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The problems of autarkic military industrialization and its restructuring in Franco’s Spain: a case study on the National Company of Optics (ENOSA)

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ABSTRACT

The National Industrial Institute (INI) was founded as an instrument for State control of the economy in a context of autarchy typical of the early years of Franco’s Regime. Its corporate philosophy and actions were similar to other economic policies of that time, both in Europe and in the United States. Among the enterprises linked to this holding, the National Company of Optics (ENOSA) was created in 1950 with the participation of military and scientific institutions. The company aimed to manufacture lenses and precision instruments for the Army by using domestic technology. However, it failed to reduce its dependence on imports, particularly from Germany. After many difficulties, it was restructured in 1961, and its production diversified towards the fabrication of teaching materials. We have addressed the history of ENOSA as a case study about the failure of the autarkic industrialization model and the reorganization that the INI companies had to tackle in response to the new socio-economic conditions of developmentalism. In conclusion, we can tell in advance that ENOSA was a failed experiment to create a national technology company. However, it eventually achieved an interesting projection in the field of educational innovation.

KEYWORDS: Francoism, National Industrial Institute (INI), Autarky, ENOSA

JEL CODES: D02, L20, N44, O12, O25

1. Introduction

During the 1930s, governments began to intervene directly in the economy to face the crisis, compensate for the shortage of capital, increase investment in public works, and replace private enterprise when this was judged insufficient or inadequate. In Italy, Mussolini launched the Istituto per la Ricostruzione Industriale (IRI) in 1933, with the initial aim of rescuing the banks and avoiding their bankruptcy. The IRI was eventually constituted as a real holding that founded a plethora of public companies and came to control most of the secondary sector (Castronovo 2012). The role of the State was crucial as a driving force not only for growth but also for convergence between Northern and Southern Italy during the Post-war period (SVIMEZ, 2016).

Notwithstanding, State control was not exclusive to fascism or any particular ideology but, in many cases, concerned with political pragmatism (Comín and Díaz 2001). Self-sufficient management, promotion of domestic industry, and protectionism against
foreign influence were also accepted in both communist systems and Western democracies to preserve social order and political status. In the Soviet Union, because of its opposition to capitalism, the utopia of a planned economy, as well as the development of local autarkies in rural areas, were promoted throughout the 1920s and 1930s (Harrison 1978). In democratic countries such as France and the United Kingdom, autarkic nationalist policies were implemented during the post-war period (Edgerton 2007). Finally, in the United States of America, the action of the federal government was appreciated not only as a source of employment and social subsidies but also as a change agent that made possible the positive development of the country (Nash 1999). Behind all these examples, reasons are not exclusively economic but also political.

Directly inspired by the Italian IRI, Franco’s regime founded the National Industrial Institute (INI) on September 25, 1941, intending to endorse the industrialization of Spain after the Civil War. It became a tool of autarky to intervene in the national economy through the creation and participation in companies (Martín Aceña and Comín 1991, p. 25) and thus guarantee the political and social stability of the dictatorship (Comín 2012, p. 238). Industrial development was considered essential to transform the agrarian foundations of society and promote an ideal of prosperity similar to that of other Western economies. In the words of Juan Antonio Suanzes, head of the INI since its creation until 1963, it was intended to “greatly improve the living standards of Spaniards, a crucial aim of the State and Franco himself.”¹ Despite the propaganda and social engineering planned for the creation of a working class under the paternalistic tutelage of the State, this policy did not prevent the appearance of strong social imbalances.

As a result of Spain’s international isolation, the INI took on the task of founding State-owned companies to supplement the weak industrial network of the private enterprises. Its model was similar to that of a socialized planned economy, but it was also inspired by the autarkical-military projects of Nazi Germany and Fascist Italy (Catalán 1995). According to Ballestero (1993), Gómez Mendoza (2000), and Torres Villanueva (2003), Suanzes’s philosophy of subordinating everything to the national interest led the INI to prevent competition and appropriate private entrepreneurship projects. The official discourse justified this control as a transitional measure that was done for the general interest. They also said that the final responsibility for economic development was to be transferred to the private sector, although this was not always fulfilled².

The INI action is usually divided into two main stages. The first corresponds to the autarky established until the late 1950s and was focused on the reconstruction of the national economy. For Suanzes, a self-sufficient economy was required to guarantee the existence, honor, freedom of movement, and political independence of the country to satisfy its own needs (Gómez Mendoza 2000, p. 37). Franco’s regime had to face serious

¹ The original quote in Spanish is: “Mejorar extraordinariamente las condiciones de vida de los españoles, objetivo esencial del Estado y del Caudillo ”. Instituto Nacional de Industria. Revista de Información, Año IX, nº 1 (abril 1957), p. 4.

structural problems to put together an industrial and capitalist economy (Carballo, Temprano González and Moral Santín 1980). Thus, State involvement in enterprises was so important that the public sector completely dominated the automotive sector, more than three-quarters of fertilizers, half of the aluminum, and almost 25% of oil production (Miranda Encarnación 2003, p. 105). Some well-known examples belong to the energy sector, such as ENDESA and ENCASO, mining and metallurgy, such as the ADARO Group and ENSIDESDA, pieces of machinery, such as Boetticher and Navarro, shipbuilding, such as the national companies Bazán and Elcano, and transport companies, such as Iberia, ENASA-Pegaso, and SEAT. Several companies were involved in military purposes due to the political situation (Martín Aceña and Comín 1991, pp. 134-137). Such sectors were also prioritized in other totalitarian models, such as Hitler’s Four-Year Plan or Mussolini’s Ricostruzione Industriale (Catalán 2002, p. 271).

The second stage of the INI is connected with the 1959 National Stabilization Plan, which set a new scenario in which autarky was replaced by the free market, the expansion of capital, and the development of more internationally competitive companies, which led to an increase in living standards and consumption capacity (Catalan 2002, pp. 276-277). Large totalitarian enterprises remained, but authoritarianism and economic nationalism got lighter. The institute diversified its spectrum, cooperated more with private entrepreneurship, and reoriented its horizons towards other auxiliary and precision industries, liquefied gases, food, cellulose, textile fibers, commerce, tourism, and technology. All in all, it was arranged as an extensive holding company with a multitude of businesses related to very different sectors.

One of the technological industries of the INI was the Empresa Nacional de Óptica, S.A. (ENOSA), created in Madrid by decree of October 6, 1950. A research project initiated in 2019 and funded by the Ministry of Science, Innovation, and Universities3 revealed the interest of this company for several reasons: first, it was a small business compared to others such as those mentioned above, so it is possible to conduct an in-depth analysis of its characteristics and its evolution in the framework of the Spanish industrialization of the decades from 1950 to 1970; second, it was dedicated to the production of technical artifacts of great specificity, high manufacturing costs, and low economic profitability, which made it one of the first failures of the INI; third, it had a curious history that originated in the military intervention on the industry but then turned to completely different purposes, linked to education4.

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3 The project is entitled La imagen del Instituto Nacional de Industria (1941-1975). Difusión, territorio y arquitectura en el tiempo histórico del Franquismo, and is directed by Rafael García Garcia, from the Universidad Politécnica of Madrid, and M. Angels Layuno Rosas, from the University of Alcalá.

4 ENOSA had a capital of 80 million pesetas that the INI did not want to increase. Its labor force slightly exceeded a thousand employees at maximum. There was only a factory located in the Pinar de Chamartín, Madrid, with an extension of about 6,000 m². In comparison, the INI had larger companies dedicated to more significant sectors for Franco’s regime, such as energy production or automotive. For example, ENASA-Pegaso had an initial capital of 240 million pesetas, and the INI investments increased to 1,659 million in 1955 in addition to 2,073 million in 1957. Its labor force surpassed 12,200 workers distributed
2. Aims and scope

The starting question when addressing the particular study of ENOSA has been the following: was the INI able to launch a pioneering industry, which contributed to the development of science and technology, and thus reduced Spanish dependence on foreign countries?

Technology companies were no exception in the INI framework. The best known is surely Marconi Española, S.A., dedicated to the construction of telegraphy, telephone, and radio devices. However, Marconi had been created before Franco’s dictatorship in 1917, and the INI only had a small stake between 1941 and 1969. Mention may also be made of the Empresa Nacional de Telecomunicaciones (National Company of Telecommunications), the Empresa Nacional Radio Maritima (National Company of Maritime Radio), and the Empresa Nacional Torres Quevedo (National Company Torres Quevedo), although their influence on the State economy as a whole was limited because they were not sufficiently representative (Martín Aceña and Comín 1991, pp. 234-235). ENOSA was fully financed by the INI in 1950 and was dedicated to the field of optics, which was a novelty. We hypothesize that, despite all the efforts made, it never covered its initial objectives, it could not be innovative enough in terms of technology and was forced to redirect its activity towards very different areas. Per this understanding, we have proposed two research objectives:

a) To analyze the development of ENOSA concerning the policies of the INI and the economic changes experienced between the first and second periods of Francoism.

b) To verify in which socio-economic sectors ENOSA acquired relative importance by evaluating its productive activity.

The research methodology is based on the case study, according to the model suggested, among others, by Yin (1994) and Stake (1999), which has been repeatedly applied in the social sciences. The case studies focus on the analysis of a specific object, which has particular and exclusive characteristics, in order to make complete scrutiny of the events that affect it in a geographical framework over time and thus understand their complexity. This article deals with the evolution of a specific INI company based in Madrid to explain the conditions that determined its origin and development concerning its context, delving into the “hows” and “whys” of its successes and failures. It is a unique study due to the specific history of this corporation, whose evolution is unrepeatable and difficult to understand if not through a descriptive and inductive analysis as the one proposed.

The data have been gathered from extensive documentation preserved in the Historical Archive of the Sociedad Estatal de Participaciones Industriales (State Society of Industrial Participations –SEPI–) in Madrid. That documentation includes official reports in three factories in Barcelona, Valladolid, and Madrid-Barajas, the last of which had an extension of more than 1 million m².
of the INI and ENOSA, as well as files, budgets and balance accounts, technical studies, communications between managers, etc., in addition to photographic and audiovisual material. We also went to the Central Archive of the Ministry of Education, located in the AGA of Alcalá de Henares, where some agreements between ENOSA and this public body are kept.

All the collected evidence has been evaluated qualitatively and interpreted with the help of specialized literature on the Francoist dictatorship, its economic policies, the actions of the INI, and the social and educational transformations that occurred during the decades of 1950 to 1970 in order to obtain a holistic vision of that period and draw valid conclusions. We agree with other authors, such as Welch et al. (2011), in considering contextualization and explanation as an additional element for a case study like this one. That is to say, it is possible to theorize and contribute to scientific knowledge through the in-depth analysis of the interactions between empirical phenomena and their contexts, something that has already been carried out by Dubois and Gadde (2002) precisely in the field of industrial research.

3. Contextualization

3.1. Optics in Spain during the early decades of the 20th century

Optic studies in our country have a long tradition, dating back to the publication of the treatise *Uso de los anteojos para todo género de vistas* (Use of glasses for all types of views, 1623). Its author, Benito Daza de Valdés, was the first to systematize contents of geometric and physiological optics in Spanish. Nevertheless, during the following centuries, this discipline was mostly applied in magic lanterns, phantasmagoria, and theatrical shows, as Francisco Dalmau, Luis Corrons, and other opticians from Barcelona did in the decades of 1840-1850 (Cuenca Córcoles 2018). Those illusions displayed through visual devices, halfway between science and magic, enjoyed the public and aroused the interest of writers and artists for new perceptions about the world offered by technology (Fernández 2013).

The first efforts to endow technology with a scientific character were made in the engineering schools of the Army. These educational institutions were created in the 18th century following the enlightened approach that “useful sciences” could contribute to the nation’s progress. Throughout the 19th and early 20th centuries, military engineers trained in these schools promoted technical advances in different areas, despite the little recognition they received. Since 1907, there has been a remarkable development of Mathematics, Physics, Chemistry, and Medicine, thanks to the creation of the *Junta para Ampliación de Estudios e Investigaciones Científicas* (Scientific Studies and Research Expansion Board –JAE–), within the framework of The Free Institution of Education (Caballero Garrido and Azcuénaga Cavia 2010). Under the presidency of Santiago Ramón y Cajal, the JAE encouraged exchange programs between teachers and students and provided scholarships to facilitate training stays in Europe with the aim of acquiring the technical and scientific knowledge of other countries (Sánchez Sánchez 2012).
The growth of research activities was necessary for Spain quite backward then. Due to its modernization and regeneration yearning, this environment has often been characterized as the Silver Age of Science (Ribagorda 2018). But the lack of coordination and continuity, together with a shortage of investment and qualified personnel, has called into question the real impact of its achievements. The infrastructural and institutional changes that occurred in that context were not as large, profound, or lasting as expected, the same that happened with other periods of scientific bonanza in our history (Ausejo Martínez 2004). Therefore, the results and strategy of the JAE were questioned in the Second Republic because they were too focused on pure sciences and had relegated technological progress. This led to the creation of the Fundación Nacional para Investigaciones Científicas y Ensayos de Reformas (National Foundation for Scientific Research and Reform Trials –FNICER–) in June 1931 by José Castillejo (Rodríguez Fraile 2007, p. 244). One of the objectives of this institution was to ensure the practical application of scientific discoveries in the development of the Spanish industry, and another was the decentralization of laboratories and research centers outside Madrid (Rodríguez Fraile 2007).

The FNICER took command of the Laboratory of Industrial and Automatic Mechanics created by Leonardo Torres Quevedo, a research center that manufactured scientific devices, in some cases with lamps and optical elements. More relevant was the publication of the Revista Española de Óptica (Spanish Journal of Optics) in October 1932, promoted by a group of university professors, ophthalmologists, and industrial and military engineers such as Pedro Méndez de Parada, to disseminate the latest theoretical and practical knowledge of this discipline.

A fundamental figure for optics in Spain was José María Otero Navascués. This Navy engineer received a pension from the JAE in 1929 to study at the Swiss Federal Institute of Technology. Later he continued his training at the Technical College of Berlin and returned to Spain in 1935 to join the newly created Rockefeller Institute of Physics and Chemistry under the direction of Professor Julio Palacios. What he learned abroad helped him to promote optics studies by training researchers and establishing professional networks (Pérez Fernández-Turégano 2012). In 1939 Otero Navascués became one of the managers of the Consejo Superior de Investigaciones Científicas (Spanish National Research Council –CSIC–), a new institution created by the government of Franco to replace the FNICER and the JAE, rebuild Spanish science and control it ideologically. First, he directed the Optics and Spectroscopy section of the Institute of Physics Alonso de Santa Cruz, where he worked with about thirty researchers. Afterward, in 1946 he founded the Institute of Optics Daza de Valdés, for which he acquired the first electronic microscope in Spain that same year (Granizo Barrena and Delgado Oliva 2014, pp. 215-218).

The Institute Daza de Valdés focused on two main areas, vision, and spectroscopy, which were diversifying into physiological optics, physical optics, the design of optical instruments, photography, the study of atomic spectra, luminescent materials, and

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colorimetry. Outstanding professors such as Miguel Catalán, García Miranda, López-Enríquez, García Santesmases, Piedad de la Cierva, etc., worked here and published world-renowned contributions, such as the studies carried out in 1941-1942 by Otero Navascués and Armando Durán on the photometric performance of optical systems at low luminosities, and on the phenomenon of nocturnal myopia (Villena 1957, pp. 384-386). The complexity of these investigations and the number of collaborators, more than sixty, are a good sample of the scientific-technological development achieved during Francoism, as Camprubi (2017) has valued this positively in contrast to the underestimation given to it in other occasions. Another issue is whether the CSIC actually implemented an R+D policy or rather an aggregation of research activities in areas that were strongly linked to charismatic leaders (Delgado and López 2019, p. 12).

In the case of Otero Navascués, his interests expanded beyond the field of optics: in 1948, he was one of the founders of a secret committee for atomic research, renamed in 1951 as Junta de Energía Nuclear (Nuclear Energy Board –JEN–). Otero also runs the Laboratorio y Taller de Investigación de la Armada (Navy Research Laboratory and Workshop –LYTIEMA–) between 1947 and 1955, favoring the transfer of scientific and technological knowledge between the aforementioned institutions, as well as with other European societies (Romero de Pablos 2016, p. 52). Cooperation with the CSIC allowed the development of quality optical instruments for the Navy. In the personal archive of Otero Navascués are preserved documents that give account, for example, of how “the Institute has assisted the Laboratory of Optics of the Navy […] has solved the problem of the fabrication of sextants, manufacturing a prototype that meets all the requirements of accuracy and precision”\(^5\) (Granizo Barrena and Delgado Oliva 2014, p. 216). The LYTIEMA produced more than one hundred prototypes and small series of sextants and binoculars (Valcayo and Baratas 2018, p. 244). The desire to manufacture these devices on a large scale, not only for the Army but also for the civilian market, is one of the reasons that would lead to the ideation of a National Company of Optics later.

### 3.2. The industrial mobilization of the Army

ENOSA was founded on the initiative of the Army, which had long been involved in research and technology activities and reached a considerable influence on industrial planning (Arcas González 2019, pp. 58-59). During the Civil War, Suanzes understood that State intervention in the economy was imperative and established, from the Ministry of Industry, regulatory commissions to control production. Their role was similar to that of the Comisiones de Movilización Industrial (Commissions for Industrial Mobilization) that had been created in 1916 by the Spanish Army. These commissions imitated those that were organized by several countries during the First World War in order to transform the civilian and private industry into a war industry under the supervision of the government. Thanks to their visits to the factories and the preparation of reports and

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\(^5\) The original quote in Spanish is: “el Instituto ha auxiliado el Laboratorio de Óptica de la Marina, […] ha resuelto el problema de la fabricación de sextantes, fabricando un prototipo que reúne todos los requisitos de exactitud y precisión requeridos”.
statistics, the Commissions for Industrial Mobilization had detailed knowledge of the secondary sector in Spain and its structural problems (San Román 1999).

When he became president of the INI, Suanzes assumed the negative evaluation that the commissions made about the economic backwardness of the secondary sector. Consequently, he implemented with an ultranationalist perspective most of their suggestions on industrial location, the strategic importance of certain sectors, the need to increase hydrocarbon production, etc. In addition, he recruited many experts from the Army and Navy who were involved in the former commissions and had industrial training, such as Joaquín Planell and José Sirvent (San Román 2000, pp. 63-65). The INI was appreciated as the industrial rear of the Spanish Army, and it was logical to incorporate the military into its organization chart as well as that command model inspired by the military way of doing (San Román 1999, p. 175).

**FIGURE 1.** Sextant produced by ENOSA

![Sextant produced by ENOSA](https://example.com/fig1.jpg)

*Source: AHS, Memoria del INI, Anexo ENOSA, 1969.*

In the case of ENOSA, its first president was Vice Admiral Felipe Abárzuza y Oliva, and the executive officers were mostly colonels of the Navy, among whom Pedro Méndez de
Parada deserves to be highlighted for his knowledge of optics⁶. This connection aligned it to other companies of national interest that also supplied the Army, such as Marconi or Torres Quevedo. The governmental decree established that ENOSA’s main objective was “the production of optical instruments to meet national needs, both civilian and military”⁷, for example, binoculars, telescopes, sextants, etc. (Fig. 1). Some of these artifacts were also useful for espionage, that was significant in Madrid during the Second World War and the first years of the Cold War (Juárez 2005; Del Hierro 2021). The geopolitical context of US hegemony and the struggle against communism is crucial to understand the political plans of military engineers and their interest in defending not only a national industry but also the progressive integration of Spain in the international markets (Camprubí 2017, pp. 22-24). The presence of the military in power helped to spread the idea that a renewed Army was key in the demand for industrial and technological products that would help protect and modernize the country (Arcas González 2019). Besides, only the military had sufficient authority and decision-making capacity to prevail over the economic elite, break traditional molds and promote innovation (Moya 1984, p. 119).

These ideas justified the foundation of ENOSA, which had the support of LYTIEMA. This laboratory licensed the company to manufacture its prototypes for twenty-five years from December 27, 1950. In return, ENOSA would pay a royalty of 5% on the number of sales. Subsequently, on February 27, 1959, the company signed another contract to supply optical devices to the Ministry of the Navy⁸. Collaboration was also reflected in the provision of human resources. About twenty students from the third class of the LYTIEMA apprentice school joined ENOSA in 1955 to manufacture optical instruments that were labeled with the logo of both societies (Valcayo and Baratas 2018, p. 245).

The main client of ENOSA was, therefore, the Army, which demanded binoculars, rifle scopes, and periscopes. During Second World War, the fabrication of optical glass acquired great importance for precision armament. Its production was expensive and complex, so it needed strong funding from governments (Zen 2018, p. 8). But the protection of the Army and the State was not enough for ENOSA to achieve the expected results and, before the end of the 1950s, it was clear that the experiment would not succeed. Why did a supposed cutting-edge company like ENOSA fail to ensure sufficient demand for its products? Had it done so, not only would it have guaranteed its survival, but it would have achieved that military mobilization that sought to develop a national technological industry.

Among the causes of failure are technical difficulties in the production of such complex and unprofitable products, lack of specialized manpower, and insufficient demand. Also,

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⁷ The original quote in Spanish is: “la fabricación de instrumentos ópticos con destino a satisfacer las necesidades nacionales, tanto de índice civil como militar”. AHS, Direcciones INI, ENOSA, año 1964, caja 151.
⁸ AHS, Expedientes Originales, ENOSA, caja 71, doc. 597.
the economic situation in those times did not allow large expenditures or special budgets for the Army, such as those of the Primo de Rivera dictatorship. The American aid resulting from the agreements signed in 1953 could have served to compensate for the lack of funding, but the money was used for other purposes. Despite the lack of competitiveness generated by a closed market, ENOSA’s products ceased to be of interest to the Army due to the technological changes that occurred worldwide, which led to the progressive replacement of optics by electronics and glass by plastic. In a report from 1961, which we will quote later, ENOSA is compared to similar corporations that had stopped manufacturing optical devices and were in the process of restructuring, such as the Italian San Giorgio, Salmoiraghi, and Galileo. The creation of ENOSA took place out of time; that is, it arrived all but too late. It probably would have worked in the 1940s because its optical devices were suitable for the military operation of that time, but in the 1950s, the technology had taken a big step forward, and those products were somewhat outdated.

The failure of the first stage of ENOSA is the consequence of this economic policy based on companies linked to military demand and in need of external technological advice, criticized by authors such as López García (1999). When ENOSA became operational in the mid-1950s, economic conditions conducive to the free market and competition from new products and foreign machinery diverted the Army’s initial interest. The conundrum, however, appears more complex and relates to many structural deficiencies in the Spanish economy, including excessive State control that limited its expansion, a chronic deficit in the trade balance, and the shortage of qualified personnel for technological development. Economists of the time, such as Manuel Torres (1956), also warned about the inadequate implementation of partial plans of industrialization, housing construction, colonization and new irrigation systems, taxation, financing, etc., that despite their apparent precision, were essentially a list of good wishes. They also claimed how necessary the integration of those projects was in a single general development plan that connected all of them realistically.

3.3. The impossibility of technological self-sufficiency

Francoism considered science and technology an instrument for the development of a domestic industry that was not dependent on foreigners. That is why organizations such as the Institute of Optics Daza de Valdés and the Patronato Juan de La Cierva participated in the foundation of ENOSA (CSIC 1967, p. 49). During the first decades of the dictatorship, there was a plethora of engineers who communed with Francoism and pursued the desire to regenerate Spain by applying a kind of “technological nationalism” (Camprubí 2017, p. 18). Not only did they contribute decisively to consolidating Franco's government, but they were the true promoters of his totalitarian policies, in collaboration

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9 This shortage was not exclusive to ENOSA. It also happened in other technology companies such as Marconi. In the AHS, Estudios e Informes, Marconi, años 1943-1945, caja 322.4 (625), there are references to the “dificultad de encontrar Ingenieros preparados para nuestras instalaciones y, una vez encontrados, de mantenerlos el tiempo suficiente para su formación”.

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with third interest groups. The arrangement of these policies was utilitarian, that is, linked to industrialization, was conceived in the departments of the CSIC, assumed a high ideological burden inspired by National Catholicism and a yearning for redemption, and had little results in the first years (Sanz Menéndez and López García 1997, p. 83).

But the utopia of self-sufficiency was never effectively achieved because of poverty and a lack of scientific and industrial tradition (Presas 2008). Even in the harshest years of isolation, the Regime maintained commercial relations with anti-Franco powers such as the United Kingdom. The technical development was a good pretext to promote international alliances that favored not only a positive image of Francoism but also expert advice and the establishment of agreements for the import of foreign machinery and equipment. In this regard, it is essential to mention the network of German contacts of José María Otero Navascués, who was CEO of ENOSA from its foundation until 1961. Otero’s initial plan was to turn ENOSA into a subsidiary of Carl Zeiss, a leading optical company in Germany. The INI signed a contract with this company on July 1, 1950, months before the foundation of ENOSA, for the inauguration of a factory of 2,000 workers in Madrid and the cession of licenses in exchange for the payment of a rather onerous fee.10

Autarky as an isolationist economic model in which Spain was excluded from commercial circuits was not as intense as is believed (Camprubí 2017, pp. 19-20). The official discourse defended economic self-sufficiency as a prerequisite for political independence, especially in the early years. But Francoism accepted the entry of knowledge and technology, especially if it came from Germany, as evidenced by the numerous documented visits of Nazi consultants to companies such as ENCASO and CAMPSA (San Román 1999, pp. 195-215). The external dependence of Spanish companies was also manifested in the adoption of new management models, a growing injection of capital, and opportunities for the qualification of the labor force (Delgado and López 2019). Copying foreign products was common in Spanish innovation policy since long before the dictatorship and then consolidated the inferiority of Spain compared to other countries (López and Valdaliso 2001, p. 328).

In the context of the Civil War and during the Second World War, the economic relationship with Germany was strengthened by the interest that the Iberian Peninsula aroused as a source of minerals and raw materials (Barbieri 2015). Later, it was the INI and the Patronato Juan de la Cierva who worked to maintain this relationship and implemented a systematic strategy to attract German talents (Presas 2008). Since 1944, scientists who did not want to be accused of being Nazis escaped from Germany, and many took refuge in Spain, where the government provided them with political and labor shelter in INI companies such as Pegaso and CETME (Collado Seidel 2005; Romero de Pablos 2007, p. 309). In the field of optics, it is worth mentioning that Professor Franz Weidert fled Berlin before the arrival of the Russians and landed at the Institute Daza de

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10 AHS, Expedientes Originales, ENOSA, caja 71, doc. 597.
Valdés (Villena 1957, p. 384-386). In this line, the aforementioned agreement signed between ENOSA and Carl Zeiss stipulated “the incorporation of two German engineers and a workshop foreman of the same nationality, signing the corresponding employment contracts on 1 April”\(^\text{11}\). Also, an annex to that agreement, dated October 22, 1951, warned that “as soon as the state of war between Germany and the Allies ends, ENOSA and the CARL ZEISS FOUNDATION will begin negotiations for the signing of an arbitration agreement”\(^\text{12}\).

In the middle of the Cold War, the normalization of relations allowed to retake institutional or personal contacts that some Spanish engineers like Otero Navascués had begun in the 1920s and 1930s. Most of the German scientific structures were not destroyed and quickly adapted to the new context of peace so that their technicians could continue advising the Francoist companies (Presas 2008, p. 177). Since 1954, Carl Zeiss organized a training program of up to six-months-stays for ENOSA staff at its headquarters in Oberkochen. In 1955 a team of six German opticians and engineers visited the factory in Madrid so that “for a short period of time, not exceeding two months, to instruct our workers”\(^\text{13}\). And in 1959, the Spanish company decided to sign another contract with Schwelmer Einsenwerk Miller, which included the subsidized stay of several of its technicians in Madrid\(^\text{14}\). The documentation also includes partnerships with foreign companies for the acquisition of equipment, machinery, and tools\(^\text{15}\).

These trade agreements reflect that autarky was quite relative. Actually, they were linked to the economic policies promoted since 1951, characterized by progressive liberalization, the growth of imports, progress towards multilateralism, and the beginning of developmentalism (Viñas et al. 1979; Guirao 1998; García Delgado 1990). Technology transfer to Spain and increasing investments from Europe and the USA consolidated the new economic context and eventually led to industrial growth (Miranda Encarnación 2003, p. 119). By contrast, domestic investment in R+D was often unnecessary and the shortage of qualified manpower became chronic due to the “lack of technical means and

\(^{11}\) The original quote in Spanish is: “la incorporación de dos Ingenieros alemanes y un Maestro de Taller de la misma nacionalidad, suscribiéndose los correspondientes contratos de trabajo en 1º de abril”. AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1951, p. 2.

\(^{12}\) The original quote in Spanish is: “tan pronto como termine el estado de guerra entre Alemania y los Aliados, ENOSA y la FUNDACIÓN CARL ZEISS entablarán negociaciones para la firma de un convenio de arbitraje”. AHS, Direcciones INI, ENOSA, año 1951, caja 148.

\(^{13}\) The original quote in Spanish is: “por un breve periodo de tiempo, no superior a dos meses, instruyesen a nuestros operarios”. AHS, Biblioteca, Memoria del INI, Anexo ENOSA, 1954, p. 3. The visits to Germany continued in the following years, including the maintenance of an ENOSA delegation in Munich to manage supply operations; see in AHS, Fondo Direcciones INI, ENOSA, año 1962, caja 149.

\(^{14}\) AHS, Direcciones INI, ENOSA, año 1959, caja 148.

\(^{15}\) AHS, Direcciones INI, ENOSA, año 1959, caja 148. Other corporations from abroad are also mentioned, for example, Crouzet and Ultrasonics from France, Societe Genevoise from Switzerland, and Apparechi Controllo e Misura from Italy.
specialists that slow down the industrial development in which the country, and especially the National Industrial Institute, are engaged”¹⁶.

The poor preparation of the working class was a consequence of the long abandonment of primary education and vocational training, related to apathy and a policy defined as “demobilization of the masses” in the first decades of Francoism (Mayordomo et al. 1999; Malefakis 2000; Núñez 2003). The problem would not be solved until the dissemination of technical education, thanks to the Professional Training Act of July 20, 1955. Promoted by Ministers Ruiz Giménez and Rubio García-Mina, and financed in part by the corporations themselves, it tried to provide skilled workers for the “growing development of the industry” (Negrín Fajardo 2006, p. 436; Puelles Benítez 2009, p. 339).

ENOSA had to invest a considerable amount of time and money in operator training. Between 1954 and 1956, the excess budget devoted to formation exceeded 10 million pesetas. In addition to being costly, this task proved complex and could be one of the causes of the company’s failure. It is true that “over the years a really good team has been formed” and perhaps this work of industrial qualification was one of its greatest merits. But the human resources were poorly optimized because they were dedicated to manufacturing very small series and had to complete their day with other tasks that prevented specialization. As a result, a low coefficient of production per direct operator was found in the entire workforce¹⁷.

As a momentary solution, they managed the incorporation of one hundred and twenty experts in scientific instruments from the Torres Quevedo Institute. According to an excerpt from the 1941 CSIC Report (cited by Romero 1998, p. 378), this body intended, with excessive rhetoric, to increase the scientific, industrial, and economic potential to reduce imports. That discourse emphasized an autarkic approach that clashed with the absence of a truly technological industry in Spain. A 1957 restructuring transferred the production workshops and operators of Torres Quevedo to ENOSA, which became the industrial extension of the institute. The agreement between the two entities reduced the first to a study center that designed scientific and educational devices, such as microscopes, which ENOSA then manufactured in series and marketed (CSIC 1967, p. 49). Samples of this are the fabrication of incubators for babies and the attached image, which shows a binocular magnifying glass for geological investigations, whose support contains the brand of the two entities (Fig. 2)¹⁸.

¹⁶ The original quote in Spanish is: “carencia de técnicos medios y de especialistas que frena el desarrollo industrial en que el país, y muy especialmente el Instituto Nacional de Industria, están empeñados”. AHS, Expedientes Originales, ENOSA, año 1959, caja 62, doc. 509.

¹⁷ The original quote in Spanish is: “en el transcurso de los años se ha formado un equipo realmente bueno”. AHS, Expedientes Originales, ENOSA, año 1961, caja 71, doc. 597.

¹⁸ The references to the collaboration between ENOSA and Torres Quevedo are huge and can be traced in AHS, Fondo Sirvent, ENOSA, año 1957, caja 33; Expedientes Originales, ENOSA, año 1957, caja 48, doc. 402; y Registro General, ENOSA, año 1957, caja 48, doc. 402.
FIGURE 2. Binocular magnifier manufactured by ENOSA and the Torres Quevedo Institute

Source: Laboratory of San José del Parque School, Madrid. Photographed by the author.

From a more critical perspective, the operation seems to be an example of the strategy of seizure of resources and monopolization of the market that the INI so often practiced. By absorbing the productive area of the Torres Quevedo Institute, ENOSA was monopolizing all the functions of manufacturing research material for the CSIC. So, the transfer of knowledge and human resources was a way of sharing the goodies rather than a cooperative plan to boost the technology industry. Moreover, the takeover created economic difficulties because the profitability of these products was limited, and ENOSA’s expenses were increased by the salaries of the new staff, in addition to a royalty of 3.5% on sales and 3.5 million pesetas in which the transfer of machinery was calculated. More beneficial was the production of school supplies and experimental equipment, which did not require as much precision and could have a better market outlet, something that the Torres Quevedo already did with little success thanks to its relationship with the Ramiro de Maetzu and San José de Calasanz high schools (Romero 1998).

These transfers between companies and centers linked to the CSIC were frequent during the period in which Suanzes was at the same time president of the INI and of the Patronato Juan de la Cierva because there was a conscious desire to apply research to
the development of a national industry (López García 1999). Since the signing of the agreements with the United States, this collaboration became less necessary because the autarkic circle stopped, and technology began to arrive from abroad too. In addition, the interests of scientists and companies ceased to coincide or were less profitable for all parties, and science policy diverged towards the creation of other commissions and bodies. Thus, ENOSA would disconnect from the closed circle of the CSIC and LYTIEMA to chart a different path.

4. ENOSA'S trajectory from optics to education

4.1. The first autarkic stage

The certification of incorporation of ENOSA was notarized on January 30, 1951, with a capital of 80 million pesetas\(^{19}\). Within a fully autarkic context, INI was the sole shareholder and had absolute control. The factory was built in an urban development area in the north of Madrid known as the Pinar de Chamartín, where the Institute of Construction Sciences of the CSIC and the laboratories of the Navy were also installed\(^{20}\). Production began in 1955, once machinery and optical glass were received from abroad\(^{21}\).

The initial workforce had only 188 employees, which gradually increased until they peaked at a maximum of about 1,200 in the early 1970s, with a significant portion of women. The start-up was complex since the first tasks were devoted to the assembly of prototypes and the construction of new instruments “whose necessary preparation is very laborious”\(^{22}\). The Army’s first orders, in smaller quantities than expected, were scopes for bazookas and rifles, binoculars, and bimadores, with high manufacturing costs (Fig. 3).

A few years later, they realized that ENOSA would not be able to survive on such a small captive market. In 1956 the company applied for several credits that were authorized by the INI management and totaled 29.3 million pesetas\(^{23}\). The debt situation only worsened, and successive capital increases were requested: 135 million pesetas in 1954, 160 million in 1957, and 230 million the following year\(^{24}\). The INI rejected all of them, first because

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\(^{19}\) AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1951, p. 1.

\(^{20}\) AHS, Direcciones INI, ENOSA, año 1961, caja 148. The factory was erected on Avenida de San Luis, 91, by Ingeniería y Construcciones Sala Amat, according to a project by the architect D. J. Domínguez Aguado. It was finished in 1955 and was an interesting example of rationalist architecture composed by two wings assembled in an “L” shape.

\(^{21}\) AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1953, p. 2. The machinery was to be bought in Germany, but certain difficulties with import licensing forced the company to purchase it in Switzerland, England, France, and the Netherlands. The glass was obtained from Casa Parra-Mantois in France and from Bulkhead in Germany, according to a 1952 report. In another 1955 report it is said that “el importe de todas estas adquisiciones fue de 9.8 millones, de los cuales 5 corresponden a maquinaria mecánica y 2.9 a accesorios”.

\(^{22}\) The original quote in Spanish is: “cuya necesaria preparación es muy laboriosa”. AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1957, p. 2.

\(^{23}\) AHS, Registro General, ENOSA, año 1956, caja 41, doc. 319.

\(^{24}\) AHS, Registro General, ENOSA, años 1954-1957, caja 30; y Registro General, ENOSA, años 1957-1958, caja 51.
it did not want to invest more money in a company that was in deficit and second because its financial possibilities diminished with the change of government in 1957. The new Ministry of Finance endeavored to control public spending and urged the Institute to conform to the rules of private enterprise, opposing the autarkic model developed until that moment by Suanzes. As a result, the liquidity injection into several corporations of the holding company was frozen (Comín 2012, p. 241).

**FIGURE 3.** Interferometer used at the ENOSA factory in 1956

![Interferometer](image)

*Source: AHS, Fototeca, Album 4-99-2, doc. 01522.*

Without planning or market research, the board of directors of ENOSA considered the possibility of manufacturing other products aimed at the civil sector. A surprising initiative was presented in 1959 to get a contract of 24.6 million pesetas with CAMPSA for the manufacture of five hundred gasoline pumps in cooperation with the German company Schwelmer Eisenwerk Muller. The proposal was rejected by the INI management because neither the investments nor the adaptation needs of the factory were sufficiently explained\(^{25}\). What was an optics company doing manufacturing pumps? It appears to be an attempt by an INI company to intrude into an odd sector, asserting its privileged position and exploiting its relationship with other corporations of the State holding, with the aim of overcoming competition. No wonder they received “numerous contestations from domestic manufacturers, which believe that such an extension should

not be allowed because the market is sufficiently served with domestic production and ENOSA was created for other specific purposes”\textsuperscript{26}.

Another weird option took place in 1961 when the board formulated an attempt of agreement with Antonio Enrich Valls, of CAMER, S.A., for the collaborative fabrication of industrial looms MAXBO-JET, of Swedish patent. Nor was it carried out due to the high investment in machinery and the total lack of experience in this sector. As a result of the above, the situation of the company reached a critical point which called into question its very survival\textsuperscript{27}.

4.2. The 1961 restructuring

On May 27, 1960, the INI appointed a committee to make a diagnosis of the situation of ENOSA; its conclusions were sent to Suanzes on February 27 of the following year. Despite the caution with which the historical documentation of the Franco Regime must be examined, for its propagandistic tone and its biased omissions, in this case, it must be recognized a rigor and a critical capacity that reaches even the acrimony. The report proposed the closure of the company while leaving the possibility for its continuity in case of finding an adequate solution to three major difficulties: financial insufficiency, insufficient infrastructure, and market problems\textsuperscript{28}.

Regarding the first point, the initial capital of 80 million had been exceeded by 2,452,900 pesetas for the construction of the factory, purchase of machinery, acquisition of raw materials, and start-up, which generated from the first moment a deficit of 2.97%. The report criticized “insufficient consideration of the means of financing, which is one of the causes of the current lack of economic consistency”, which caused that the profitability calculations had to be based on very hypothetical numbers. Insufficient self-financing led to requests for capital increases, denied by the INI, and several short-term bank loans “which exceeded any measure of prudence, stifling industrial development, trade and performance”. ENOSA's financial situation was described as unsustainable, with numerous recognized and potential debts that made it unable to survive without the INI’s advances. The accumulated losses in the ten years of life reached 106.5 million pesetas, and by November 31, 1960, the share capital had been entirely consumed. In conclusion, “for the INI is interesting any solution, however costly it may be, that cuts the annual loss that represents the maintenance of this Society in its current situation”\textsuperscript{29}.

\textsuperscript{26} The original quote in Spanish is: “numerosas impugnaciones de fabricantes nacionales, que estiman no debe autorizarse tal ampliación por estar suficientemente atendido el mercado con la producción nacional y además considerar que ENOSA fue creada para otros fines específicos distintos”. AHS, Direcciones INI, ENOSA, año 1960, caja 148.

\textsuperscript{27} AHS, Direcciones INI, ENOSA, año 1962, cajas 149 y 150.

\textsuperscript{28} The full report, from which all the information is quoted verbatim, can be found in AHS, Expedientes Originales, ENOSA, año 1961, caja 71, doc. 597. Other documents referring to this report can be consulted at AHS, Direcciones INI, ENOSA, año 1961, caja 148.

\textsuperscript{29} The original quotes in Spanish are: “la insuficiente ponderación de los medios de financiación y que es una de las causas de las que se deriva la falta de consistencia económica actual […] que excedieron a toda medida de prudencia, asfixiando el desarrollo industrial, el comercial y los resultados […] para el INI es
On the second point, there was a disproportion between the planned and the built factory, the necessary machinery, and the workforce, which was much lower than the 2,000 workers estimated in the contract signed with Carl Zeiss. In addition, the cost of tooling in the first years surpassed the budget of up to 27 million pesetas, as did the investment in workforce training. Just the cost of the staff donated by Zeiss in the first years amounted to 5.7 million pesetas.

With regard to the third point, the manufacture and sale of optical devices were unprofitable because it was conditioned by the Army orders and limited to the domestic market. The company relied excessively on a single type of customer and the orders were not enough to assure the precarious march of the Company, even less in the conditions of amplitude that was inially conceived. Sales forecasts for the first five years were 204.5 million pesetas, but only 44.3 million had been achieved. Of all the items ENOSA offered in the military market, only four were profitable because they sold in significant numbers: visors, binoculars, glasses, and sextants.

“It was therefore the size, the exaggeration of the means, the lack of foresight, and the false economic approach that led to the current situation [...] The Company has been faced with the reality of adequate facilities for the manufacture of optical instruments, destined for a practically zero military market, and a civilian market of diverse and complex characteristics.”

Sales to the civilian market barely accomplished 20% of the total. It is worth mentioning some items by Carl Zeiss, such as slit lamps, theodolites, and refractometers, which were in low demand, difficult to manufacture, and of high costs. The same happened with other scientific and pedagogical instruments of great diversity and complexity, which were produced in very short series and, therefore, very expensive, such as the prototypes of the Torres Quevedo Institute. The report warned on the company’s difficulties in entering the civil market and recommended specializing in a smaller group of instruments, which could be produced on a large scale and with international projection to obtain greater profitability. However, it warned of competition in this sector. To recap, such were the problems of ENOSA that the diagnosis report proposed its end or its complete restructuring under the supervision of the INI because there was no doubt that the Company was not be able to overcome the critical situation.

Seen in context, at the end of the 1950s, it was evident the failure of the Army-controlled autarky, advised by Germany and overprotective for public enterprises with the aim of preserving its dominance over private competition. The INI resisted modifying this model interesante cualquier solución, por costosa que sea, que corte la sangría anual que para el mismo representa el mantenimiento de esta Sociedad en su situación actual”.

30 The original quote in Spanish is: “Han sido pues las dimensiones, la exageración de los medios, la falta de previsión y el falso planteamiento económico, lo que ha conducido a la actual situación […] La Empresa se ha encontrado ante la realidad de unas instalaciones adecuadas para la fabricación de instrumentos ópticos, con destino a un mercado militar prácticamente nulo, y un mercado civil de características diversas y complejas”. AHS, Expedientes Originales, ENOSA, año 1961, caja 71, doc. 597.
until the departure of Suanzes, who was replaced in 1963 by José Sirvent, who was more open-minded to the proposals of the new Minister of Industry, Gregorio López-Bravo (Cebrián and López 2019, pp. 141-142). ENOSA was not only a loss-making business with little chance of success, but it was designed according to an outdated model in which it lacked its own technology, qualified workers, and a reasonable investment in addition to other structural deficiencies.

Under the 1951 Corporations Act, it was cause for the dissolution of a company that economic losses reduced its assets to less than one-third of the share capital. In the case of ENOSA, it had been consumed whole, so its closure was justified. However, the resulting complications postponed the final decision. In March 1961, the INI had to inject 79.9 million pesetas to pay off outstanding bank loans. In April, it commissioned the firm Galtier Hispania, S.A. to carry out a valuation of the factory and machinery, whose result was that the economic benefit derived from the sale of the complex was scarce. And then came the problem of termination of contracts and staff compensations, which should be dismissed or relocated to other companies.

Moreover, the INI wanted to prevent optical research and production from disappearing from the national economy. They did not want to accept the failure of ENOSA or withdraw from a technological sector like this, which was wanted under State supervision. Suanzes was suspicious of Otero Navascués because he was distracted by other more ambitious projects, such as the Junta de Energía Nuclear (Nuclear Energy Board –JEN–), which he directed between 1948 and 1974 (Romero de Pablos 2007, p. 307). This abandonment of optics by nuclear physics was noticed at the time (Villena 1957, p. 383). Otero’s innovative ideas went against the autarkic and protectionist policies of the INI defended by Suanzes, and the resources of the JEN reached such dimensions that they could compete with any of the INI’s research centers far from its control (Sánchez and López 2020, p. 53-56). This diversity of interests could be a cause of disaffection between Otero and Suanzes, along with other particular reasons that led the former to question his role in ENOSA, even though it had been a personal bet.

At the end of 1961, most of the managers began to think about the possibility of saving the company by reorienting its administration and activities. The change of heart is surprising and can be considered a flagrant breach of the law, but the INI considered economic profitability a secondary aspect and repeatedly acted as a sanatorium for companies through rescue and refinancing operations such as the one finally implemented here (Schwartz and González 1978). In any case, the restructuring of ENOSA in the new socio-economic context derived from developmentalism was only possible if new dynamics were generated and led by other actors. The departure of Otero Navascués, the replacement of almost all military officers by engineers, and the reinforcement of Luis Augué Durán and José Antonio de Artigas Sanz in the management team seem to respond to this change.
Auguet was president of ENOSA since January 13, 1953, and remained in the chair until 1975, a year before his death. He was a Doctor of Industrial Engineering and a professor at the School of Engineering in Madrid, as well as an excellent illustrator and science communicator (Moreno-Torres 2015, p. 26). Between 1942 and 1965, he was head of the Fábrica Nacional de Moneda y Timbre (Royal Mint of Spain) and was in charge of the construction of its headquarters in the Barrio de Salamanca in Madrid (Santos and Ganges 2019, pp. 287-303). He was also president of the Spanish Society of Ceramics and Glass and executive officer at the INI (García Verduch 2002, p. 417). His first stage at the head of ENOSA had led to the complex situation explained, but the management of the Institute decided to rely on his experience. José Antonio de Artigas was also a doctor in industrial engineering, a member of the Royal Academy of Sciences, and one of the world's leading experts in optics and electricity. His contributions to the international glass industry led him to collaborate with the astronomical observatory of Mount Palomar in California (Artigas de Castro 1977). Therefore, he had a high qualification to occupy the vice-presidency of ENOSA, where he worked closely with Auguet between 1952 and 1968, the year in which he was dismissed due to age.

On November 10, 1961, Luis Auguet presented to Suanzes a proposal for a new orientation of the industrial activities of ENOSA, with the following set of measures:

- a) Settlement of debts and refinancing by replenishing capital with “various annuities from the Provident Fund for possible losses of companies”.

- b) Reorganization of the company with a new, more professional, and less militarized organizational chart (Fig. 4).

- c) Increase in investment in machinery and facilities worth 25 million pesetas.

- d) Termination of the contract with Carl Zeiss due to the high costs of the royalties on its patents, the remuneration of German engineers, and other expenditures that totaled 27.6 million pesetas on December 31, 1960.

- e) Reorientation of the activity towards new business focused on the manufacture of gas valves and teaching materials.

Regarding the latter, an agreement was established with the company Butano to start the construction of gas valves by express order of the INI (CSIC 1967, p. 49). This type of product was classified within the “precision mechanics” sector, which served as

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31 AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1952, p. 4.
32 AHS, Fondo Sirvent, ENOSA, año 1968, caja 33.
33 The original quote in Spanish is: “diversas anualidades con cargo al Fondo de Previsión para posibles pérdidas de Sociedades”. AHS, Expedientes Originales, ENOSA, año 1961, caja 71, doc. 597.
34 On the termination of the Carl Zeiss contract see AHS, Expedientes Originales, ENOSA, años 1958-1961, caja 62, doc. 505; also, AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1961, p. 3. This contract was a problem because the production of optical instruments, according to those patents, was scarce. After 1958, Auguet tried to modify it by reducing or cancelling the fee. This eventually happened at the end of 1961, although ENOSA kept on paying Zeiss for several years.
justification for ENOSA’s staff to be considered capable of manufacturing it, although it was necessary to train and expand the workforce. The solution seems like a trick devised by the INI to make ENOSA useful. What was an optics company doing manufacturing gas valves if it was completely out of its field? Were there no other companies in the country that were better suited to do so? Following Catalán (2002 p. 278), we believe that this is a clear example of the INI’s protectionist policy, which, under the excuse of complementarity and reciprocity between its companies, legalized intrusiveness and expelled competition from the private sector, taking over the national market.

**FIGURE 4.** New organization chart of ENOSA

![New organization chart of ENOSA](https://example.com/figure4.png)


However, the main developing area was the construction of educational materials, which had begun years earlier as part of the activities inherited from the Torres Quevedo Institute. The idea was not very original; it was the same one that had been carried out in that body when they replaced its production of very expensive and unprofitable scientific instruments with equipment for didactic experiences. But the 1961 report had already shown interest in the education sector:

“Since there is no doubt that experimental teaching in Spain tends to develop more and more (and we should be pleased), there is a potential
market of some interest that is guaranteed by the current policy of the Ministry of National Education, which tends to the maximum development of this type of education [...] The instruments that are currently manufactured are with profit, which demonstrates that this sector can be profitable”

Auguet’s plan detailed the invoicing calculations and potential customers of these products, anticipating the recovery of ENOSA from 1964. Despite the reluctance shown by the technicians and part of the board of directors of the INI, its manager José Sirvent approved the plan on November 30, 1961, because it might be considered a very important step towards its economic regularization. Thus began the new journey of ENOSA under close supervision and the fear of “that the Company continues to be a seedbed of losses that once fed the banks and now and before the INI”, in the words of Suanzes himself.

4.3. The second stage of developmentalism

Since the end of 1961, the restructuring of the National Company of Optics began on the basis of an expansion of the workforce, a change in the business model, and the planning of new productive activities in a fully developmental socio-economic context. The focus was on the production of teaching materials, “whose production represents a very significant percentage of the total in the factory” (Instituto Nacional de Industria 1971, p. 191), at the expense of military artifacts, which were relegated to the background. By the end of 1962, ENOSA had reduced its debt and increased its turnover, which reached 80.7 million pesetas, well above the 14 million of the previous year. For better organization, these five areas were established:

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35 The original quote in Spanish is: “Al ser un hecho indudable que la enseñanza experimental en España tiende a desarrollarse más y más (y de ello debemos felicitarnos), se presenta en potencia un mercado de cierto interés que viene garantizado por la actual política del Ministerio de Educación Nacional, la cual tiende a un máximo desarrollo de este tipo de enseñanza […] Los instrumentos que actualmente se fabrican es con beneficio, lo cual demuestra que este sector puede ser rentable”. AHS, Expedientes Originales, ENOSA, año 1961, caja 71, doc. 597.

36 Ibid.

37 The original quote in Spanish is: “que la Empresa siga constituyendo un semillero de pérdidas que antes alimentaban los Bancos y ahora y antes el I.N.I.”. AHS, Direcciones INI, año 1963, caja 149.

38 AHS, Biblioteca, Memoria del INI, ejercicio 1961, pp. 273-274.

39 The original quote in Spanish is: “cuya producción representa un porcentaje muy notable de la total de la fábrica”.

40 AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1962, p. 2.
a) **Mechanical atelier**, complemented by other workshops of tooling and assembly elements (Fig. 5), which were dedicated to the production of butane gas valves\(^{41}\).

b) **Optics workshop** aimed at developing lenses and optical devices such as microscopes, magnifying glasses, binoculars, etc.

c) **Teaching material studio**, which manufactured equipment for experiences or experimental sets, consisting of boxes and suitcases with prototypes to carry out in the classroom practices of physics, mechanics, electronics, chemistry, biology, geology, etc.

d) **Atelier of metal, welding, carpentry, and foundry** for the construction, assembly, and finishing of components with new techniques; an efficient organization of these ateliers allowed to reduce costs and increase the productivity of the workforce.

e) **Workshop of prototypes and repairs** dedicated to the repair of machines and the manufacture of useful devices for the assembly line\(^{42}\).

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\(^{41}\) For this area, measuring devices and valve patents of the Danish company KOSANGAS were used; see at AHS, Direcciones INI, ENOSA, año 1962, caja 149.

\(^{42}\) AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1963, pp. 1-4.
In a positive trend, already profitable, in 1965 the board of ENOSA asked the management of the INI for a new capital increase of 300 million pesetas, justifying it in “the current disproportion between the share capital -80 million pesetas- and the external funds of the Company -186,9 million pesetas”. José Sirvent’s response was delayed in time and limited the expansion to 70 million “and that an equal amount is long-term credit”43. From the reading of the reports and balance sheets of this decade, three indicators of improvement can be deduced. First, the leading role of the Research & Projects department, whose function was to plan future areas of development and brainstorm new products with an increasing budget, which rocketed to 40 million pesetas in 1972. Second, the qualification of workers, which in the past was insufficient due to the complexity of the factory tasks and the quality requirement of the products, now seemed more in line with production needs (Fig. 6). Third, the continued increase in demand and turnover, which went from just 700,000 pesetas in 1955 to an all-time high of over 850 million in 1972.

43 The original quotes in Spanish are: “la desproporción actual entre el capital social –80 millones de pesetas– y los fondos ajenos de la Empresa –186,9 millones de pesetas […] y que otra cantidad igual la constituyan créditos a largo plazo”. AHS, Registro General, ENOSA, años 1964-1966, caja 103, doc. 766; Fondo Sirvent, ENOSA, años 1966-1968, caja 33; y Direcciones INI, ENOSA, año 1968, caja 151, doc. 766. In these files there are documents regarding several loans by the Banco Exterior de España, which seem to be a direct consequence of the above.
### TABLE 1. Sales data and income statements of ENOSA (in pesetas)

<table>
<thead>
<tr>
<th>Years</th>
<th>Total net sales (in pesetas)</th>
<th>Profit and loss account (in pesetas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>14,248,024.21</td>
<td>14,475,184.12</td>
</tr>
<tr>
<td>1962</td>
<td>80,758,359.21</td>
<td>81,551,922.16</td>
</tr>
<tr>
<td>1963</td>
<td>162,291,776.27</td>
<td>162,556,617.04</td>
</tr>
<tr>
<td>1964</td>
<td>252,214,897.61</td>
<td>252,430,414.86</td>
</tr>
<tr>
<td>1965</td>
<td>283,269,695.95</td>
<td>283,314,099.25</td>
</tr>
<tr>
<td>1966</td>
<td>315,143,463.63</td>
<td>315,169,293.83</td>
</tr>
<tr>
<td>1967</td>
<td>378,405,760.77</td>
<td>383,872,336.63</td>
</tr>
<tr>
<td>1968</td>
<td>477,789,043.61</td>
<td>448,911,420.15</td>
</tr>
<tr>
<td>1969</td>
<td>497,541,997.47</td>
<td>499,283,184.18</td>
</tr>
<tr>
<td>1970</td>
<td>584,047,524.85</td>
<td>585,229,960.23</td>
</tr>
<tr>
<td>1971</td>
<td>659,021,000.87</td>
<td>659,617,411.04</td>
</tr>
<tr>
<td>1972</td>
<td>850,455,534.27</td>
<td>850,461,323.11</td>
</tr>
<tr>
<td>1973</td>
<td>706,037,327.96</td>
<td>733,696,638.14</td>
</tr>
<tr>
<td>1974</td>
<td>427,417,479.64</td>
<td>567,784,645.86</td>
</tr>
<tr>
<td>1975</td>
<td>405,961,650.64</td>
<td>279,619,358.89</td>
</tr>
</tbody>
</table>

*Source: Own elaboration based on information from the AHS, Biblioteca, Memorias del INI, Anexo ENOSA.*

In the late 1960s, ENOSA was able to quickly supply quality optical items for some of the most prestigious English, Swiss, and Italian optical firms (CSIC 1967, p. 51). 90% of sales were limited to the domestic market, but exports of teaching materials increased to countries such as Argentina, Peru, Brazil, and Mexico, where in 1967, the possibility of creating a subsidiary company in cooperation with SIMEX was considered. This fits in with the situation generated at the end of that decade, by which the Spanish industry began to be capable of manufacturing consumer goods with intermediate quality standards and relative competitiveness abroad (Cebrián and López 2019, pp. 144-145). The product catalog was expanded with new instruments such as interferometers, collimators, tape recorders, projectors, stereoscopic microscopies, new types of binocular magnifiers and lighting accessories, as well as manuals and books to support teachers, which were published in collaboration with the Torres Quevedo Institute to guarantee their quality. Other devices were created with ENOSA’s own patents, such as the Enoscop overhead projector, the Adiscope, which was a projector of animated images, and the diakinas, a kind of slide divided into quadrants.

In quantitative terms, the period of greatest production of teaching materials was between 1966 and 1974 (Valcayo and Baratas 2018, p. 248-251). This stage coincided with the educational reforms sponsored by Ministers Lora Tamayo and Villar Palasí, which began to take off from the model of National Catholicism to modernize primary education through progressive liberalization, increased school investment, and the introduction of

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technocracy (Negrín Fajardo 2006, pp. 439-441). The General Law of 1970 was conceived as a complete reform of the educational system in line with the social, economic, and cultural changes of the time and sought to implement new teaching methods and techniques based on an experiential model that would allow the student to learn by themselves (Capitán Díaz 1994, pp. 775 and 781).

**TABLE 2. ENOSA production data (in units)**

<table>
<thead>
<tr>
<th>Years</th>
<th>Teaching materials</th>
<th>Optical items &amp; instruments</th>
<th>Gas valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>4,200</td>
<td>3,000</td>
<td>800,000</td>
</tr>
<tr>
<td>1964</td>
<td>20,768</td>
<td>4,527</td>
<td>1,189,110</td>
</tr>
<tr>
<td>1965</td>
<td>32,786</td>
<td>11,719</td>
<td>1,609,500</td>
</tr>
<tr>
<td>1966</td>
<td>10,838</td>
<td>15,958</td>
<td>1,299,500</td>
</tr>
<tr>
<td>1967</td>
<td>30,331</td>
<td>16,280</td>
<td>1,513,000</td>
</tr>
<tr>
<td>1968</td>
<td>40,008</td>
<td>36,613</td>
<td>1,440,000</td>
</tr>
<tr>
<td>1969</td>
<td>12,294</td>
<td>34,342</td>
<td>1,322,300</td>
</tr>
<tr>
<td>1970</td>
<td>52,103</td>
<td>29,889</td>
<td>1,603,600</td>
</tr>
<tr>
<td>1971</td>
<td></td>
<td>92,000</td>
<td>1,019,500</td>
</tr>
</tbody>
</table>

*Source:* Own elaboration based on information from the AHS, Biblioteca, Memorias del INI, Anexo ENOSA.

We have found evidence of successive agreements between the Ministry of Education and ENOSA to provide teaching materials to State schools and collaborate in teacher training programs. The most eloquent was signed on January 14, 1966, to design audiovisual material. In addition to detailing the administrative conditions and prices of each product, in its sixth clause specifies that “the exclusive right for the sale distribution is granted to the National Optics Company on the production of the Cultural Extension Commissariat”. On July 10, 1968, another agreement was formalized for the creation of film series with their guides on practically all subjects, which were provided to educational centers all along Spain as part of an Economic and Social Development Plan. Finally, in June 1969, the Publications Service of the Ministry updated the cooperation with ENOSA through three new contracts: one to specify the bases of collaboration between the two, another for production and distribution, and a third “for the technical promotion of audiovisual material and its modernization and adaptation to the progressive needs of Education at all times”.45

The documentation lists a wide variety of audiovisual materials that were very innovative resources for the classroom, such as cinematographic films, slide series, sound recordings, and TV programs for the schools, which private initiatives could not produce

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45 The original quotes in Spanish are: “el derecho de exclusiva para la distribución en venta se concede a la Empresa Nacional de Óptica sobre la producción de la Comisión de Extensión Cultural […] para la promoción técnica de material audiovisual y su modernización y adecuación a las necesidades progresivas de la Enseñanza en cada momento”. Archivo Central del Ministerio de Educación (ACME), ES 28005, caja 79357.

Josué Llull [https://doi.org/10.1344/rhiihr.38033](https://doi.org/10.1344/rhiihr.38033)
due to their low profitability. The ministry also commissioned ENOSA to supply the sound projection and reproduction devices necessary for the use of these materials, that is, overhead projectors, slide projectors, adiscopes, episcopes, tape recorders, screens, illuminated pointers, etc.  

(Fig. 7). In the following decade, the company became a reference for educational innovation by covering other fields, such as educational toys, foreign language teaching with audiolingual methods, and automatic response evaluators. In 1970, more than seven hundred entities, both public and private, bought ENOSA products.

Finally, the company contributed significantly to the development of technology in Spain and, in a way, to reduce dependence on the outside, which were its original objectives. Yet, such a contribution was not made in the field of optics, but in that of education, because of the variety and quality of its teaching materials (Llull Peñalba 2022). Taking up the debate raised by López and Valdaliso (2001, p. 324-325) on whether it is technology or structural changes that favor economic growth, we think that ENOSA’s capacity for innovation was a consequence rather than a determining factor of the general context of technocracy and developmentalism of the 1960s in Spain.

Nonetheless, we must criticize the reiteration of old vices of Francoism, for instance, the direct designation of the State enterprise as the beneficiary of the contracts. This was mostly the case because ENOSA’s proposals were always chosen in public tenders. On the one hand, the lack of real competition, whether domestic or foreign, deprived Spanish students of access to other resources that might have been cheaper or of higher quality. On the other hand, the scarce funding and the difficulties in implementing the Education Act of 1970 lowered the high expectations of ENOSA. Also, there were some coordination problems with the ministry, which forced the company to store a large number of products until they were delivered.

Outside the educational field, continued the production of Butane gas valves and the construction of medical prototypes, such as ophthalmological and audiometry equipment, dentistry and surgical material, laboratory instruments, diagnostic devices, prostheses, and even a hemodialysis system (Valcayo and Baratas 2018, p. 248). ENOSA considered eye and hearing rehabilitation as a future line of development, participating in congresses and Special Education activities. The commitment to innovation reached its climax in the early 1970s when a RAX terminal connected to an IBM-360 computer was installed in the Research & Projects department, intending to implement twenty optical calculation programs. In addition, the possibilities of laser application in education were explored.

46 Ibid.
48 ACME, ES 28005, cajas 55264 y 79358.
and several ENOSA experts collaborated with the Aerospace Commission and the ITT Laboratories in Madrid in a study on infrared radiation\footnote{AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1970, pp. 3-4.}.

**FIGURE 7. Use of a ENOSCOP projector in a classroom**

![ENOSCOP projector in a classroom](image)

*Source: AHS, Memoria del INI, Anexo ENOSA, 1974.*

The positive trend was abruptly interrupted because of the 1973 oil crisis, which led to a fall in demand for gas valves, a sector in which competition also increased. Total sales were significantly lower in 1974 and 1975 and the targets could not be accomplished “mainly because of the retraction of orders which has been strongly noticed in educational material, the primary source of our income, as a result of the global contraction in exports and the very sharp decline in the internal market, mainly by the Ministry of Education and Science.”\footnote{The original quote in Spanish is: “a causa principalmente de la retracción de pedidos que se ha dejado sentir muy intensamente en el material educacional, fuente primera de nuestros ingresos, consecuencia de la contracción mundial en lo que se refiere a la exportación y a la fortísima disminución del mercado interior, muy principalmente por parte del Ministerio de Educación y Ciencia”. AHS, Biblioteca, Memoria
Sales of teaching materials already accounted for 37.8% of the company’s total in 1963, and in the 1970s, they were the company’s almost exclusive goal. ENOSA’s survival depended heavily on a sector that was drastically reduced\(^{53}\). Indeed, the company was ill-prepared to overcome this difficult situation. It had focused its production on the educational field, which was now in decline, and had not consolidated other alternatives. One of them was to return to the manufacture of military equipment, namely optotronic instruments for AMX-30 tanks, telescopic rifle sights, and night vision technologies, for which new contracts were explored with the Army and the Empresa Nacional Santa Bárbara (National Company Santa Bárbara)\(^{54}\). To this end, ENOSA considered buying shares in EISA, another military products company of the INI. However, the technological advance experienced in electronics, the sophistication of this type of artifacts, which were quite far from the field of optics, and the suspicion of the Army about a possible merger of both entities, prevented the agreement from being concluded\(^{55}\). As a result, ENOSA continued to focus on the educational field, and its results, in quantitative terms, continued to decline over the following years.

The financial mismatches and the accumulation of losses forced them to look for new bank loans and to ask the management of the INI for a capital increase of 220 million pesetas, which was accepted in 1975\(^{56}\). This rescue intervention sounds curious when, only two years before, the INI had seriously thought about the possibility of selling ENOSA, first to Bankunion and the Confederación de Cajas de Ahorro (Confederation of Saving Banks), and then to the multinational ITT\(^{57}\). The capital increase allowed the company to be restructured in monetary terms and then introduce several measures to extend its life. But in 1985, the INI transferred all the shares of ENOSA to the Empresa Nacional de Electrónica y Sistemas (National Electronics and Systems Company –INISEL–), which disappeared in 1992 when it was merged, along with other public corporations, into the multinational INDRA (Valcayo and Baratas 2018, pp. 251-252). Today the site of the factory is occupied by the Madrid Marine Corps and other military facilities.

### 5. Conclusion

ENOSA was a singular case in the framework of the INI. Due to its size and specificity, it was not considered an important company compared to other larger corporations in strategic sectors such as energy or automotive. However, it is a paradigmatic example of cooperation between scientific-technological innovation, the Army, and industry since it

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\(^{54}\) AHS, Biblioteca, Memoria del INI, Anexo ENOSA, 1974, pp. 3 y 8.

\(^{55}\) AHS, Direcciones INI, ENOSA, año 1971, caja 156.

\(^{56}\) AHS, Biblioteca, Memoria del INI, Anexo ENOSA, año 1975, pp. 5-6. See also the extensive economic balance sheet and its addenda, which justify the intervention of the INI due to the difficult financial situation of the company.

\(^{57}\) AHS, Direcciones INI, ENOSA, año 1973, caja 159.
put into practice the designs of leading institutions such as LYTIEMA, the Torres Quevedo Institute, and the Carl Zeiss company. The training of specialized personnel and the application of their products in the field of education are other significant achievements of ENOSA.

Among its main shortcomings, it shares with other INI initiatives the disproportion between its means and profitability. On the one hand, it had oversized infrastructure and production capacity; on the other hand, it was not always well managed. The replacement of the military by engineers in senior management positions is an obvious symptom of its restructuring within the framework of the Stabilization Plans, which gave priority to the financial balance and sustainability of companies. It is, therefore, a perfect example of the transition from a first model of autarkic industrialization under the control of the Army to a second model oriented towards technocratic developmentalism and the civilian free market. This evolution not only coincides with the two stages of the economic policy of the INI, during and after the mandate of Suanzes, but also with the First and Second Francoism, respectively.

ENOSA summarizes, perhaps too eloquently, many of the difficulties experienced by the public companies of the Regime. The origin of these companies was conditioned by the pressures of oligarchies interested in appropriating the means of production and distribution of the industry in collusion with the State (Comín and Díaz 2001, p. 144). But this interventionism characteristic of wartime lasted for too long through a kind of economic nationalism, as several authors have called it, which prevented the INI from a rational allocation of resources, an efficient level of production, and adequate competition, all of which would have improved labor conditions and increased the consumption capacity of workers. According to Barciela López (2003), it was the fierce defense of autarky and totalitarian policies that led the Spanish economy to disaster until the mid-1950s.

This was a relatively small company, specialized in a series of very specific products that were expensively manufactured with external technology, aimed at a limited clientele and with little profit margin. Only the State’s protection guaranteed the necessary resources to survive, in addition to several rescues, the advantage of having a captive market and collaboration with other INI companies such as Butano. As a result, ENOSA could be considered profitable just for ten years, from 1963 to 1973, coinciding with a high production of gas valves and teaching materials. This was possible only because it demonstrated extraordinary flexibility thanks to the favorable circumstances of developmentalism. Yet, this adaptability was not enough to survive in an increasingly competitive market, less protected by the government and, therefore, more exposed to global crises, as evidenced by the decline in its figures since 1974.

The reorientation of its activities from military optics toward education is perhaps the most interesting aspect of its trajectory. From a critical point of view, in its first stage, ENOSA was not capable of producing a technology that would help the State and the Army reduce dependence from abroad. But the teaching materials developed in its second
stage were a boost to the modernization of education during the last decades of Francoism. These materials were a continuation of the innovative work of the Torres Quevedo Institute and must be related to the social and economic context of technocracy. What is more, they were in line with the pedagogical approaches of the 1970 Ley General de Educación, whose purpose was to prepare the population for the social and economic development of the country through the application of practical methods and instrumental techniques (Capitán Díaz 1994, pp. 775-781). A consequence of this legacy is the existence of many ENOSA artifacts in the laboratories of educational centers and universities throughout Spain, where they are still used today (Fig. 8).

**FIGURE 8. Teaching materials manufactured by ENOSA**

![Teaching materials manufactured by ENOSA](https://example.com/image)

*Source: AHS, Memoria del INI, Anexo ENOSA, 1965.*

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Els problemes de la industrialització militar i la seva reconversió a l’Espanya de Franco: un estudi sobre el cas de l’Empresa Nacional d’Òptica (ENOSA)

RESUM
L’Institut Nacional d’Indústria (INI) es va fundar com un instrument per al control estatal de l’economia, en un context d’autarquia propi dels primers anys del règim de Franco. La seva filosofia i les seves actuacions van ser similars a les d’altres polítiques econòmiques de l’època, tant d’Europa com dels Estats Units. Entre les empreses dependents d’aquest holding es va crear l’Empresa Nacional d’Òptica (ENOSA), l’any 1950, amb la participació d’institucions militars i científiques. L’empresa tenia com a objectiu fabricar lents e instruments de precisió per a l’exèrcit usant tecnologia nacional. Tanmateix, no va aconseguir reduir la seva dependència de les importacions, sobretot d’Alemanya. Després de moltes dificultats, va ser reestructurada el 1961 i la seva producció es va diversificar cap a l’elaboració de materials didàctics. Aquest article aborda la història d’ENOSA com un estudi de cas sobre el fracàs del model d’industrialització autàrquica i la reconversió que les empreses de l’INI van haver d’afrontar en el context de les noves condicions socioeconòmiques del “desarrollismo”. Com a conclusió, podem avançar que es va tractar d’un experiment fracassat de crear una empresa tecnològica nacional, la qual, no obstant, va arribar a assolir una interessant projecció en el camp de la innovació educativa.

PARAULES CLAU: Franquisme, Institut Nacional d’Indústria (INI), Autarquia, ENOSA
CÒDIGOS JEL: D02, L20, N44, O12, O25

Los problemas de la industrialización autárquico-militar y su reconversión en la España de Franco: un estudio de caso sobre la Empresa Nacional de Óptica (ENOSA)

RESUMEN
El Instituto Nacional de Industria (INI) se fundó como un instrumento para el control estatal de la economía, en un contexto de autarquía propio de los primeros años del Régimen de Franco. Su filosofía y sus acciones fueron similares a las otras políticas económicas de la época, tanto de Europa como de Estados Unidos. Entre las compañías dependientes de este holding, en 1950 se creó la Empresa Nacional de Óptica (ENOSA) con la participación de instituciones militares y científicas. La empresa tenía como objetivo fabricar lentes e instrumentos de precisión para el ejército utilizando tecnología nacional. Sin embargo, no consiguió reducir su dependencia de las importaciones, sobre todo de Alemania. Tras muchas dificultades, fue reestructurada en 1961 y su producción se diversificó hacia la elaboración de materiales didácticos. Hemos abordado la historia de ENOSA como un estudio de caso sobre el fracaso del modelo de industrialización autárquica y la reconversión que las empresas del INI tuvieron que afrontar ante las nuevas condiciones socioeconómicas del desarrollismo. Como conclusión, podemos anticipar que se trató de un experimento fallido de crear una empresa tecnológica nacional que, no obstante, llegó a alcanzar una interesante proyección en el campo de la innovación educativa.

PALABRAS CLAVE: Franquismo, Instituto Nacional de Industria (INI), Autarquía, ENOSA
CÓDIGOS JEL: D02, L20, N44, O12, O25