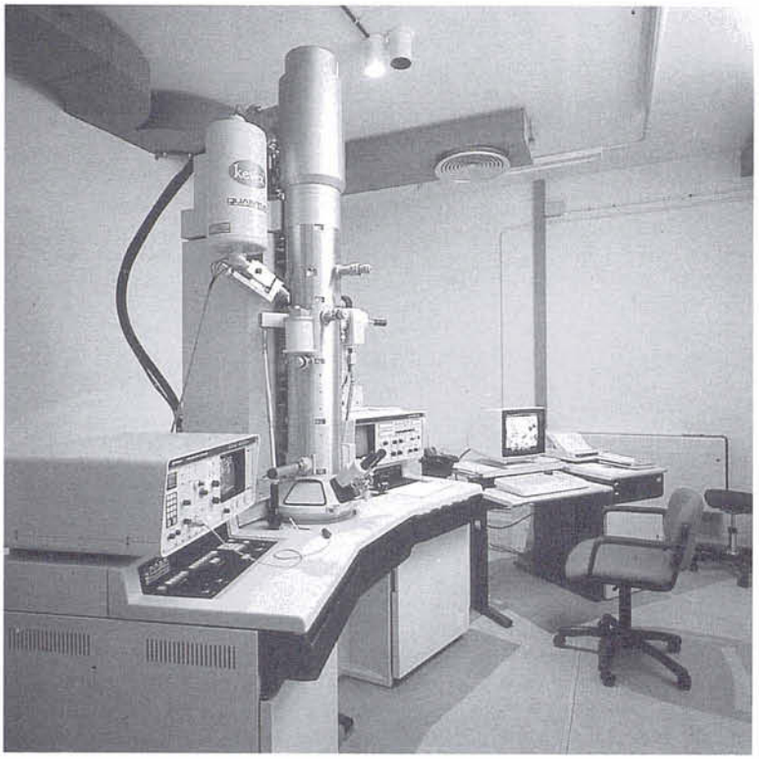
SCIENCE IN CATALONIA



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THE PROTECTIONIST POLICIES OF CATALONIA, AIMED AT CONSOLIDATING THE NASCENT INDUSTRY, CONTRASTED WITH THE POLICY OF FREE TRADE THAT EXISTED IN THE REST OF SPAIN, AND UNDERLINED THE DIFFERENCE IN INTERESTS AND POLITICAL POSITIONS.

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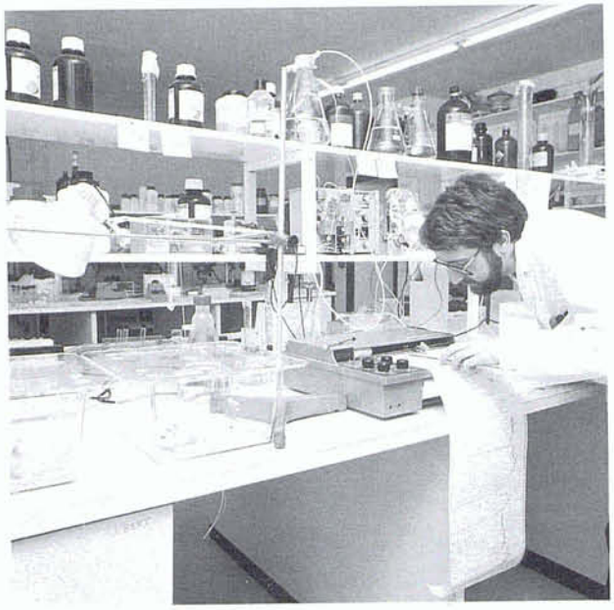
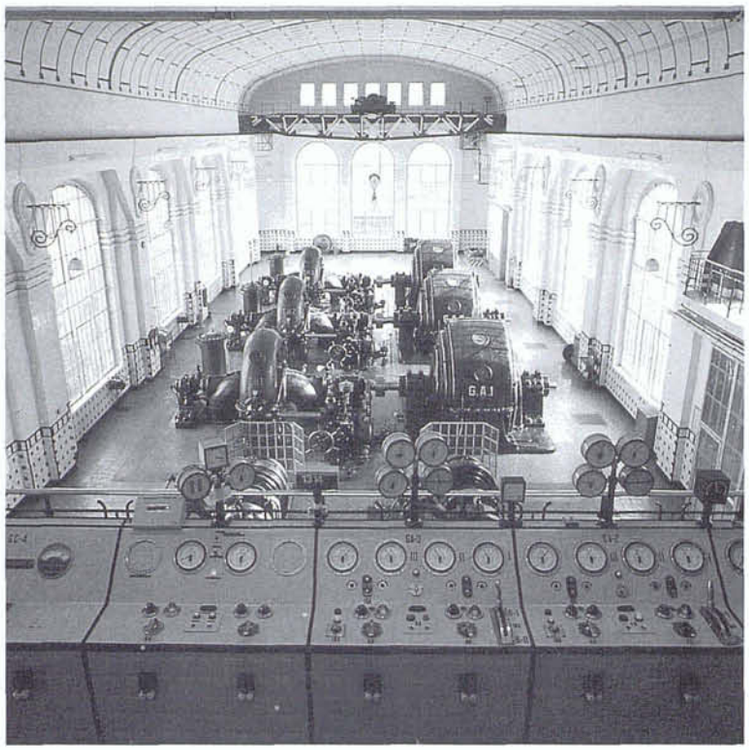


It is an established fact that western science and culture have their origins and their roots in classical Greek culture, but we often forget the difficulties and the obstacles that hindered transmission and continuity after the break caused by the fall of the Roman Empire and the destruction of the ancient world. This is a very important point. Classical knowledge entered Europe via the Arabs and, although Spain was the stage on which the Reconquest took place, it was also the bridge that allowed the transmission of culture. Charlemagne had to strengthen his empire's southern borders by creating the Spanish March, the origin of Catalonia. Our Pyrenees became a fortress and hiding place, and in their sheltered valleys a very important culture flourished. In the tenth century, the monastery at Ripoll was a leading cultural centre. In its scriptorium, the classical works made known through the great caliphate of Cordova were translated into Latin. In this way, works on geometry, arithmetic, astronomy and clockwork reached Europe for the first time. The Ripoll translation of the works on geometry is indispensable for a critical establishment of Euclid's texts on the "Elements", of which, due to the fire at the library of Alexandria, no original has survived. It should be remembered that these texts were the basis for the understanding and teaching of geometry until the nineteenth century. To Ripoll, also, we owe the introduction of the astrolabe, for many centuries the most sophisticated scientific instrument available, allowing one to measure the zenithal height of the stars and relate it to basic astronomical data, using a sort of table engraved in metal. The scriptorium and library at Ripoll had a great influence, thanks to the work of the monk Gerbert d'Aurillac, who spent a few years there from 940 and who went on to become bishop of Reims and finally Pope, with the name of Sylvester II. Tradition has it that he invented or introduced the water-clock, which goes to show the scientific and innovatory spirit of Ripoll. Two centuries later, when the king of Castile took Toledo, a second, very important, wave of classical knowledge entered the western world. The Toledo School of Translators was founded in 1130.

As well as the recovery of these texts and instruments, we have to take into account the recovery of technology lost after the destruction of Rome and the ancient world and which was reintroduced very slowly. The Romans, as we know from the books of Vitrubi (14 B.C.), were familiar with water mills and other mechanisms, although they made no extensive use of them. This technology gradually reappeared and, in the thirteenth century, formed the basis of the medieval industrial revolution, inspired and divulged by the Cistercian monks. What we could call industrial centres grew up around their monasteries, in which hydraulic power was used, amongst other things, to grind corn, make paper, saw logs and drive the hammers and bellows of the forges. Catalonia's great contribution to this field in the middle ages was the technique known as the Catalan forge, found in many different places and surviving in Ripoll until this century. The fundamental characteristic of this development was a stream of water that drove a stream of air over the layers of iron and coal. Using this system, the air stream is very effective and produces a much more complete combustion of the coal and produces iron of a much higher quality than that produced by other processes. To get an idea of the importance of this method, it need only be



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said that it was the forerunner of the steel-making systems of today and was not superceded until the appearance of modern foundries, many centuries later.

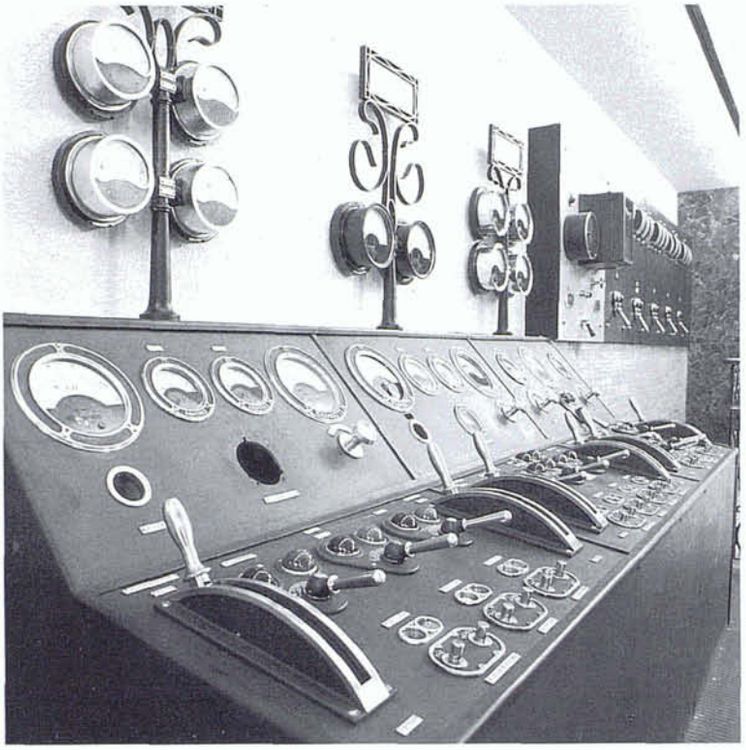
In the thirteenth century, some outstanding contributions were made by Ramon Llull, a man of extraordinary activity who produced some remarkable work. Llull was born in Majorca, soon after the island had been recovered from the Arabs by Jaume I, king of Catalonia and Aragon, and lived in a world marked by the confrontations between Arabs and Christians, both in war, piracy and slavery as well as in ideological and religious aspects. His enthusiasm for converting the infidels with rational arguments he considered to be clear and irrefutable led him to create a system of combinatorial logic which, using a system of wheels, compared different virtues and qualities. It was not a formal logic, according to the whole classical and modern tradition, but a logic of contents. This contribution was an important landmark in the long period from Aristotle to Léibnitz, who was influenced by it in his search for a calculable universal language. Llull's system of wheels has also been considered a remote forerunner of modern computers.

Amongst the events that contributed to the creation of the new mentality of the Modern Age, we have to include the spread of navigation and the discovery of new lands and new worlds. Progress in cartography played an important part in this development. In the fourteenth and fifteenth centuries, the School of Cartographers in Majorca had the most precise techniques and produced the most accurate maps. Historically, it was the link between the ancient techniques and the new systems of Toscanelli and Mercator. Our navigational maps, much sought after, included details of the coasts and the wind directions, in a system of lines that joined different places of interest, before the introduction of the longitude and latitude network and other similar systems.

The Catalan Atlas of 1375 is a masterpiece of Majorcan cartography, attributed to the Jew Cresques Abraham. It is very accurate in its description of the African coast, and includes the Canary Isles. On the other hand, Asia appears completely out of proportion, as occurs in all the representation of the time, based on Marco Polo's observations and on a series of legends.

In the modern age, there is the interesting figure of Narcís Monturiol (1819-1885), responsible for a number of exciting projects and social and political utopias as well as the conception, design and construction of the submarine.

He was not motivated by military interests, like those that came to be dominant later, so much as by humanitarian intentions arising from his wish to improve the terrible work conditions he had witnessed in coral extraction. Two different submarines, with the fish shape that gave rise to the name Ictineos, sailed the sea bottom off Barcelona and Alacant in 1859, 1860, 1861 and 1862.



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Monturiol solved many of the problems of underwater travel. His submarine had two chambers, with an artificial atmosphere that allowed it to stay under water for long periods of time, and it was able to dive vertically. The problem he was unable to solve was that of the driving force, since, not having electricity at that time, he had to rely on steam power.

Doctor Jaume Ferran (1852-1929) was a great exponent of biological and medical investigation. His great scientific discovery was the anti-cholera vaccine, one of the most important preoccupations of his time. A personal letter from Doctor Louis Pasteur to Doctor Ferran recognizes the leading role played by the latter in this discovery.

The Catalan industrialization of the nineteenth century was a particularly interesting phenomenon. Catalonia had few natural resources and little iron or coal. In spite of everything, it developed an important industry, starting with the textile sector.

In the race between water and coal as energy sources, Catalonia started by taking advantage of the hydraulic force of the rivers, moved on to the exploitation of the coal mines, especially in the Pyrenees, around Sant Joan de les Abadesses, and finally went back to hydraulic energy, which it efficiently converted using modern turbines. A series of factories and "colonies" were established along the river valleys and the Llobregat became the hardest-worked river in Europe.

The money available for investment in industry, and the money it produced, was limited and broad popular col·laboration was necessary. The railway lines were financed by private companies and the construction and financing of the Berga Canal, for industrial ends, is an outstanding example of the cooperation of a whole town.

In the field of technology, there was constant progress and improvement, giving rise to new developments such as the looms known as *bergadanes.*

The protectionist policies of Catalonia, aimed at consolidating the nascent industry, contrasted with the policy of free trade that existed in the rest of Spain, and underlined the difference in interests and political positions.

Thanks to Catalonia's efforts, Spanish industry managed to keep up with that of other European countries like, for example, Italy. Spain in general, and especially Catalonia, started to lose ground as a result of the Spanish Civil War (1936-39) and the subsequent regime.

In some ways, the Catalan industrialization of the nineteenth century was an epic achievement, comparable, on a different scale, to the legendary conquest of the American west. Catalonia showed it was an efficient modern society, with a collective will and optimism and a yearning for progress and well-being.

These historical qualities allow us to look forward with optimism to an important technological and scientific future. ●