

## A. Italian renaissance mathematics

### Perspective - Piero della Francesca

Piero della Francesca was the first major painter to fully understand perspective, because he was a mathematician as well as an artist (for example in The Flagellation of Christ). To give a sense of depth, a sense of the third dimension, Piero used mathematics. The problem of perspective is how to represent the three-dimensional world on a two-dimensional canvas. The parallel lines in the three-dimensional world are no longer parallel in the two-dimensional canvas, but meet at a vanishing point. Piero's work was the beginning of a new way to understand geometry, but it would take another 200 years before other mathematicians would continue where he left off.

## B. 17th century mathematics

### Coordinates - Descartes

By the 17th century, Europe had taken over from the Middle East as the world's powerhouse of mathematical ideas. Great strides had been made in the geometry of objects fixed in time and space. In France, Germany, Holland and Britain, the race was now on to understand the mathematics of objects in motion and the pursuit of this new mathematics started in a village in the centre of France. Descartes was born in 1596, a sickly child who lost his mother when very young, so he was allowed to stay in bed every morning until 11.00am, a practice he tried to continue all his life.

Descartes was a mercenary. Very early one autumn morning in 1628, he was in the Bavarian Army camped out on a cold river bank. Inspiration very often strikes in very strange places. The story is told how Descartes couldn't sleep one night, maybe because he was getting up so late or perhaps he was celebrating St Martin's Eve and had just drunk too much. Problems were tumbling around in his mind. He was thinking about his favourite subject, philosophy. He was finding it very frustrating. How can you actually know anything at all?! Then he slips into a dream...and in the dream he understood that the key was to build philosophy on the indisputable facts of mathematics. Numbers, he realised, could brush away the cobwebs of uncertainty.

He wanted to publish all his radical ideas, but he was worried how they'd be received in Catholic France, so he packed his bags and left. Descartes found a home in Leiden, Holland. He'd been one of the champions of the new scientific revolution which rejected the dominant view that the sun went around the earth, an opinion that got scientists like Galileo into deep trouble with the Vatican. Descartes was not only interested in mathematics, but also in mechanics. He merged algebra and geometry. He wrote a sort of dictionary between the two, which was published in Holland in 1637, and included mainly controversial philosophical ideas. But the most radical thoughts were in the appendix, a proposal to link algebra and geometry: Each point in two dimensions can be described by two numbers, one giving the horizontal location, the second number giving the point's vertical location. Suddenly, geometry has turned into algebra. Descartes had unlocked the possibility of navigating geometries of higher dimensions, worlds our eyes will never see but are central to modern technology and physics.

There's no doubt that Descartes was one of the giants of mathematics. Unfortunately, though, he wasn't the nicest of men. He was entirely self-convinced that he was right, also when he was wrong and his first reaction would be that the other one was stupid that hadn't understood it.

### Prime numbers - Mersenne and Fermat

In the 17th century, there was a Parisian monk who went to the same school as Descartes. He loved mathematics as much as he loved God. Indeed, he saw maths and science as evidence of the existence of God, Marin Mersenne was a first-class mathematician. One of his discoveries in prime numbers is still named after him (Mersenne In mathematics, a Mersenne prime is a prime number of the form  $M_n = 2^n - 1$  ).

But he's also celebrated for his correspondence. From his monastery in Paris, Mersenne acted like some kind of 17th century internet hub, receiving ideas and then sending them on. Mersenne urged people to read

Descartes' new work on geometry. He also did something just as important. He publicised some new findings on the properties of numbers by an unknown amateur who would end up rivalling Descartes as the greatest mathematician of his time, Pierre de Fermat.

Unlike the aristocratic Descartes, Fermat only tackled mathematics in his spare time. By day he was a magistrate. Battling with mathematical problems was his hobby and his passion. Fermat's greatest contribution to mathematics was to virtually invent modern number theory. He devised a wide range of conjectures and theorems about number including his famous Last Theorem, the proof of which would puzzle mathematicians for over 350 years. Fermat managed to find several new patterns in numbers that had defeated mathematicians for centuries.

One of his theorems, his Little Theorem, is the basis of the codes that protect our credit cards on the internet. Technology we now rely on today all comes from the scribbles of a 17th-century mathematician.