THE SECRET OF PLOËRMEL. BROTHER BERNARDIN'S ASTRONOMICAL CLOCK

by Bernard North

WHILE on holiday in France in 2008 we happened upon the small town of Ploërmel situated about sixty kilometres to the south-west of Rennes. The town is modern rather than romantically mediaeval, and at the 1999 census, the population was 7,525. It is set on the edge of the magical Paimpont forest, which legend proclaims is the home of Merlin the Magician, amongst other fantastical characters. On one side of the main square there is what appeared to be an abbey or church Not being able to find an entrance from the square we went to one corner and found to our surprise a sign 'Horloge Astronomique - Musée – J-M de la Mennais' on the wall of a building Following this sign we came to a nondescript opening through another building. Proceeding through this opening we came into a delightful courtyard, full of flowers, trees and shrubs, in the centre of which was a large glazed kiosk (Fig.1). The kiosk contained a large magnificent astronomical clock and orrery belonging to the Community of Brothers of Ploërmel. We learned later that this clock was classified as a historic monument in 1982 by the French Minister of Culture. The design and workmanship of this clock is excellent and it is surprising that it appears not to be known about in the UK. The intention of this article is to make good this omission.

Fig. 1. The kiosk containing the astronomical clock.

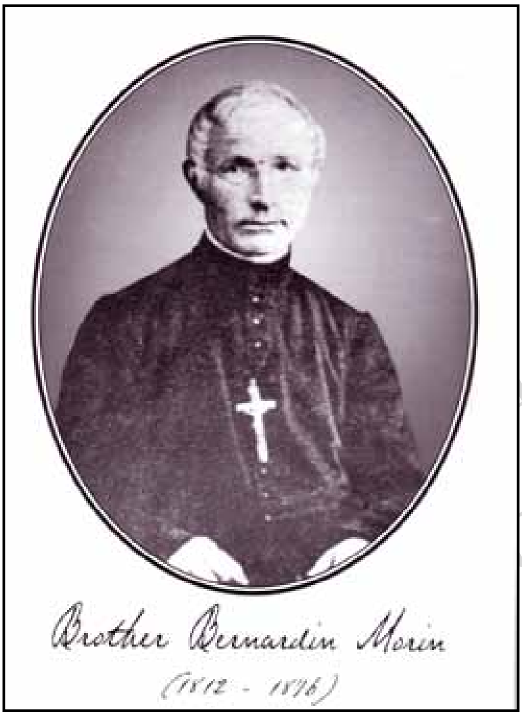

Fig. 2. Brother Bernardin, who designed and made the clock in the 1850s.

THE COMMUNITY OF BROTHERS OF PLOËRMEL

In 1819, Father Jean-Marie De La Mennais, a French priest, founded a teaching order of Brothers to open and run schools in post-Revolution Brittany. They became known as the De La Mennais Brothers or Brothers Of Christian Instruction. They are now known as The Community of Brothers of Ploërmel. Since then the order has spread to twenty-five countries, including Southampton and Liverpool in England.

Father De la Mennais did not believe that the Brothers should limit themselves to teaching reading, writing and arithmetic. He decided that they should train young people for a profession in life. Lessons were given in hydrography and navigation.

BROTHER BERNARDIN (1812-1876)

Gabriel Morin, who took on the name Brother Bernardin when he joined the Community (Fig.2), was born in Guer, a small town situated about twelve miles from Ploërmel. He belonged to a family of thirteen children, three of whom became Brothers of Ploërmel. Father De la Mennais, having noticed Brother Bernardin's aptitude for mathematics, sent him to teach in the school at Ploubalay, near Dinard, where he could go for lessons in mathematics. From 1837 on, Brother Bernardin gave courses in mathematics, astronomy and navigation to the young Brothers in Ploërmel. He was a man of faith and science, and an author of many scientific works, including a book on arithmetics that ran to six hundred pages.

It was with the object of making his lessons clearer for his students that he set about constructing the astronomical clock between the years 1850 and 1855. He was not a clockmaker and it appears he only ever made the one clock. Brother Bernardin made long calculations by hand, which were unfortunately lost in 1903 at the time of the expulsion of the Brothers from Ploërmel. However, another Brother had made a copy of Brother Bernardin's 125 page notebook describing all the works, numbered from 1 to 197, giving for each wheel the diameter, the thickness, the number of teeth, and the time of rotation. Brother Bernardin died in 1876 at the age of sixty four. He had spent thirty nine years at Ploërmel.

HISTORY OF THE CLOCK

Brother Bernardin designed the clock with the help of some other Brothers. All calculations were carried out by hand. All wheel and other castings were made in the local community forge. Brother Bernardin manufactured each part. He cut the teeth of the two hundred wheels by hand, using a manually operated lathe. This does seem extraordinary for a man who had never made a clock before. He was helped in the construction by four of his learned brethren, who were specialists in mathematics. He also received help from Brothers working in the community forge. According to witnesses he only had to make some alterations on two occasions; he had been a fraction of a millimetre out!

The clock began to function in May 1855. When it was completed the clock was kept in the motherhouse in Ploërmel, in the northern part of the building overlooking Boulevard Foch. In 1874, a big building programme was undertaken and the section where the clock was kept was demolished to construct the Procure, a

Fig. 3. The movement, with the vertical rods connected to the planetary system and two of the cables connected to the bells that are suspended from the ceiling.

store for books, clothing, etc. Brother Bernardin dismantled the clock and packed it into cases. It was not put together again in his lifetime.

In 1878, Brother Marcellin-Marie Rouzioux, a missionary from French Guiana, profited by his home-leave in France to reassemble the clock. It is not known where the clock was situated at that time; the kiosk where it is now situated was built in 1895. In 1904, after the expulsion of the Brothers, the clock was put up for auction. It seems strange that its merits were not appreciated and that it was not wanted. It was offered for sale, incredibly by metal weight. It was indeed fortunate that a buyer was not found! The clock was overhauled in 1920 by Terraillon, a firm from Morez (Jura), and again in 1979 by Ungerer, a firm from Strasbourg, who found that the planetary system was blocked in such a way that the three driving wheels were damaged. The clock remained for several months in Strasbourg, where it was reassembled in the firm's workshops. Three small cogwheels had to be remade.

They profited by the occasion to check the calculations using a computer. They did Brother Bernardin's calculations the other way round. The problem for him had been as follows: according to all the books on astronomy, Jupiter completes an orbit of the sun in 11 years 315 days, so he had to calculate the number of cogs to reach such a result. In Strasbourg, they did the calculations in the reverse order. They counted the number of cogs on all the wheels, and calculated the speed of rotation of each one. They thus calculated that in the clock Jupiter makes a complete orbit in 11 years 315 days, as it does in space.

After being overhauled in Strasbourg, the clock was classified as a Historical Monument in 1982.

THE ASTRONOMICAL CLOCK

The clock (Fig. 3) has a wooden second pendulum and an anchor escapement, and is powered by weights that are wound up every day. It is also linked to a large orrery. It chimes the quarters, the half hours and the hours, as well as the Angelus at 6.00 a.m. and at midday.

Fig. 4. Side view of the movement, with the rods transmitting the movements to the dials.

The mechanism of the Angelus is made so as to enable it to be rung as many times as required without affecting the regular times in any way.

Three rods transmit the movements of the central clock to the dials (Fig. 4). The upper rod makes one revolution a minute and only actuates Dial 1. The second rod makes one revolution in 24 hours. It acts directly on dials 5 and 6 that rotate in 24 hours, and then by means of numerous reductions, acts on dials 2, 3, 4, 7, and 10.

A third rod makes one revolution in 23 hours 36 minutes and acts on dials 8 and 9.

The kiosk in which the clock is placed is neither heated in winter nor cooled in summer. Yet it is stated that it keeps good time – the actual accuracy is not known.

Due to the location of the clock in the kiosk it is difficult to take photographs showing the clock, the planetary system and the bells to their best advantage.

THE DIALS

The clock has ten dials (Fig. 5) and their functions are as follows:

Dial No 1 indicates the mean time of our time zone (Greenwich). Standard time (in France) is advanced sometimes by an hour, sometimes by as much as two hours. The dial has the traditional hour, minute and second hands.

Fig. 5. View of the dials.

Figs. 6-9: The dials nrs. 2, 3, 4 and 5.

Dial No 2 serves as a calendar. The short white hand indicates the date, and the long yellow hand, the day of the week. For 30 day months the white hand has to be moved forward by hand.

Dial No 3 gives the position of the moon and the months of the year with the seasons and signs of the zodiac. A lunar month has an average of 29.53 days. The long yellow hand revolves in 29 days 12.75 hours and indicates the phases of the moon. The white hand revolves once a year and indicates the month, the season and the sign of the zodiac.

Dial No 4. The equation of time (the difference between real time and mean time) is shown by a white hand that revolves once a year. The yellow hand, which moves anti-clockwise and revolves once a day, has attached to its extremity a small sun that disappears when the sun sets. Thus it is invisible at night and only re-appears at the moment the sun rises. The two rectangles move up or down and indicate the times of rising and setting of the sun. They are actuated by two eccentric wheels, situated behind the dials. They are at their lowest about June 21st and at their highest about December 23rd.

Dials Nos. 5 and 6 give the standard time, to the nearest minute, for the whole world. These dials rotate once every 24 hours. It is midnight at the bottom of dial 6 and at the top of dial 5. Inversely, it is noon at the bottom of dial 5 and at the top of dial 6. The dials consist of the two earthly hemispheres on the equatorial plane: each one is determined by its latitude and longitude. Each dial makes one revolution in a mean solar day. To find the time at a particular

location the place must be found on one of the hemispheres, then by finding the number indicating its meridian, this gives the time for the chosen location.

Figs. 10-14: The dials nrs. 6, 7, 8, 9 and 10.

Dial No 7 gives the position of the moon, the earth and the sun. The yellow hand follows the sun and revolves in 24 hours, the white hand follows the moon and revolves in 24 hours 50 minutes. At the new moon, they overlap. At the full moon, they are in a straight line. At the time of the first and last quarters, they form a right angle.

Dials Nos. 8 and 9 give a view of the heavens at any moment over Ploërmel. The bold white line represents the ecliptic, i.e. the course followed by the sun through the constellations of the zodiac throughout the year. These two dials make one revolution in a sidereal day, i.e. in 23 hrs 56 minutes.

Dial No 10. The long yellow hand makes a complete revolution in one year. It gives the position of the sun on the ecliptic by means of its right ascension and its declination. The

Fig. 15. The planetary system, showing the revolution of the heavenly bodies, stands on a separate pedestal.

Fig. 16. The gearwork of the planetary system.

white hand indicates the years; it rotates once every century. The small black hand indicates the centuries; it rotates once every 1000 years!

It is interesting to note that Brother Bernardin had a sense of humour. In a letter written on 15th May 1857 to a Brother in Senegal, in which he described his newly constructed astronomical clock, he wrote

> When we reach the year 2700, I will change 1800, 1900, and 2000, into 2800, 2900 and 3000 – Do you think that in a thousand years I will be able to spare the time to change a figure in 10 different numbers?

THE PLANETARY SYSTEM

The planetary system (Figs. 15 and 16) is driven from the central clock by two rods. One rod sets the whole system in motion, whilst the other causes the earth and Jupiter along with its satellites to rotate, and the moon to revolve around the Earth. The Sun and the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn and Uranus are shown, together with the four satellites of Jupiter, six satellites of Saturn and the moon round the Earth. The planets Neptune (discovered in 1846) and Pluto (discovered in 1930) are not shown.

CONCLUSION

To find such an unusual and fascinating astronomical clock and orrery in a small town was a stroke of good fortune. Further, to learn that it was designed and made by a mathematician who had never made a clock before or since was extraordinary. The quality of the design and workmanship is of the highest order. A visit is strongly recommended.

ACKNOWLEDGEMENTS

This article is largely based on an illustrated 42-page booklet, *Brother Bernardin's Astronomical Clock*, which also gives technical drawings, reproductions from Brother Bernardin's mathematical manuscripts and other additional details. It is available from the Community of Brothers of Ploërmel, 1, Boulevard Foch, B.P. 35, 56801 PLOËRMEL cedex, France.

For an on-line description (in French) and illustration of the astronomical clock see http://horloge.astronomique.free.fr/index.html.

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