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Specialist training for radiotelegraph officers in Spain (1910-2010): from wireless operators to university graduates

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ABSTRACT

This paper describes the history of training in Spain for naval radio electronics officers. First, we explore the knowledge and conditions required of the first wireless operators recruited by the *Spanish Transatlantic Company* for their transatlantic steamers, and the courses delivered by the Marconi School of Wireless and the General School of Telegraphy in Madrid to train the first Spanish radiotelegraph operators. Subsequently, responsibility for delivering these courses passed first to the Advanced School of Telegraphy in 1920, and then in 1938 to its successor, the Official School of Telecommunications, where experts in modern telephones and radio introduced significant changes in the training. Then, we examine the inclusion of these courses through the Official Maritime Schools before these were fully integrated into the Spanish university system in 1988. Finally, we analyse the Bologna process, under which the current officially recognised Degree in Naval Radio Electronics Engineering was established in 2010.

1. Introduction.

In the late nineteenth century, Guglielmo Marconi's invention of wireless telegraphy was gradually and successfully adopted by the main British shipping companies of the time, and a new crew member was established: the expert in long range wireless telegraph communications, called a telegraphist or naval radiotelegraph operator. This new maritime profession was rapidly consolidated in major European countries through the *Marconi Wireless Telegraph and Signal Company* in England and its German competitor, *Telefunken*, which, given the lack of initiative on the part of the various authorities, assumed responsibility for training their own operators.

In Spain, such experts were notable for their absence until finally, in 1910, wireless telegraphy (WT) was used for the first time on board the *Spanish Transatlantic Company* (Spanish initials: CTE) steamers, *Alfonso XII* and *Patricio de Satrústegui*, on the occasion of the journey of the Infanta Isabel de Borbón to Argentina. The staff responsible for onboard communications was provided by the Spanish subsidiary of the Marconi Company, *La Nacional*. However, the *Transatlantic Company* repeatedly insisted on the need for Spanish operators on their crews, and even offered its facilities in Cádiz to the *National Company of Wireless Telegraphy* (Spanish initials: CNSTH) so that this latter could begin to offer training (Cruz and Piniella, 2015).

Taking the above as a starting point, this paper discusses and analyses the most interesting aspects of this subject, with the sole aim of helping to gain further knowledge about the history of training for maritime radio communications in Spain, and more specifically, the professional responsible for this, the naval radio electronics officer. Our study is based on documents held in the Transatlantic Company Archives (Spanish initials: FCTE), complemented with extensive information from the daily newspapers and specialist periodicals held in the National Library of Spain press archives. We also compiled essential information from the Postal and Telegraph Museum referring to the training of the first Spanish radiotelegraph operators and the private or public schools that delivered these courses. Both aspects have been studied from a technical perspective by authors such as Bengoechea and Jarillo (1912) and Grey Martin (1912), and in depth from a historical perspective by Olivé Roig

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(1998) and more superficially by Arroyo Ruiz-Zorrilla (1989). We also consulted databases at the universities of Cádiz and La Laguna in Tenerife, which are the only two universities in Spain that currently offer this degree.

2. The first radiotelegraph operators: genesis of a profession.

2.1. The CTE's wireless operators.

The advances made in WT in the first decade of the twentieth century led to its rapid adoption by the world's leading shipping companies of the period. In Spain however, this new technique remained almost unheard-of for nearly a decade until Spain's largest shipping company, the CTE, introduced it in mid-1910 on its transatlantic steamers, having decided to install Marconi's system throughout its entire fleet.

Since the inception of WT, the CTE had been fully cognizant of the importance of installing wireless telegraphy apparatus on its ships; however, it encountered a major obstacle to this undertaking. Despite the many offers it received from the leading manufacturers of these devices, none of them except the *Marconi* also provided qualified staff to operate this new equipment on board.

Given the lack of Spanish staff trained in radiotelegraphy, the CTE asked the English company to supply wireless operators for its Spanish steamers. Under the command of the ship's captain, these were responsible for transmitting and receiving all types of maritime and commercial dispatches and messages, exclusively via the Marconi system (Cruz and Piniella, 2014).

After studying at the English company's school in Liverpool[3], these wireless operators, who were generally of British origin, were initially employed in the profession as second telegraph operators on an English transatlantic ship. With time, they would then be promoted to first operators and even to the rank of special inspector or other senior positions within the company. However, due to the pressing need for telegraph operators on ships occasioned by the global expansion of WT, the *Marconi* company began to recruit telegraph operators from various European countries. These were given a short period of specifically maritime radiotelegraph training, which together with previously acquired knowledge in ordinary telegraphy was intended to equip them for in all kinds of service. In practice, however, this was not the case. Many were disappointed to find that proficiency in this new profession required prior specialist training that included a large amount of solid theoretical knowledge, something that was only available under the experienced guidance of specialist schools, as well as patient study and constant operation of the equipment in order to attain the confidence necessary to tackle difficult situations and operate the apparatus, which although minimal, was always complex. Clearly, it was not enough wear a radiotelegraph operator's uniform to become an officer fit for service at sea (Cruz and Piniella, 2015).

2.2. First professional qualifications.

The news that foreign wireless operators were working onboard the CTE's steamers soon came to the attention of the Spanish Directorate General of Posts and Telegraphs, which quickly responded by demanding that Spanish vessels carry Spanish telegraph operators. However, since this proved impossible, it then required that foreign telegraph operators hold a Certificate of Professional Aptitude, and where this was not already the case these were urged to take the examination at the earliest possible opportunity, as stipulated in the agreements of the International Radiotelegraph Conference in Berlin in 1906, signed and endorsed by Spain through regulation of the radiotelegraph service in 1908[4].

The first examination was held in the port of Cádiz, after which the CTE wireless operators would be considered the most highly qualified of the period, having passed the stringent examination with ease. However, the conditions of the Berlin Agreement were too demanding for most candidates. Consequently, the International Radiotelegraph Convention signed in 1912 in London established two classes of certificate: a first class one for operators with skills equal to those of the CTE's wireless operators (20 words per minute); and a second class one for the those whose rate of transmission and reception was between 12 and 19 words per minute. These latter were only considered qualified for work on ships that used WT solely for their own service, or as auxiliaries on ships that also carried at least one telegraph operator holding a first class certificate (Cruz and Piniella, 2015).

3. The Marconi School of Wireless and the General School of Telegraphy.

3.1. Towards a Spanish training school.

Unable to recruit Spanish operators, by mid-1911 the CNTSH had no alternative but to train its own radiotelegraph operators, for which it would be essential to establish a school to provide them with the necessary training. The first document located in this respect is a letter from the chief executive officer of the CNTSH, Antonio Comyn, addressed to the CTE in response to this latter's repeated requests for Spanish operators on its crews, announcing the establishment of a school for operators

[3] Founded in 1903, the Liverpool School was the first school in the world to provide comprehensive training in the Marconi wireless telegraphy system for young people who would later become operators on ships and at WT stations operated by the Marconi Company. Once admitted by Company, they spent a year at the Liverpool School preparing for the examination required by the British Post Office. Those who passed this examination were awarded a special certificate attesting to their proficiency as operators.

[4] "Onboard and coastal station services shall be provided by telegraph operators holding a certificate issued by the Directorate General of Posts and Telegraphs. This certificate shall accredit the professional skills of the telegraph operator with respect to the following: First: repair of the apparatus. Second: transmission and aural reception at a speed of not less than 20 words per minute. Third: knowledge of the regulations applicable to radiotelegraph communications. The certificate shall also state that the government has sworn the telegraph operator to secrecy regarding the correspondence". Royal Decree of 24th January, 1908. GACETA DE MADRID, 25th January.

in Madrid: *"We are about to establish a School for Operators in Madrid to ensure that one way or another they can obtain the official certificates. Besides procuring the Spanish operators that we desire, I think that this will also provide a service to the Brussels Company and to Spanish ship owners, since the current situation is quite difficult."*[5]

Thus, recent permission from the State to construct and operate a future network of Spanish coastal radiotelegraph stations, coupled with the concern of the Spanish authorities about the presence of foreign telegraph operators onboard ships, the continued insistence of the CTE and the possibility of their equipment being adopted by other Spanish shipping companies,[6] all eventually led the CNTSH to establish the Marconi School of Wireless at number 168 Bravo Murillo, in the Madrid neighbourhood of Tetuán. Although private, this was the first centre to solely and exclusively train Spanish radiotelegraph operators.

3.2. The Marconi School of Wireless.

Since this was a new profession likely to be in high demand due to the gradual installation of onboard and coastal stations in Spain, many were interested in learning the requirements for admission into the above-mentioned school. Candidates for admission had to be aged between eighteen and twenty-five, to be in suitable physical condition for service, and to present a certificate of good conduct or be able to prove good conduct in their previous job. In addition, they had to be able to write in Spanish correctly and legibly, transmit and aurally receive at least twelve words or sixty letters per minute in Morse code in any language or telegraph key, translate a paragraph in French or English to Spanish, and possess a basic knowledge of electricity, mechanics, and arithmetic (*Arquitectura y Construcción*, March 1913, p.68.).

However, despite the need for these new professionals, it seems that it was not easy to obtain the qualification, because of the two hundred candidates for admission, only twenty were accepted for the first course, of whom only eleven remained after five months.

The training delivered on these courses consisted of theoretical classes on electricity and WT, practice in aural reception until achieving at least twenty words per minute, transmission of dispatches, operation and repair of equipment in the school workshops, station accounting, legislation and English. Nonetheless, despite the abovementioned conditions, the CNTSH allowed any candidate with some knowledge of languages who could demonstrate the ability to transmit and aurally receive twenty words per minute to take the examination (Bengoechea and Jarillo, 1913).

Upon completion of each course, the school issued graduates with a certificate that authorised them to fill future vacancies within the CNTSH itself, as well as entitling them for admission to the various foreign Marconi Companies abroad, subject to certification by the respective governments of each country in accordance with international legislation (*Revista La Energía Eléctrica*, 10^{th} December 1912, p.463).

The first training course began on October 21, 1912, and was immediately followed by another four that concluded between 1912 and 1913. The CNTSH then ceased providing these courses since it considered that it had covered its own needs, and this role was then assumed by the new General School of Telegraphy (Sanchez Michana, 2004).

3.3. The General School of Telegraphy.

Various professional groups of the period had repeatedly insisted on the need for an official school: eventually, in 1913, the legal basis was established for what was intended to be a centre for training future telegraph operators for work in the Spanish Telegraph Service. As a new departure, it would also deliver advanced training to officers to perfect their skills in the new techniques that were then emerging. Pursuant to the decree creating this training centre, it was called the General School of Telegraphy and was under the authority of the Telegraph Service. The school was to be responsible for teaching the knowledge necessary to perform all State-run telecommunication services, and for issuing the certificates of aptitude envisaged in the International Radiotelegraph Convention and Regulations agreed in London, later governed by the Telegraph Service Regulation on radiotelegraph operator training.

Undoubtedly, the sinking of the *RMS Titanic* was fundamental in the school's creation since the tragedy brought to light the lack of regulation governing radiotelegraph service operators employed on ships. Proof of this was the requirement for all countries signatory to the London Radiotelegraph Convention of 1912 to create an official school to issue certificates of aptitude in the operation of this telecommunications system.

Finally, on October 20, 1913, classes began in an imposing building on the street of Echegaray in Madrid, and the school became the first official, permanent centre to continuously deliver telecommunications courses in Spain (Olivé Roig, 1998 pp.57-59). At the time, the Telegraph Service had no radiotelegraph stations, since operation of this service had been granted years before to the CNTSH, and it therefore had little interest in training radiotelegraph operators. However, the agreement signed in London a year earlier by the Spanish government combined with the need for an official school to teach this new branch of telegraphy obliged the service to train the radiotelegraph operators required by Spanish shipping companies. This was the first time that the School of Telegraphy had provided training for people who did not belong to the Telegraph Service, and it consequently established two types of student: official and external.

The following year, the school regulations organised the courses into two levels. The first comprised the fundamental principles, further subdivided into four specialisations: 1) Telegraph Service employees; 2) Telegraph Service mechanics; 3) Auxiliary staff; and 4) Radiotelegraph operators. The second level consisted of advanced WT training, and in turn was sub-

[5] FCTE-BTG: Letter from A. Comyn to Joaquín Rodríguez Guerra, 11th February 1912.

[6] This initiative was adopted by the main Spanish shipowners, like "Pinillos", "Correos de África", "Isleña Marítima", "Navegación e Industria", "Marítima Mahonesa", "Tintoré", etc. In 1915 the number reached a hundred of Marconi stations. (Agacino, 1915 p.250).

divided into two sections, one for further studies and the other for complementary studies.

3.4. Radiotelegraph operator examinations.

Chapter 10 (radiotelegraph operators) of the regulations established that for the 4th section, admission to officially recognised training would be by examination, and candidates were required: to be Spanish, be more than 15 years old, to provide proof of good conduct and not to have any physical defect that would render them unfit for service. The examination comprised two parts; the first was eliminatory and consisted of taking dictation with good spelling, while the second included various tests on geography, arithmetic, elements of electricity and French.

Those who passed were admitted in order of merit to fill the places offered by the school. Once there, they took a six-month course during which they studied the science and operation of radiotelegraph and radiotelephone equipment, legislation, service fees and English. Subsequently, they practised transmitting and aurally receiving Morse code until attaining a speed of twenty words a minute (*Revista El Electricista*, 4th January 1915, pp. 8666-8667).

In 1920,[7] the General School of Telegraphy became the Advanced School of Telegraphy. The courses were delivered at number 19 Recoletos, in Madrid, and in the offices of the Directorate General of Posts and Telegraphs at number 16 Conde de Peñalver. In accordance with the decree, the courses were once again restructured, this time into three levels, establishing an elementary level to train radiotelegraph and radiotelephone operators.

After witnessing a decade of advances in telephony and radio, the school broadened its courses to adapt to new demands. In 1930, its programmes were restructured to include qualifications in radiotelegraphy and radiotelephony (clearly geared to professional practice at sea),[8] and advanced radio communications. The syllabus for this latter encompassed numerous subjects related to naval radio communications (radio engineering, radio direction finding, radio beacons, installation and adjustment of transmission and reception stations, fault diagnosis, etc.). The course was open to all Spanish citizens who were qualified radiotelegraph operators, even though they would clearly exercise their profession beyond the Telegraph Service (Olivé Roig, 1998 pp. 67-77).

These courses were consolidated with the creation of the present-day Official School of Telecommunications (Spanish initials: EOT), which coincided with the start of the extraordinary development witnessed by the Spanish merchant navy and fishing fleet in the forties. The declining number of radiotelegraph operators with an official certificate issued by the EOT who were opting to work on ships rendered it necessary to reorganise the training of such personnel through a new regulation issued by the Ministry of Shipping in 1946.[9] This established that radiotelegraph operators working on merchant ships and at centres under the authority of the Navy would be classified into three categories: First, Second and Auxiliary Naval Radiotelegraph Operators[10].

It also established that the rank of second naval radiotelegraph operator was open to radiotelegraph operators holding a professional certificate issued by official school after taking a course at the Official Maritime Schools (Spanish initials: EON), which would include the agreed content and practical experience required to provide the necessary professional, naval, military and merchant training, and would also cover the content stipulated by the international convention on safety of life at sea (IMCO, 1948). Similarly, second radiotelegraph operators who met the established conditions of navigation and work could obtain the category of first naval radiotelegraph operator through examinations. For the purposes of possible recruitment and appointment, candidates in both cases were required to hold a seaman's certificate.

Radiotelegraph operators who were already serving in the Spanish merchant navy would be classified as first or second depending on the qualification held, except in the case of those with less than two years' service, who would be required to take and pass the abovementioned course.

At the time, it was thought that the training of these maritime communications professionals should be oriented towards marine studies, then under the Ministry of Industry, as evidenced by the role assigned to the EON, using them to provide specialisation courses for future radiotelegraph operator officers from the EOT.

Regardless of the application procedures for admission to the school, examinations for external candidates were held in Madrid for the categories of second and first class radiotelegraph operators in June and September, respectively. The examination for second class radiotelegraph operators was open to all Spanish citizens aged between 17 and 49 years old, whereas only those holding a duly validated second category certificate were eligible for the rank of first class radiotelegraph operator.[11] Furthermore, due to circumstances affecting the profession and at the request of various institutions and individuals, special examinations for first and second class radiotelegraph operators were held in several ports when there was a good reason to form special tribunals[12].

[7] Royal Decree 22nd April 1920. GACETA DE MADRID 120, de 29th April.

[8] Royal Decree 20th September 1930. GACETA DE MADRID 268, de 25th September.

[9] Law 17th May 1946. BOE 156, 5th June.

[10] Article 11 of the Law of 19th February 1942 established that since the merchant navy constituted a natural reserve in times of war, the Ministry of Shipping should play a decisive role in personnel training, indicating the courses they should receive to equip them for the performance of their military duties and being directly involved in their training.

[11] Diario Oficial de Correos y Telecomunicación, 7th August 1948, p.2924

[12] "Some 2nd class radiotelegraph operators have been unable to obtain the rank of 1st because they have been serving on ships engaged, for example, in fishing for cod, and are thus at sea in the months of June and September when, in accordance with regulations, the Official School of Telecommunications examinations to rise in category are held. Consequently, a special examination will be held in January." Diario Oficial de Correos y Telecomunicación, 29th November 1947, p.1762.

4. Incorporation of naval radiotelegraph operation in Maritime Studies.

4.1. Law 144/1961, on Maritime Education.

Although radio communications in Spain had largely become the responsibility of naval radiotelegraph operators, unlike in other countries, their training had never been associated with maritime studies but rather had remained linked from the outset to the study of telecommunications. Consequently, maritime studies included very little information on the new technologies that were gradually being installed on ships. This, together with the extraordinary development witnessed by the Spanish merchant navy and fishing fleet at the time, Spain's signing of the SOLAS international convention in 1960[13], and the fact that the number of officially qualified radiotelegraph operators was declining daily, created an urgent need to reorganise the training of these personnel. Thus, one year later and in accordance with international regulations, a new law was passed on maritime education[14] which classified these studies as intermediate level. This was the moment and the opportunity to adapt radiotelegraph operator studies to the new regulations, bringing them into line with other, similar studies in existence.

4.2. 1964 curriculum.

In 1963, the undersecretary for the merchant navy successfully proposed regulating new professionals in the maritime radio communications service. These would be trained in the EON, and there would be two certificates: first and second class radio operator officer.[15] Thus equipped, they would be eligible to become chief officers of the second and third category radiotelegraph stations on merchant and fishing ships, and to operate without constraints in the maritime radiotelegraph and radiotelephone service.

The syllabus for 1st and 2nd class radio operator officer courses was established in 1965,[16] and teaching began in the academic year 1965-1966 at the EON in Cádiz, Barcelona, Bilbao and Tenerife. Meanwhile, courses for the lesser qualifications of naval radiotelephone operator and its restricted counterpart were taught in Vocational Marine and Fishing Schools. The first intake would not graduate until June 1968, so to cover the shortage of EOT graduates, service needs would be met until then by enabling telegraph operators from the Telegraph Service, corporal rank radiotelegraph operators from the navy and radiotelegraph station operators on merchant ships to take special examinations for this purpose.

The 1964 Plan organised academic training for the three specialisations (navigation, engineering and naval radio electronics) into two academic years plus one practical year. In addition, candidates were required to pass the final examinations on the main subjects studied in order to be awarded the corresponding qualification.

Having successfully passed both years, candidates for the qualification of 1st class officer then had to demonstrate their ability to receive and transmit all types of communication at a speed of not less than twenty-five words per minute, to translate a professional radiotelegraphic publication into and out of Spanish, to hold a conversation of any radiotelegraphic nature on international maritime traffic, and to send and respond to distress, emergency and safety calls, weather forecasts and shipping and flight warnings.

Surprisingly, although the new radiotelegraphy specialisation had been approved, the 1965 order did not establish a period of practical experience over its two year duration. Consequently, once they had completed their studies, the future officers were not fully equipped to carry out their work on board with due efficiency. Therefore, regulations were established in 1968 to bring the practical experience component for radiotelegraph operator officers into line with that already in place for their peers in navigation and engineering. Radiotelegraph students would be required to spend one hundred days at sea on a ship equipped with at least a second class radiotelegraph station, under the orders of the chief officer of the radiotelegraph station. In 1971, ships became obliged to accept these students,[17] although it is noteworthy that no radiotelegraph operator students embarked on steamers (Table 1).

Table 1: Number of students undertaking compulsory practical experience on Spanish vessels.

Means of propulsion	1000 to 2500 GRT	2500 to 4000 GRT	4000 to 10000 GRT	Over 10,000 GRT
Engine	1 marine or engineer student	1 marine student and 1 engineer student	2 marine students, 1 engineer student and 1 radiotelegraph operator student	2 marine students, 2 engineer students and 1 radiotelegraph operator student
Steam	2 engineer students	2 engineer students	2 engineer students	1 marine student and 3 engineer students

Source: Authors.

Subsequently, in 1971,[18] an additional requirement was established stipulating that in order to obtain their professional qualifications, students had to carry out their compulsory practical experience or part thereof on Spanish ships. The aim of this measure was to stop the exodus of these maritime professionals onto foreign vessels, which offered much better pay. In addition to this factor, many officers would be deployed on land to operate the coastal radiotelegraph stations, which by that time came under the authority of the Spanish National Telephone Company.

[13] In accordance with the 1960 SOLAS Convention, all ships with a gross register tonnage (GRT) in excess of 1,600 were required to install WT stations.

[14] Law 144/1961 of 23 December on the reorganisation of Maritime and Fisheries Education.Official State Gazette 311, of the 29 December.

[15] Decree 3654/1963 12th December: BOE 10, 11th January.

[16] Order of the Ministry of Commerce 25th May 1965: BOE 163, 9th July.

[17] Order of the Ministry of Commerce 17th May 1971: BOE 164, 9th June.

[18] Decree 2596/1974, 9th August, about professional degrees of Merchant and Fishing Fleet: BOE 222, 16th December.

5. Towards university studies.

5.1. Recognition of advanced maritime education; the 1977 Plan.

Maritime studies had been declared intermediate level, but this classification was only applied up to the first professional qualification, and thus the next qualification up, that of 1st class radio operator officer, remained undefined in terms of academic level. Finally, a new classification was approved: the 1961 law was repealed and studies leading to the award of 1st class radio operator officer were considered to constitute advanced maritime education, which in turn was classified as being equivalent to the second cycle of university education. Meanwhile, studies leading to qualification as a 2nd class radio operator officer were classified as being equivalent to university school level.[19]

Born as a result of the decree, the 1977 Plan was the decisive instrument leading to the definitive incorporation of maritime studies into higher education, and hence to the full integration of these professionals in the Spanish university system. It also represented a considerable advance for the professional profile of radio operator officers in the occupational and academic fields, enabling them to undertake doctoral theses and participate in future research projects on maritime radio communications. For the first time, a distinction was made between the academic qualifications for these professionals, distinguishing between a Merchant Navy Diploma and Degree in the three specialisations, to which a subsequent third cycle Doctorate in Marine Sciences was added.

The entry into force of the Law on University Reform of 1983, which stated in its preamble that "*the formulation and approval of curriculum and research plans*" was of primordial importance in universities,[20] and more especially the approval in 1986 of an action plan to reform university education, provided the impetus to create a new curriculum that would equip students for the arrival of innovative satellite technology.

From then until the present day, the syllabus would undergo further modification, although retaining the same core subjects. Each university could devise its own curricula, and the qualifications progressed from the one Diploma and one Degree, in turn divided into the three specialisations then delivered in the Advanced Merchant Navy Schools (Spanish initials: ESMC), to three completely independent Diplomas and Degrees, which in the case of the specialisation in naval radio electronics were entitled the Diploma (Spanish initials: DRN) and Degree (Spanish initials: LRN) in Naval Radio Electronics, and were taught in the Faculties of Marine Sciences.

5.2. Recent changes: new curricula (1994 and 2000).

In the late 1980s, central government began to transfer responsibility for university education to those autonomous regions that had assumed these educational functions in their constitutions. These thus became responsible for managing the ESMC located in their regions, although the Ministry of Transport and Communications retained responsibility for the control and issuance of professional qualifications. The Barcelona, Bilbao, Cádiz, La Coruna and Santa Cruz de Tenerife schools were all affected by this change (Arroyo, 1989, p.217).

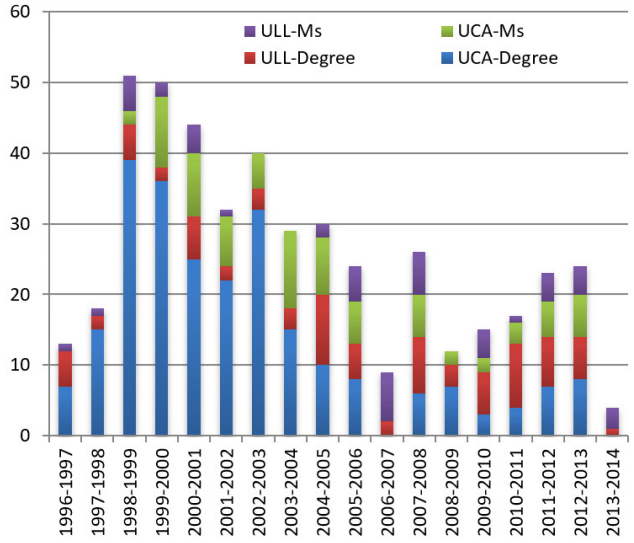
Of the seven schools in existence, only Cádiz and Santa Cruz de Tenerife offered Naval Radio Electronics.

5.3. The Degree in Naval Radio Electronics Engineering: integration into the European Higher Education Area (Bologna).

In 2005, the Cádiz Faculty of Marine Sciences began to implement the European ECTS credit system on the Diploma, as a result of pilot projects employing this system in Andalusia. One of the objectives was to establish the criteria for adapting subjects with LRU credits to the ECTS system. Application of this system to all core and compulsory subjects led to changes in how course content was organised, taught and assessed, in order to facilitate the necessary preparation and launch of a future degree course fully adapted to the European Higher Education Area.

The universities of Cádiz and La Laguna adapted the officially recognised Degree in Naval Radio Electronics Engineering to European Higher Education Area requirements, and began delivery of the course in the academic year 2010-2011. Figure 1 shows the number of graduates in Naval Radio Electronics for the period 1996-2014 at the two Spanish Universities of Cádiz and La Laguna, the only ones to offer this course.

Figure 1: Naval Radio Electronics graduates in Spain, 1996-2014.



Source: Authors.

Conclusions.

The mid-1910 agreement signed between the CTE and the Marconi Company to install WT stations on two of the former's transatlantic steamers marked the beginning in Spain of

[19] Decree 1439/1975, 26th June, on qualification of the teaching Nautical degrees: BOE 158/1975, 3rd July.

[20] Law 11/1983, 25th August on University Reform: BOE 209, 1st September.

the present-day profession of naval radio operator, and therefore gave rise to the need for training in a new profession that would only begin to be a reality in Spain a decade later. As in other countries, the English company was initially responsible for training the first maritime radiotelegraph operators, although through its Spanish subsidiary it urged the Spanish authorities to assume this role. However, the inertia of the Spanish authorities and the growing demand among Spanish shipping companies for operators eventually led the CNTSH to found a Marconi School of Wireless in Madrid in 1911. Although private, this can be considered the first Spanish school to train radiotelegraph operators.

The launch and early days of this training were followed by a first period, between 1913 and 1930, when responsibility for training was compulsorily assumed by the Telegraph Service and delivered through the General School of Telegraphy, newly established for this purpose, where for the first time individuals could obtain a Certificate of Professional Aptitude as a naval radiotelegraph operator. Subsequently, advances in telephony and radio led the then Advanced School of Telegraphy to establish new qualifications in 1920: radiotelegraph operator, radiotelephone operator and radio communications expert, all clearly oriented towards professional practice at sea.

In 1938, the EOT gave a clearly secondary importance to this training. Combined with the expansion of the merchant navy in the 1940s, this led once again to a lack of sufficient qualified officers to meet the needs of the Spanish maritime radiotelegraph service. This shortfall was not addressed until the Spanish government signed the 1960 SOLAS convention, obliging enactment in 1961 of Law 144, and marking the beginning of a second stage that was completely unlike the previous one. Maritime studies were recognised as representing expert intermediate education, opening the way for integration of a third specialisation in Naval Radio Electronics in studies governed by the Ministry of Transport and Communications, through the 1964 Plan. After this, the new professional qualifications of 1st and 2nd class merchant navy radio operator officer were delivered by the EON.

This was followed by what could be considered a third period which consisted of the inclusion in 1975 of these studies in the Spanish university system, after being recognised as equivalent to the second cycle of university education. As a result, the curriculum was restructured in 1977, distinguishing between the professional academic qualifications by establishing the Merchant Navy Diploma and Degree in Naval Radio Electronics.

In the early 1990s, responsibility for university education was transferred to the autonomous regions. Thereafter, each university could formulate its own curricula, and Cádiz established the DRN and LRN in the 1994 plan. The profession became increasingly diversified, seeking greater specialisation in the labour market. However, the agreements of the 1974 SOLAS convention to gradually implement the Global Maritime Distress and Safety System (GMDSS) on vessels of over 1600 GRT, led in the 1980s to a widespread decline in the number of radio operator officers on ships. Today, the profession has virtually disappeared.

Given the almost total disappearance of naval radio operator officers on ships, and therefore of the associated training, it is all the more paradoxical then that is this one of the most successful university degrees in terms of subsequent employment, inviting reflection on the future role of such studies, which are increasingly oriented more towards the field of telecommunications and less towards the marine sciences.

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Appendix.

Workforce entry of Naval Radio Electronics graduates.

As with all traditional maritime registers in Europe and the United States, the Spanish merchant navy has witnessed a significant decline in recent decades. Among various other factors, this has been the principal cause of an overall reduction in student numbers on maritime degree courses. In the specific case of Naval Radio Electronics, numbers have also been affected by implementation in 1998 of the GMDSS in the world fleet, which has rendered the presence of radio operator officers on ships virtually obsolete, and there is no longer any obligation to include them in the crew on ships of over 1600 GRT.

Nevertheless, the findings presented in the study "Survey results on workforce entry three years after completion of studies", conducted by the Evaluation and Quality Unit at the University of Cádiz for the Report on the Degree in Engineering Radio Electronics of the Faculty of Nautical Sciences (Table 2), show that all graduates found employment following the completion of their studies, and that more than 60% of DRN

and almost 70% of LRN graduates found employment related to their training profile.

Table 2: Results for workforce entry of Naval Radio Electronics graduates (three years after completing the course) .

Qualifications	Found employment			Level of employment	
	since completing the course	three years after completing the course	in accordance with educational profile	overall	related to the qualification
Diploma in Naval Radio Electronics	100%	100%	61.5%	100%	61.5%
Degree in Naval Radio Electronics	100%	90.0%	66.7%	90.0%	60.0%

Source: Authors.