CATALAN INTERNATIONAL VIEW
A EUROPEAN REVIEW OF THE WORLD

by **Carme Pararedas** and

Pere Forès

From Ictineu I to Ictineu 3: 150 years of contributions to underwater technology

In 2004 a team of engineers and designers decided to build a manned scientific submarine named Ictineu 3 as a tribute to Narcís Monturiol, the Catalan inventor of the submarine. It is a modern submarine, designed and built with cutting-edge technology, incorporating innovations with respect to the rest of modern submarines in terms of design, construction materials, and in particular its energy system. In keeping with all submarines since 1891, Ictineu 3 includes the basic elements already established by Monturiol in order to solve key problems: a double hull, a CO2 treatment device and buoyancy control systems. As with Ictineu I and II, Ictineu 3 has also been made by the people for the people, always counting on the support and collaboration of the wider society.

The Ictineu 3 project was born in 2004 as the result of numerous factors: Firstly were the concerns Pere Forès raised in relation to manned submarines. His initial tests in this area began when he was only eleven years old. Second there was the unfortunate incident involving the oil tanker Prestige, which highlighted the state's lack of resources for intervening under the sea. Thirdly, there was a trip to the Azores which led to the fortuitous meeting of two underwater vehicles and four enthusiasts, lovers of both the sea and technology.

These were sufficient reasons for us to decide we wanted to build a civilian submarine, put it in the service of the nation and begin a new industrial sector which would generate wealth and knowledge. Since 2009 marked the 150th anniversary of the launch of Monturiol's first Ictineu, we thought we would name the project Ictineu 3 in his honour. Currently we are just a few months from finishing the construction work and the beginning of sea trials. Hopefully our first dives will begin in spring 2012.

Some historical background

Narcís Monturiol was born in Figueres in 1819. He was a versatile man who excelled in the field of politics, humanism, the struggle for social rights, and as an inventor. It was to be in the latter field where he was to play a key role in the history of underwater exploration and navigation since he solved major problems and laid the foundations of modern submarine technology. Furthermore, he did so, 'without the least precedent that could be taken as a starting point'. His book *Assaig sobre l'Art de Navegar per Dessota de l'Aigua* [1] (An Essay on the Art of Underwater Navigation), first published in 1891, was the starting point for the development of modern, functional submarines which currently operate all over the world. It received a certain degree of public acknowledgment, such as from Isaac Peral and the German Navy. The latter created its submarine force in 1905 using Monturiol's essay as a key technical reference. Monturiol established key concepts such as a double hull (with one hull to resist the high pressure and an exterior hull to provide the hydrodynamic shape and protect the equipment between the two hulls), systems to deal with excess CO2 and produce oxygen for the air which is breathed on board, the buoyancy control systems based on diving tanks on the outside and buoyancy tanks on the inside, and security and emergency systems. It was to take 100 years for some of these concepts to be used again, for example in producing the definitive form of military submarines (USS Albacore 1959).

The first Ictineu was launched in the port of Barcelona in 1859 [2]. The prototype submarine was 7 meters in length, made entirely from wood and shaped like a fish. Monturiol made 69 dives during which he amassed a wealth of technical and scientific information that formed the basis of the design and construction of the Ictineu II. His second submarine was 17m long, made 19 dives and included a double engine, an innovation which was not to reappear until 30 years later. This ingenious submarine engine, which ran on manganese peroxide, was not used again until 1933 in an experimental submarine which managed to travel four times faster than existing submarines.
In short, Monturiol was a pioneer who developed his project using modern methodology, employing techniques which are currently used on technological and scientific projects.

Ictineu 3's contributions to recent developments in underwater technology

While Ictineu 3 is intended to pay homage to Monturiol, it is by no means a replica of the first Ictineus of the nineteenth century. On the contrary, it is a modern, highly competitive submarine, which incorporates cutting-edge technologies in terms of the materials used for its construction, its instrumentation and its energy systems. It can be adapted to suit any task. Ictineu 3 incorporates innovations that make it more competitive with respect to other submarines that are currently on the market, and offers a new concept in the form of a highly automated underwater vehicle.

The Ictineu 3 is designed to operate at a maximum depth of 1,200 meters, manned by a pilot and two passengers. It will be the ninth deepest submarine in the world and the first to incorporate a large acrylic window (1.5 m in diameter) at a depth exceeding 1000m. It will be certified and classed by Germanisher Lloyd according to the highest standards of quality and safety.

The Ictineu 3 incorporates numerous innovations that make it a cutting-edge tool for underwater

observation and intervention. These include: innovations in stainless-steel materials and design for an unparalleled volume to weight ratio; for the first time composites will be used as structural material; it will incorporate the first certified, pressure-tolerant lithium-ion polymer battery system for high energy capacity; and it includes improvements in the design and ergonomics of work-class submersibles. All of these developments were created by and belong to *ICTINEU Submarins SL* (Ltd.).

These innovations enable the Ictineu 3 to have features and capabilities which are far superior to most civilian submarines. It is also very versatile, making it suitable both as a scientific, work-class submarine, and for filming or for recreational use: weighing less than 5500 kg it is lightweight and can be easily operated from most research vessels; its reduced size means it can be easily transported to its work place (it fits in a 20' open top container); passengers can enter/exit from the surface of the water; it has a high power capacity, so it is able to work its thrusters, lights and instrumentation simultaneously, while also being able to travel up to 20 nautical miles underwater; it has the capacity and facilities for customers to attach whichever sensor or instrument they require as well as providing a wide field of view for photography and video recording. Last but not least, it allows for long dives in excellent comfort, something not normally found on most work-class subs.

Catalonia's industrial sector and the future

Catalonia is an industrial nation which began its industrial revolution in the eighteenth century and which has always been noted for its enormous ability to innovate. Its industrial sector has constantly evolved and adapted, even making advances to face new technological challenges. It is only when we take into account this heritage and tradition, and the extent of the industrial sector, which includes all areas, that we can appreciate the gestation and development of a project of the scale of Ictineu 3 in Catalonia.

While it is true that neither Catalonia nor Spain have an established underwater technology industry, at present there are several universities developing advanced submarine technology, and several research centres in marine sciences. To these can be added various shipyards and engineering workshops with the capacity to carry out projects of this kind. The Ictineu 3 has been an opportunity for many of these companies to break into the industry. All the design work, the calculations and systems engineering was done entirely in Catalonia, in collaboration with engineering companies that have shown a great capacity for innovation, research, and the ability to meet new challenges. The launch of Ictineu 3 will place Catalonia as sixth in the world in terms of its ability to investigate and operate on the seabed, with this project of great strategic importance in a country with a strong maritime tradition. These agents mean Catalonia has the industrial, scientific and technological base that is sufficient to open up a new industrial sector for the country. One with a great capacity for growth and with high value-added factors that could help the country overcome the recession. We are referring to a sector with strong growth at the international level that in 2008 had a global turnover of some €29 billion which, thanks to high levels of growth, should have reached 46 billion in 2011. In countries like the UK the industry is well established and shows a 30% annual growth rate [3].

Future goals and visions

As a company, ICTINEU Submarins SL wants to be a leader in this sector, and to this end it proposes some challenges for the future which are also a vision of the environment in which it wants to develop:

To contribute to a better understanding of the seas and oceans. To provide new data and knowledge to help us understand the mechanisms behind their complex ecosystems, to improve their management and exploitation, and ultimately to improve the coexistence between humans and this great unknown world.

To contribute to the development of our industrial fabric, marine technologies and the tools for understanding and exploring. To generate knowledge and share it with society. To create synergy between industry, the academic world and research centres. To contribute to the country's growth: by generating knowledge and work we create wealth and prosperity.

Each and every day we make every effort to achieve these aims

Of the €2.5 million the project costs, by November 2011 €1.808 million had already been invested in R&D and construction costs. €1.96 million has been collected in total, with 13% coming from public subsidies, 53% from loans, 28% from private equity, 4% from sales and 2% from donations. The Ictineu 3 is just a few months away from completion, but lacks €200,000 in funding. A crowdfunding campaign has therefore been launched, calling on society as a whole that has always supported it, since the project was born and grew out of the selfless collaboration of many people: members of the public, academics and business people. Everyone motivated by the sea, science and technology, culture and our nation. They have ranged from volunteers who have contributed their labour to contributions of money or material. Everyone does their bit, to the best of their ability to create a submarine made by the people, for the people.

ICTINEU Submarins SL is a member of the Catalan Society of Technology, a subsidiary of the Institute of Catalan Studies and founding member of the Catalan Maritime Cluster.