Jean Baptiste Delambre

The life of geodesist-astronomer and mathematician **Jean Baptiste Joseph Delambre** (September 19, 1749 – August 19, 1822) is a Horatio Alger tale of a poor lad who through determination and grit overcame many hardships to win the admiration and praise not only of his profession, but also of his nation and the world. He was born in Amiens where he began his education. He won a small scholarship that enabled him to attend the Collège du Plessis in Paris where he studied literature and history. He was especially skilled in languages and made various translations of works in Latin, Greek, Italian and English. After graduation he was so destitute that he lived a whole year on just bread and water. He made ends meet as a private tutor while studying mathematics, finally securing a position tutoring the son of Geoffroy d'Assy, the Receiver General of Finances. In 1780 Delambre attended the lectures at the Collège de France of Joseph Jérôme de Lalande, who had participated in the calculation of the distance from the Earth to the Moon. Delambre wrote a series of annotations and emendations of Lalande's work, which convinced the latter to entrust Delambre with the most complicated astronomical calculations. Lalande prevailed on M. d'Assy to establish a first-rate observatory at his home to be used by Delambre in his investigations.

In the following year, William Herschel discovered the planet Uranus prompting the Académie des Sciences to propose a prize contest in 1790 to determine its orbit. Delambre won the prize by forming the tables of the planet's motion. After this coup he established himself as a foremost expert in positional astronomy by constructing solar tables, and tables of the motions of Jupiter and Saturn. He then turned his attention to the satellites of Jupiter, an extremely difficult and broad undertaking. In 1792 he published *Tables du Soleil, de Jupiter, de Saturne, d'Uranus et des satellites de Jupiter.* As a result he was elected member associé in the section sciences mathematique of the Académie. In 1788 the Académie proposed the establishment of a "uniform system of measures" founded on some "natural and invariable basis." The Assembly formally approved the plan for a new system of measures on May 8, 1790, and King Louis XVI gave his approval on August 22, 1790. On June 19, 1791, the king charged a commission of twelve mathematicians and scientists to develop the metric system with its fundamental unit of measure, the meter. The next day the king was imprisoned after trying to flee the country. A year later, still in prison, Louis issued the order for Delambre and Pierre Méchain to make a careful and accurate measure along the arc from Dunkirk to Barcelona. The undertaking was extremely laborious, and was made all the more difficult and dangerous by the changing governments in France, not all of which were interested in or sympathetic to the expedition.

The technique used to measure the meridian is known as *triangulation*, used to determine distances, using the properties of triangles. Suggested by the Dutch mathematician Gemma Frisius in 1533, this most common type of geodetic survey is used for many other purposes as well, including navigation, astronomy, and directing guns during wars. It consists of marking a route by a network of highly visible landmarks: towers, peaks, church spires, etc., with these points representing the vertices of a series of connected triangles. Knowing all the angles formed by two adjacent triangles and at least one of the lengths of a side in one of these triangles, the lengths of all other sides in both triangles can be determined by trigonometric formulas. An initial triangle is laid out by plotting three points: two at the ends of a base line and one at a distant landmark. The surveyor uses a theodolite to measure the angles towards the landmark at both ends of the base line. The baseline is measured by counting revolutions of a wheel of known diameter or by using measuring chains or rods laid end to end. Once one triangle has been measured, further triangles are constructed from its sides, producing chains of triangles that can accurately measure long distances [Figure 9.10]. Since relatively small triangles are used the curvature of the earth isn't a concern. To establish an arc of triangulation between two widely separated locations, a base line is measured and longitude and latitude determined for the initial point at one end. The locations are then connected by a series of adjoining triangles forming quadrilaterals extending from each end [Figure 9.11]. Figure 9.12 shows a portion of the Delambre survey.

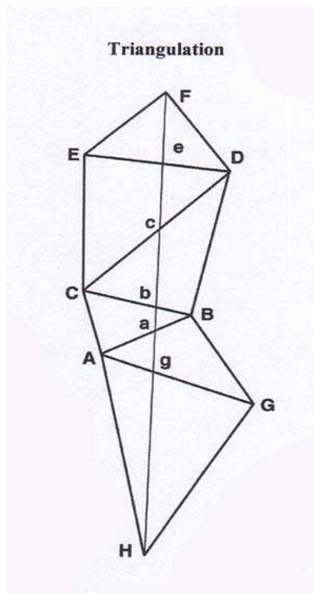

Figure 9.10

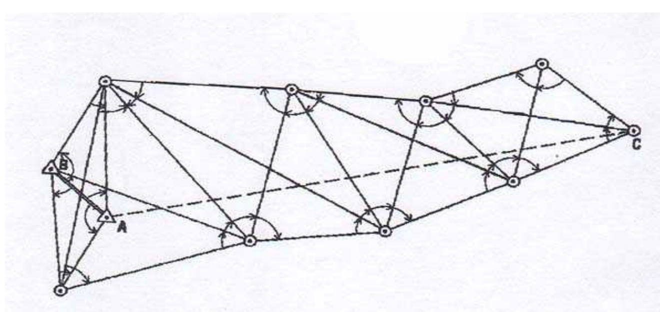

Figure 9.11

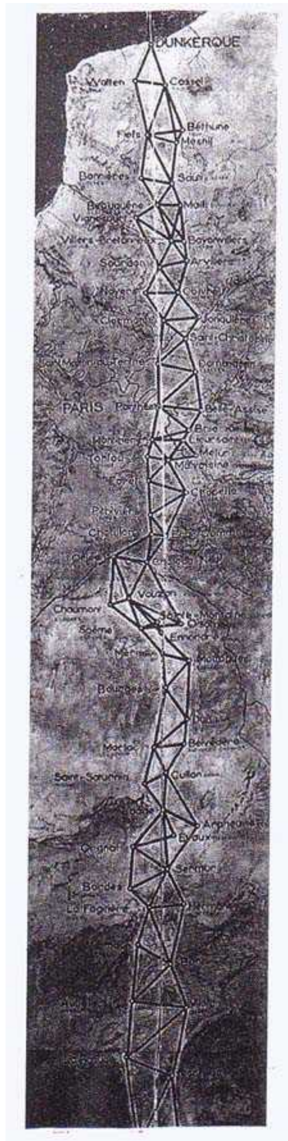

Figure 9.12

The project, which began on June 25, 1792, was divided as follows: Méchain was responsible from

Rodez to Barcelona, a distance of 170,000 *toises* and Delambre was responsible for the portion from Dunkirk, to Rodez a distance of 380,000 *toises*. Delambre explained the inequity: “The reason for the unequal division was that the Spanish part was entirely new, whereas the remainder had already been measured twice; we were agreed that the former would provide many more difficulties.” Méchain’s assignment was through arduous country in the Pyrenees. The operation was hampered by various difficulties, caused by the French Revolution. Heading north, Delambre ran into trouble immediately. Militiamen detained him because the deposed monarch had signed his credentials. When he made it to Saint-Denis, he was met by a mob that suspected him of being an aristocrat. He saved his life and mission by giving a lecture in which he explained how the metric process was one more piece of the revolutionary process. At Herment he hung a white cloth on a clock tower to better observe it in making measurements. The royalist flag was white and the townspeople were not appeased until Delambre sewed strips of red and blue to the white cloth to make it resemble a French tricolor flag.

Meanwhile, Méchain made it no further than his third observational site, at Essone, before he was arrested, when its citizens believed he was engaged in some kind of counterrevolutionary activity and mistook his instruments for weapons. Finally, he was allowed to proceed and eventually reached Spain. He was hurt in an accident and by the time he had recovered, he was not allowed to leave the country because by that time Spain was at war with France. When he made measurements of Barcelona’s latitude by reckoning from the stars, he made an error of 3º due to refraction from the atmosphere. By the time he discovered his error in 1794, he could not return to take further measurements. Rather than admit the error he sought to conceal it by extending the meridian to the Balearic Islands, thus eliminating Barcelona altogether. He was plagued by the realization of the error for the remainder of his life.

Things didn’t get any better for the unfortunate Méchain. While he was out of the country his property in France was seized during the Reign of Terror in Paris, and his family suffered greatly. He was finally allowed to leave Spain and made it to Genoa, where he stayed for a year, learning that the Committee of Public Safety had canceled the meridian project. However in April 1795 it was restarted and Méchain was ordered back to Paris. He refused, fearing for his life, as he knew that many other scientists had been sent to the guillotine or prison. Instead traveled to Marseille and a few months later resumed his survey, but achieved very little in the next two years. Fearing that his error would be discovered, he still refused to go to Paris to meet with Delambre, or share his data with the latter, who had sent Méchain all the data he had collected.

When he finally returned to Paris, Méchain apparently still was concerned about the accuracy of the results of his survey, and so refused to publish them. He eventually received permission from Napoleon to extend the survey. He left Paris in 1803, but after completing part of his work, he contracted yellow fever and died at Castellon de la Plana. Delambre was left with the sole responsibility of completing the assignment, which he finally accomplished twenty years after the project began. His calculations made in measuring the arc of a meridian were unimaginably complicated and tedious. Those who grow up with pocket calculators and computers can hardly appreciate the labor that was necessary to make calculations before the invention of these devices. Delambre's calculations were made all the more tedious by the need to convert his observations from the newly established centesimal units of angle-measure used in his instruments to the older units of degrees, on which all tables of logarithms and trigonometric functions were based. Delambre presented *Base du système Métrique* - three volumes containing the history of the undertaking, the observations and the calculations – to the Emperor. His results were turned over to a commission of French and foreign scientists, who determined the unit of length that became the standard meter.

In 1795 Delambre was appointed to the French Board of Longitude, and in 1803 he was named *secrétaire perpétuel* (perpetual secretary) for the mathematical sciences of the Institut de France. He was the director of Paris Observatory from 1804 to 1822. At fifty-five years of age, Delambre married the widowed mother of his young assistant Leblanc de Pommard. In 1807 he succeeded Lalande to the chair of astronomy of the Collège de France, and later was appointed one of the principal directors of the university. In 1809 Delambre may have been responsible for the existence of one of the most remarkable institutions in Washington D.C. That year, in his capacity as perpetual secretary, Delambre received a letter from Sir Joseph Banks, the President of the Royal Society of London. Banks requested that Delambre intercede on behalf of a naturalized British chemist and mineralogist, born in France as Louis Macie, who was being held as a political prisoner of war by the French military. Delambre wrote a letter to the French Minister of War that resulted in the scientist's release. The latter, a wealthy man, bequeathed his property to his nephew with the proviso that, in case the latter died without issue, the estate should go to the United States of America to found "an establishment for the increase and diffusion of knowledge among men." This came to pass and in 1839, the Congress used James Smithson's bequest of 100,000 pounds to establish The Smithsonian Institution, which opened in 1846. In 1813 Delambre published *Abrégé d'astronomie* and the next year, *Astronomie théorique et pratique*, based on his lectures. His prodigious work *Historie de l'astronomie* was published in six volumes at intervals between 1817 and 1827. Delambre retired from public life in 1815 and was made a chevalier of Saint Michel by the royal government.

Quotation of the Day: "Kepler was sustained by his desire to have a case against Tycho, Copernicus, Ptolemy, and all the astronomers in the world; he has tasted this satisfaction, and I don't believe he deserves our pity for making all these calculations." –Jean-Baptiste Delambre