he spent there put a severe strain on their marriage, and Ampère was desperate to find a job nearer home.

But how was he going to secure a more amenable teaching position? His thoughts turned towards mathematics and back to the parlour games he used to play when a boy at Poleymieux, and he determined to write a paper which would impress the examining committee for a teaching post at Lyon. Inspired by reading a printed edition of lectures by Lagrange on analytical functions, Ampère wrote a paper in 1802 on *The Mathematical Theory of Games* which, following in the footsteps of Pascal and Fermat, calculated the probability of a gambler losing all his money. This paper was submitted to the Institut National in Paris in 1803, and won him associate membership of the Société d'Emulation de l'Ain, one of the few centres of intellectual life in Bourg. Lalande, who was on the Institut's examining committee together with Laplace and Jean-Baptiste Delambre, pronounced "Citizen Ampère possesses rare knowledge and marked talent."⁷

A second paper on the 'calculus of variations' was presented to the Société d'Emulation de l'Ain in March 1803. This was inspired by Lagrange's classic text, *Analytical Mechanics*, a book with which Ampère was familiar through reading it during his adolescent years. One everyday problem to which Lagrange had applied his method was the shape taken up by a chain hanging from two fixed points; he was able to produce a mathematical formulation for this 'catenary' curve using his analysis of the forces acting on the wire at each point. In his paper Ampère produced a

revised procedure for working out the shape; while it was no fundamentally new idea, this and his previous paper on probability did serve to establish Ampère's credibility in the field of mathematics.

Delambre was so impressed with Ampère's work that he had no hesitation in recommending in March 1803 for a mathematics position at the newly established Lycée in Lyon. Delambre, one of the most powerful scientists in France at that time, proved to be one of Ampère's most influential patrons. It was Delambre who, together with Pierre Méchain during 1792-1798, had undertaken the survey of the meridian line in order to establish the length of the metre as the fundamental unit of distance. As a reward for his endeavours, Delambre had been elected as the first permanent secretary for mathematics at Napoleon's newly-created Institut National.

This was all that Ampère had hoped for. The position at Lyon would enable him to give Julie the support and companionship she needed. But their reunion in April 1803 was sadly to be short-lived. Her health deteriorated further, and after only four years of happy marriage Julie died in the July, the official diagnosis being an abdominal tumour. Ampère's memories of Julie would be permanently coloured by guilt – that they had spent so much time apart and that he had not taken more of an active part in the rearing of his son. He had lost a dear companion, and one who had provided the emotional security he needed after the loss of his father.

Julie's illness had provided the context for a brief flirtation with spiritualism and the teachings of Franz Anton Mesmer, who believed that illnesses could be cured by subtly manipulating the human body's 'natural magnetism' – what he dubbed 'animal magnetism'. Although a royal commission in 1784, which included no less a person than Lavoisier, had discredited Mesmer's magnetic fluid, Julie received frequent visits from a practising mesmerist. Clearly, the methods he employed were purely mumbo-jumbo, but Ampère was nevertheless intrigued by the idea that electric fluid played some part in biological processes. It is interesting to note that Mesmer's methods gained some respectability when some psychosomatic disorders were cured by suggestion, and the Scottish surgeon, James Braid, re-introduced some of Mesmer's methods, devoid of their mysticism, as hypnotism. Today mesmerism is an accepted synonym for hypnotism, and the word 'mesmerise' owes its derivation to Franz Anton Mesmer.

The Ecole Polytechnique

Depressed by the loss of his wife, Ampère determined to make a break with Lyon and move to Paris, the acknowledged centre of academic and scientific research. In 1804, thanks again to the recommendation of