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A GEOPOLITICS OF THE DIASPORA OF BRITISH ENGINEERS IN SOUTH AMERICA IN THE FIRST HALF OF THE 20$^{\text{th}}$ CENTURY: THE CASES OF THE INSTITUTION OF LOCOMOTIVE ENGINEERS CENTRE IN ARGENTINA

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Abstract. The circulation of British engineers in South America during the first half of the twentieth century is a barely explored phenomenon that should be studied in the basis of methodologies that articulate the different elements involved, with the aim of contributing to the history of technology and providing new interpretations regarding the development and decline of the South American railway system. Through the case of the Institution of Locomotive Engineers centre in Argentina, the phenomenon of the diaspora of technical knowledge and technology transmission is examined.

Keywords: Geopolitics, history of technology, Institution of Locomotive Engineers, South America, circulation of engineers, diaspora.

1. Introduction

The diaspora of British mechanical/railway engineers in South America during the first half of the twentieth century has to be studied through the case of centre of the *Institution of Locomotive Engineers* in Argentina, discussing the objectives of the Anglo-circulation of these professionals and its impacts, both for the transmission of technical knowledge and technology transfer during the railway development of Argentina.

The issue focuses on two fundamental elements: the first one corresponds to the limited historiographical development around the circulation of British mechanical/railway engineers in South America since the role played by the Institution of Locomotive Engineers. A second element is the importance of analysing the subject from a multidisciplinary approach, i.e. from geopolitics and the history of technology, which allows to debate this phenomenon, the *diaspora*, articulated to the transmission of technical knowledge and technological change, that is, to problematise it in relation to the different actors involved, the discourses and representations that emerged, the different factors (political, economic, geographic), and the role of international relations. The following questions are formulated: Is it possible to carry out a geopolitical analysis of a phenomenon of British circulation in South America during the first half of the twentieth century? Could both cases to be studied contribute to identify and describe the economic, political and technological impact on the South American nations of Argentina in the development of the railways? Was the role of the Institution of Locomotive Engineers, in general, relevant in the process of circulation of British engineers and its South American centre, in particular? What was the impact of this diaspora in the emergence of conflicts and consolidation of local engineering in South America?

The main objective of this research is to study the phenomenon of the circulation (diaspora) of British mechanical/railway engineers in South America based on the cases of the Institution of Locomotive Engineers in Argentina during the first half of the 20$^{\text{th}}$ century. This implies:

(1.) Analysing the phenomenon of circulation articulated to other components, such as the various actors involved (the State, local engineering associations, foreign capital), to the various factors (geographical, political, economic), and the discourses or representations that emerged (nationalism, patriotism, imperialism, developmentalism),

(2.) to describe and analyse the Institution of Locomotive Engineers both as an institution, but also as a cohesion dispositive of engineers and as an instrument of labour dynamisation, on the basis of its satellite in Argentina established between 1920 and 1949. This task was carried out mainly through the publication of the *Journal Institution of Locomotive Engineers* between 1911 and 1969.

The perspective of geopolitics, from its rethinking from a bipolar vision of the international environment to a multipolar vision and the abandonment of the geographic determinism of the "centre-periphery" notion [1, p. 38], has contributed to the advancement of geopolitics as an analytical method that articulates different viewpoints, i.e. that examines different aspects of the problem to be studied. Methodologically, geopolitics is fundamental in the reflection on *power*, that is to say, it requires critical thinking about the role of power [2, p. 25]. This problematises the relationship between *knowledge* and power, of *know-how*

at the service of decision making exercised by holders of authority, and this is crucial when we are talking about the circulation of knowledge and technology transfer. Considering the aforementioned, it is no coincidence that the role of engineers is extremely relevant. Among the various advantages of the geopolitical perspective is its multidisciplinary approach, as it articulates contribution of different disciplines, such as history, geography, economics, sociology, anthropology, and does so at different scales of analysis, from the macro to the micro. Geopolitics is not intended to find absolute answers, but rather to try to understand the problem addressed in all its complexity [1, p. 352]. Such an analysis with regard to subjective visions is an effective tool for trying to understand the relationship and the origin of rivalries between diverse participants and spatial issues. Another fundamental aspect is to articulate the geographical elements, the actors involved, and international relations. The first is key because it is based on the concept of *territory*, as a terrain for the exercise of power, both for the control of strategic routes, of vital resources, but also of symbolic places where the dynamic relationships that are developed between people take place, where competition and conflict arise, but also where places of memory are constituted [1, p. 14]. This reflection is fundamental in a context of globalisation and the hegemony of an Anglo-Saxon commercial and intellectual culture. However, without actors, there is no territorial dynamic, since it is the actors – be a social, economic or political group – that governs the space, and these may be the government, an individual, or a group. The final element is that of *international relations*, which are interactions with effects of competition and interdependence, in a scenario of globalisation. It can be deduced then, that geopolitics understands that in the background, there is a situation of inevitable rivalry and conflict of power, of disputed interests, but also sometimes of cooperation [1, p. 14]. From the perspective of the history of technology, *technological change* is considered in its historical context, as a product shaped by culture, and influenced by interests and power relations [3, p. 694]. The *social construction of technology* has shown that, while technology is socially constructed, organisations and technological objects often shape society and sociability [4, p. 423]. It is therefore essential to think about the dynamic and permanent connection in the relationship between Europe and the rest of the world during the processes of knowledge production and technology transfer and to study the impact of technology on long-term productivity. The important methodological contributions made from the *history of engineering*, for its study of the type of relationship that exists between engineering knowledge and practice, and the complex articulation between continuities and discontinuities that characterises the development of engineering history. This approach is interested both in the development of the engineering profession and its evolution, taking into account its technical achievements, but it is key in problematising the rationality of engineering as a historical product influenced by culture, since even political and social factors played a significant role in technological determinations [4, p. 423]. The rationality of the engineer is not a strictly individual behaviour, it is the product of interaction, communication and conflict with other engineers, entrepreneurs, and workers, subordinated to the dynamics of employment market demand [4, p. 423]. Finally, the *history of knowledge*, a recent discipline, is interested in the role of knowledge in society and in human life [5, p. 11].

This approach understands knowledge as its capacity to circulate and be transformed. It also studies the production and social circulation of knowledge, circulation that flows between individuals, groups, and institutions, and its vulnerability to being instrumentalised. When talking about *transfer*, it should be dealt with in a critical approach, considering that it operates in a context of cultural globalisation. The aim is to examine the conceptual scopes in a process of cultural exchanges, and therefore, of hybridisations, mestizations, that is, of local re-appropriations of knowledge and circulating technology [2, p. 19]. Technological learning does not necessarily imply assimilation, adaptation and modification of existing technologies, if it is not internalised [6, p. 329]. There is a primary distinction between *technology transfer* and *technological absorption*, which is that once the recipients themselves are capable of manufacturing the product, genuine diffusion takes place, as opposed to a simple – geographical – transfer of the technology. Effective absorption allows for modification and improvements to adjust to the recipient's requirements [7, p. 24]. The concept of technology transfer has been studied from various perspectives, such as political science, economics, sociology, public policy, marketing, and technology management, probably because it is a complex process, involving groups and individuals who may have different points of view on the value and potential use of technology, and where one of the debates focuses on the social and economic benefits of such a transfer for both the providers and the recipient countries. The social sciences define technology transfer as a socio-technical process involving the transfer of cultural skills that accompanied the movement of machinery, equipment, and tools. Anthropology indicates that technology transfer must be placed in a context of cultural change and how technology affects those changes. In addition, it is essential to try to understand and explain the difference between *knowledge transfer* and *technology transfer*. For some, technology and knowledge transfer are inseparable, since the former implies the transfer or diffusion of the latter. Technology will not occur without knowledge transfer, since knowledge is the key to control technology [7, p. 65]. The concept of *diaspora* is quite appropriate for this research, because

in a dynamic of the international expertise market – as the Greek word diaspora ("dispersion", "dissemination") etymologically implies a movement beyond borders, but not alienated from social connections and associations as it seeks to mobilise and establish linkages with their country of origin while creating networks and has the effect of dislocating (relocating) knowledge [8, p. 353] and taking distance from the centre-periphery conception as from the world-system notion. Mobility has been considered a normal phenomenon in the world of scientists and engineers. The notion of nomadism [8, p. 342] appears as spatial and social, but also intellectual mobility, which are neither isolated nor static entities, and it is also a starting point to consider the geopolitics that shapes the flows of scientific knowledge holders. Finally, *circulation* means more than simple mobility, in that it implies a double movement of coming, going, and returning, which can be repeated indefinitely and knowledge is continually modified in the process [5, p. 17].

2. State of the art and sources

From the perspective of geopolitics, there is already a long tradition that has worked on the relationship between power and global political tensions, initially from the point of view of relations of domination, the "centre and periphery" discourse and the bipolarity that emerged after the Second World War. More interesting and profitable, however, is the reflection based on new researches after the influence of the cultural turn, since it makes it possible to articulate various elements that address issues of technology production and knowledge transfer and their relationship with the dynamics of power, of course, but the category of *agency* is used as the ability of actors to move, to decide, that is, a critique of determinism in which actors were placed in a structure that subjugated them and made their mobility impossible. Along these lines, texts such as [9] by Wang and Zhang understand the possibilities of the actors and how knowledge circulates and can be partially or completely adopted according to the interests of the actors involved. In [6], Kim analyses that technological skills brought through learning are crossed by various factors, such as the role of the State in encouraging the arrival of knowledge from abroad, but which must be appropriate and promote, internally, technological development and the training of skilled personnel. In [8], the importance of considering the dynamics of the international market as a scenario of disputes for generating knowledge and producing technology is discussed. The concept of nomadism, taken from the philosopher Gilles Deleuze's idea, is used, where knowledge circulates as a result of the possibility that agents have of deciding.

The history of technology is a field that deals with diverse aspects such as economic history, environmental history, and the history of medicine. It was also influenced by the cultural turn, resulting in research like Donald MacKenzie's [10] and the compilation of articles in [11], which shows the importance of rethinking the phenomena of technological development and knowledge production from the perspective of complexity, conceived as a cultural product that must be historically problematised and that is crossed by various elements and power relations. The history of technology in Latin America is still a field to be developed, and most of the existing studies have been carried out mainly by engineers, economists. and other technical professionals. Some studies, elaborated by historians, approach engineers as members of a profession, which place the activity and the gremial behaviour of these professionals in the framework of a social history. In Argentina there is a long trajectory of studies regarding the railway, among which we want to point out: [12] by Elena Salerno, and Laura Badaloni's [13] and [14], where they fundamentally address the outstanding figure of the engineer and the role of the circulation of British engineers linked to the Institution of Locomotive Engineers in the Argentine railway workshops, which covered a wide area of topics from the technical aspects of railway mechanics to innovations in administration and accounting. However, it is clear that there is a lack of historiography on the role of the Institution of Locomotive Engineers centre in Argentina.

First of all, we should mention the *Journal of the Institution of Locomotives Engineers*, published between 1911 and 1969, distributed in 59 volumes and 328 issues, which can be accessed from the electronic archive of the Institution of Mechanical Engineers. It should be remarked for its richness in sources not only written, but also visual, by using photographs, plans, diagrams, graphs, and maps. Most of the speeches (presidential or inaugural) were not given numbers and sometimes there are gaps in the numerical sequence. Some missing numbers have been found in the sequences of article numbers.

3. Context

The time frame in question is to be found in the first half of the twentieth century. New conditions were created, such as: the apogee of the automobile and road transport was rapidly imposed, precipitating the decline of the railway in general and of the steam locomotive in particular. But also, parallel to the technological changes, important social, political, and mentality changes occurred. The growing strength of the workers' movements, which contributed to the organisation of railway workers into powerful unions, raised their voice of discontent with the economic system and an industrial development that dehumanised the worker in favour of economic benefits, revolutionary ideas that reached from Europe to South America and had a strong impact, mainly in Argentina. Similarly, nationalist ideas were in vogue as a way of resisting the "invaders", who were viewed with distrust and who threatened the sovereignty of the young

nations which, without having achieved a crystallisation of their identity and complete national unity, were now ready to take charge of the destinies of their countries. In addition to the above scenario, the 1929 Crisis interrupted foreign investment and loans, which significantly affected the continuation of railway development in South American countries, but also ended up favouring protectionism and import replacement to the benefit of a local industry.

When this research refers to South America, it means, firstly, Argentina, with which the Institution of Locomotive Engineers was strongly linked and where the satellite centre was established; The steam locomotive continued to be a symbol of modernisation in South America, however, the technological change towards the diesel and electric locomotive seemed inevitable. South American countries immersed in the idea of progress and railway development realised that, at first, importing railway technology implied importing experts to install, maintain, and manage it; this was the opening of opportunities for the demand of local personnel to join the project. In South America, the first phase of major railway expansion occurred in 1880 and 1890, which reached its greatest intensity in 1910 and ended in the first half of the 20$^{\text{th}}$ century. In the second phase, governments became more involved in stimulating technological change and developing public works: "The start of the railway expansion project had to do with the achievement of a certain political stability and the rise of liberal regimes [...] to boost national prosperity." [15, p. 19].

4. British capital and railway context

Before discussing issues related to the movement of engineers, it is necessary to delve into the railway context that allows us to situate the phenomenon. It is key to address the aspects regarding the investment of British capital in America and the role of governments in the dynamics of South American railway development. It is also important to understand the main characteristics of the steam locomotive industry and trade during the first half of the 20$^{\text{th}}$ century and the impact of technological change.

4.1. British capital and railway development in South America

In South America, at the end of the 19$^{\text{th}}$ century, the steam locomotive continued to be a symbol of progress and modernisation. For this reason, the state presence in the expansion of the railway sector grew notably, in some cases with favourable results and in others not so much. Also, the incursion of foreign capital, mainly British, to a lesser extent French, and later North American created an opportunity in the South American railway project. There is no doubt that the geography of South America presented a technical challenge, as in the case of the Andes, but in some parts it could be relatively simple and economical and some of the foreign engineers had acquired experience in the Alps [7, p. 2].

Railway development meant imports of technology and trained human capital, which meant that in the first phase, foreign engineers were hired by private concessionaires or by Latin American governments due to the lack of local experience. In the second phase, they began to overcome the prejudices against local workers. The railway expansion project was favoured by the achievement of a certain degree of political stability with the rise of authoritarian liberal regimes, and its major expansionary phase occurred between 1880 and 1890 and reached its greatest intensity between 1890 and 1910, until it declined notably between 1930 and 1950 [15, p. 19]. The existence of these antecedents allowed the arrival of foreign capital, which corresponded to the expansionary cycle of the international capital market and the search for alternatives to commercially link South America with the international market, favoured by the growing economic success of export activities. The groups of foreign businessmen played a fundamental role in the process of investment and railway development, it did not imply an obstacle to the participation of local entrepreneurs. therefore, economic, reaching its peak in the decade of 1880 and after 1905 [16, p. 2]. The movement of British capital abroad was unprecedented, accounting for 75 % of all international movements in the early twentieth century, with a major impact on the world economy [17, p. 7]. From the point of view of the concept of agency, the participation of foreign investors in South American railway companies appears less as a usurping imposition of national interests, and more as an opportunity for local elites to dynamise their economies and get on the "train of progress". The profits from the dividends of British investors also created markets for manufacturers of rails, locomotives, and other railway products, and reduced the costs of transporting cheaper raw materials and expanded the market for British manufactured goods [16, p. 3]. The dynamics of this capital had reached such a level of sophistication that it required legal and contractual stability on the part of the receiving countries [17, p. 5].

The Argentinean case had a different dynamic. The first railway concessions and the flow of foreign capital occurred in a first cycle from 1854 to 1880; the second cycle lasted from 1880 to 1902; the third cycle until 1920; the last two cycles occurred from 1920 to 1934 with the consequences of the Wall Street crash of 1929, and from 1934 to 1948 with the implementation of the economic reactivation until the nationalisation of the railway system by the Perón government. In Argentina, British investments were complemented to a lesser extent by French capital and the participation of domestic capital, or the so-called "anglocriollas", shareholders who were members of the British community in Buenos Aires or local businessmen [15, p. 25]. The political resistance and instability of the 1880s

contributed to the paralysis of railway construction, but the federalisation of Buenos Aires in 1880, which lasted until 1929, provided a scenario of greater stability required for the rapid growth of the railway network. While there was some resistance to British capital, the policy did not generate an ideological aversion to foreign interests, i.e. the refusal of an anti-foreign nationalism was imposed by the "all-powerful government of the oligarchs" who maintained a positive position towards foreign interests [17].

4.2. Steam locomotives: Industry and commerce

A steam locomotive was an extremely complex product that required years of testing inside the factory. An important feature of the British industry since the 19th century was to pursue policies of internalisation, whereby the railway companies manufactured their locomotives in conflict with the private builders, the private companies being unable to satisfy the demands of a rapidly expanding railway network, and the latter arguing that such a policy meant a great loss to the business [18, p. 59]. At the beginning of the 20th century, both industry and trade were shaken by changes. On the one hand, the standardisation of production was seen as an alternative to reduce costs and shorten delivery times and, on the other hand, the trend towards customised production. During World War I, the US Railroad Administration had imposed some degree of standardisation in locomotive design, but it was still very much a "custom-made product" [19, p. 69], and standardisation was seen by the British as limiting the quality of their products and the creativity of the engineers. In the British case, the role of the state and government policies in the steam locomotive industry had a "substantial long-term economic impact" [20, p. 24]. In the United States, the number of producers had narrowed and competition increased, for from one hundred independent companies that had operated since 1830, only seven active companies remained in 1890, and in 1920, the industry consisted of five companies. And the changes occurred not only in locomotive production but also in business management and commerce. Changes had to be made in the company's organisational structure and in adapting to customer demands, where the Americans were able to take advantage by being more flexible to the customer's design demands, faster delivery, and cheaper prices, as well as having a clearer marketing strategy: "American firms employed their own experts who were constantly visiting the railway officials, and their catalogues were to be found in every office" [21, p. 476].

4.3. Technological change

Major innovations in steam locomotive engineering were introduced before 1840, and minor innovations followed. By the mid-1920s, the railway industry was in competition with other forms of transportation and the steam locomotive was considered to be in decline in favour of the diesel and electric traction locomotive: "[...] the operating economies of the diesel locomotive could not be denied. The diesel locomotive was also safer." [20, p. 3]. In one of the meetings of the South American centre of engineers, the concern was expressed: "The main question we ask ourselves these days is: What is happening to the railways? [...] Railway undertakings are passing through a critical time. Transport is being made available in over-increasing and varied forms. No longer has the iron horse the monopoly of speed and security. The iron road is feeling the effects of the concrete road." [22, p. 751]. Although the diesel engine was two to three times more expensive to build than steam engines, required standardised production techniques and used only one type of fuel, it was safer due to better traction and dynamic braking, it had smoother driving and cleaner operation, saved fuel, navigated difficult mountainous routes without assistants [20, p. 5]. After World War II, the diesel locomotive had gained considerable acceptance, and beginning in 1930, American railways began rapidly replacing steam locomotives with diesel locomotives [23, p. 1].

5. Engineering and engineers

5.1. The engineer and engineering as protagonists

The engineer became the central figure in the circulation of knowledge and the transfer of technology, for it was the engineers who were willing to make long journeys, expose their lives, take on new adventures, separate from their families and friends, and leave their homes. But it is essential to consider this actor from different angles, i.e. the engineer articulated to a structure that, without determining him, did not cease to have an impact on his decisions. A historical review of the emergence of British engineering will allow us to contextualise the successful development of these professionals, to study how the demands of technological change urged them to reinvent themselves and to associate. We must also investigate aspects related to the institutional structure that limited or, on the contrary, expanded their professional possibilities, as well as debate the figure of the engineer as a character of the status quo [24, p. 417], without openly political opinions but subordinate to the dynamics of the political development, who felt into contradiction between professional independence and the loyalty to the bureaucracy [25, p. 2]. In his various facets, the engineer not only holds technical knowledge, but also his versatility allowed him to develop skills, such as financial perspicacity, the ability to manage a heterogeneous labour force, and a certain political capacity [7, p. 9]. The engineer, as well as engineering, is a historical product shaped by culture. Engineering became the knowledge par excellence of the industrial revolution, a practical

knowledge that provided solutions to problems of material living, which quickly took on great relevance in its relationship with the development and economic progress of nations.

5.2. British engineering and engineers

This group of professionals, due to their crucial role in the industrialisation process, began their rapid social ascent between 1750 and 1850, and between 1850 and 1914 they enjoyed full recognition of this status [24, p. 408]. Several engineers had received the title of gentleman and had even become members of the parliament [26, p. 215]. However, by the 18th century, they were a heterogeneous group, where most of them were practical craftsmen from humble homes and without any formal education, although many of them had been apprenticed as millwrights, mechanics, instrument makers, or masons [24, p. 410]. In France, engineering was defined mainly through the creation of state engineering corps and the realisation of large infrastructures, while in England, the role of professional associations was fundamental [4, pp. 423, 426]. The emergence of British scientific engineering can be described in three stages: the first, the preliminary perception of a need for technical training and the positioning of the ground for its possible development; the second, the establishment of firm foundations for theoretical instruction with the recognition by some British universities and other educational bodies of an agreed body of such knowledge; the third was the widespread adoption of a comprehensive program of higher education in engineering that incorporates extensive laboratory work and research [27, p. 218]. But the fundamental change for the profession was the examination as a condition of admission to major institutions. This process of transformation and professionalisation of British education acquired the status of science with the incorporation of scientific methods and theories into technology and the accumulation of a body of technical knowledge, and this status enabled it to be a means of preserving, transmitting, and augmenting this knowledge in the mid-19th century and culminated by 1914 [25, p. 3]. Previous to professionalisation, various forms of elite mechanisms existed to control the entry into the occupation, as only the upper classes, the solid middle class and above, could afford the fees and the cost of living of the apprentices. However, those belonging to a lower social scale could still aspire to a professional status by obtaining basic training through apprenticeship in a firm and then slowly acquiring sufficient experience to be admitted to a professional institution [28, p. 389]. In addition, the apprentice was subjected to the qualifications of his practical experience which had to be confirmed by written testimonials provided by senior engineers. This system of professional training and authentication predominated throughout the 19th century [27, p. 46]. As a result of industrial development, British engineering underwent a remarkable expansion in the 19th century, positively impacting the demand for engineers that accompanied the boom in railway construction in Britain and, subsequently, abroad [29, p. 47].

5.3. Associations of engineers

The role of professional associations in British engineering was fundamental, and their proliferation was due to the rapid growth of the profession [29, pp. 56, 57], presumably as a result of the deficiency of the national educational services for technical instruction. This institutional proliferation was a response to the diverse requirements of material needs and coincided with the remarkable development of gentlemen's clubs in London, dating from the late eighteenth century and the first half of the nineteenth century. By conforming to the pattern of these clubs, engineering acquired vital visible and external forms of gentlemanly behaviour and respectability [24, p. 415]. Another fundamental characteristic of this form of professional association was to have generated a degree of organisational cohesion, occurring within an intricate hierarchy, where the entry was a matter of careful examination by the council. The formation of professional institutions also served as channels of communication and dissemination of knowledge and novelties, where visits to facilities, exploratory and learning trips, congresses, reading, discussion, and publication of articles took place. But it was also a form of sociability, a meeting place for colleagues to socialise. The first one was the *Institution of Civil Engineers* (ICE), founded in 1818 with headquarters in London, which coordinated all branches of engineering, with the initial exception of military engineering. The *Institution of the Mechanical Engineers* (IMechE), founded in 1847, split from the ICE with the formation of an independent professional association and a scientific society of their own, established in the English Midlands by engineers from the rapidly expanding industry, manufacturing, and railways. The latter was regarded at the outset as socially inferior to the ICE. The IMechE recruited from the ICE and, in addition, those from less privileged backgrounds who were working their way up on the basis of apprenticeships, and in 1947, the Institution merged with the *Institute of Automobile Engineers*. Since 1984, the Institution has supported the recognition of mechanical engineering in history and social development. Today, the Institution of Mechanical Engineers represents mechanical engineers and the engineering profession, with over 120 000 members in 140 countries, working in industries such as rail, automotive, aerospace, manufacturing, energy, biomedical, and construction [30].

5.4. The Institution of Locomotive Engineers

It was founded in 1911, incorporated in 1915, and with 52 members, quickly established itself as a national organisation that was conceived to: "By extending its

influence and the cooperation of its members, the Institution would be of great service not only to its members, but to British interests at home and abroad." [31, p. 82]. The Institution of Locomotive Engineers can also be seen as a rupture with Mechanics, insofar as its concern with railway locomotives was increasingly specialised. Its centres in Great Britain were: Leeds (1918), Manchester (1919), Glasgow (1924), Newcastle (1928), Birmingham (1929), but also Argentina in South America; in Central India and East India, with headquarters in Calcutta. Between its fundamental activities were the readings given at the meetings of the institution, which were later discussed and published in the journal:

"The feature of this Institution that makes the greatest appeal to its members is the practical nature of the papers read at the meetings and afterwards published in its proceedings. They are generally written by practical men on their actual experience, and are not, as so many engineering papers are, a collection of the experiences of a large number of other people." [32, p. 305].

Besides, the on-site visits became an alternative to learn directly, they were the most interesting and were especially expected by the younger members [33, p. 165]. They highlighted the diversity of interests in the visits: workshops, cement plants, port operations, running sheds, the power stations, the steel foundries, cloth factories.

5.5. The Journal of Institution of Locomotive Engineers

It was published between 1911 and 1969, distributed in 59 volumes and 328 issues. This publication was an instrument that had as objectives: to inform of the activities carried out by the institution in the various centres and its members; to give accounting and administrative report of the institution; to unite the group of members and create a global network of engineers to facilitate communication between them; to accumulate the academic knowledge on railway engineering amassed by its members, and to transmit it, in addition to being a way of scientific legitimisation: "we should strive to make it a medium for our mutual benefit in recording improvements noted and effected, and results of experimental work and research" [31, p. 82].

Among the visual media used by the journal are: photographs, maps, graphs, diagrams and plans, which shows an interest in facilitating the transmission of knowledge: "proposing that books and other printed media should not only be understood as vehicles for the formation of knowledge, but also as places for the circulation of knowledge." [5, p. 26]. All the texts were written in English; however, some of the articles that were in Spanish were translated into English for publication. The structure of the journal consisted of different sections, each with a specific topic, for example, administrative-accounting information regarding the institute, researches of engineers, together with their discussion among members of the Institution and the reply of the author of the article, information about the activities carried out by the institution, visits and social activities, and sections on obituaries, possible employment vacancies and words of the president of the Institution.

5.6. Engineering and engineers in South America

With the consolidation of the states in South America, the development of public works and the development of railways was stimulated, implying the reception of technology, but revealing the state of the underdeveloped countries and the lack know-how of skilled personnel and financial resources. Thus, it was necessary to hire personnel with the necessary technical expertise, engineers and other experts, as well as skilled foreign worker. Many of the engineers and technicians involved in this initial stage were British, although not exclusively, as there were a few cases of recruitment of local university graduates and technicians [14, p. 4]. This opportunity opened up for local engineers in the administrative areas of the state-owned railway companies, consolidating a local technical bureaucracy linked to the ministries of public works [15, p. 301]. However, there were few cases of skilled local personnel. Engineers linked to ILocoE's South American centre confirmed this:

"Many of the Argentine workers are unskilled, or only semi-skilled. Only a few possess any degree of artisanship, which they have picked up in the small factories in Europe. The majority have scarcely any feeling of pride in their work, which is so conducive to getting the most out of the material. It is very noticeable that many men take a delight in purposely destroying rolling stock by mishandling it on every possible occasion." [34, p. 568].

However, in Argentina, there were more opportunities for local engineers who would even become part of the Central South American ILocoE. This is the case of Patrick Joseph Grennon, who was born in Salto, Province of Buenos Aires, in 1883, and was educated in Junín, in the same province. In 1900, he joined the Mechanical Department of the Buenos Aires and Pacific Railway where he remained until 1915. He worked for a time in England and the United States. After World War I, he rejoined the Buenos Aires and Pacific Railway and was accepted as an Associate Member of the South American Centre of the ILocoE in 1923 [35, p. 158].

6. British engineering diaspora

6.1. A geopolitical space

This research argues that a geopolitical analysis of the geography in which the dynamics of the British engineers' diaspora in South America took place is more interesting. The intention is not to reproduce

a description of a rather particular territory, since, as already indicated, these geographic characteristics did not represent an insuperable challenge for the technique; in fact, they probably represented a number of challenges that stimulated the creativity of the engineers. By no means does this pretend to ignore the difficulties that the South American geography and its diverse climates imposed on the British engineers, because some of them even lost their lives due to tropical diseases, others associated with sanitary and health conditions, and labour accidents [36, p. 85].

This analysis focuses on the way in which the British engineers represented this particular space, that is to say, taking as a point of reference Derrida's idea that the image is a text, to make a symbolic reading of their graphic representations of the South American territory, as dispositive to impose a British view, a subjective dimension, legitimised by the scientific discourse. Based on the JILocoE publications, due to their variety of visual sources of diverse typology, it was possible to verify the predominance of maps over photographs, probably because it was more practical to schematise or make an abstraction of the territory, while photographs implied more complicated technical and technological conditions for that period. These maps were used to complement the written discourses.

These maps sought to simplify the complex reality of a territory that was so unfamiliar and rugged for the members of the diaspora. Indeed, these graphic representations were a way of rationalising space, a way of identifying strategic places and legitimising the development of the railway project. With respect to photography, Walter Benjamin audaciously pointed out that "the link between technique and photography seems to be consecrated to an idea of the development of progress." [37, p. 12]. So, the representations seek to build a reality through the subjectivity of the agents of civilisation who came to the encounter of the chaotic and disorderly to give it an order, to demarcate what is relevant, but at the same time leave other elements, which were not represented, which remain invisible, aside.

6.2. The diaspora, an imperialist project?

Certainly, imperialism is a complex phenomenon, the dynamics of which involved the exercise of power by taking advantage of the profound inequalities between societies. A first moment can be observed during the sixteenth and seventeenth centuries, where imperialism, as a result of Western superiority in technology and armaments, was successful, but, in a second moment, at the end of the nineteenth century, the speed with which technological skills could be communicated and transferred put an end to the period of imperialism. However, the British engineering diaspora was not an overtly imperialist movement, but they were part of and played an important role in imperialist project. This circulation was not a planned operation [38, p. 501].

6.3. The circulation of British engineers in South America

The beginning of the phenomenon of the diaspora of engineers can be traced back to the 18th century and it is difficult to quantify, with statistical precision, the departure of engineers, because many of the engineers who worked abroad did so practically anonymously [38, p. 503]. The diaspora of British engineers, which reached its peak between 1850 and 1914, not only had a profound impact on the railway development, but also on urban development and improvements in water supply and electricity production in South America [38, p. 513]. With regard to railway development, engineers were involved in its construction, organisation, including the promotion of legislation before parliamentary committees, and supervision, as well as in the supply of locomotives, rolling stock and operating equipment [38, p. 508]. In addition, they often trained local personnel, either directly on the job or formally through the establishment of local engineering schools [16, p. 9]. However, sometimes the techniques employed abroad were not always the adequate solution, as they had to be adapted to the local conditions. Another interesting point of the influence they had was the circulation of conceptions regarding the scientific administration of work, in which, based on a rationalisation of labour, they sought to eliminate the waste of time and manpower through a more "scientific" distribution of machines and tools, and a rigorous monitoring, which had a more considerable impact in Argentina and in which the role of local engineers was fundamental in its diffusion [13, p. 143]. The exponential growth in the number of professional engineers in Great Britain, from 1 000 in 1850 to 40 000 in 1914, fuelled by the railway boom, was one of the reasons for the diaspora and the search for overseas adventures [16, p. 11]. The diaspora turned out to be an employment opportunity in the context of the threat of unemployment due to the excess of skilled personnel. Many of them emigrated to where their relatives were already working, and some of them also did so with their families. In South America, this British circulation began to decrease after the second decade of the 20th century, with the nationalisation of the railways and laws that aimed to promote and demand that all high positions be filled by local engineers.

6.4. The case of the South American centre of the Institution of Locomotive Engineers in Argentina

The discussion of creating a local branch of the Institution of Locomotive Engineers in South America had been discussed early on. After several interviews

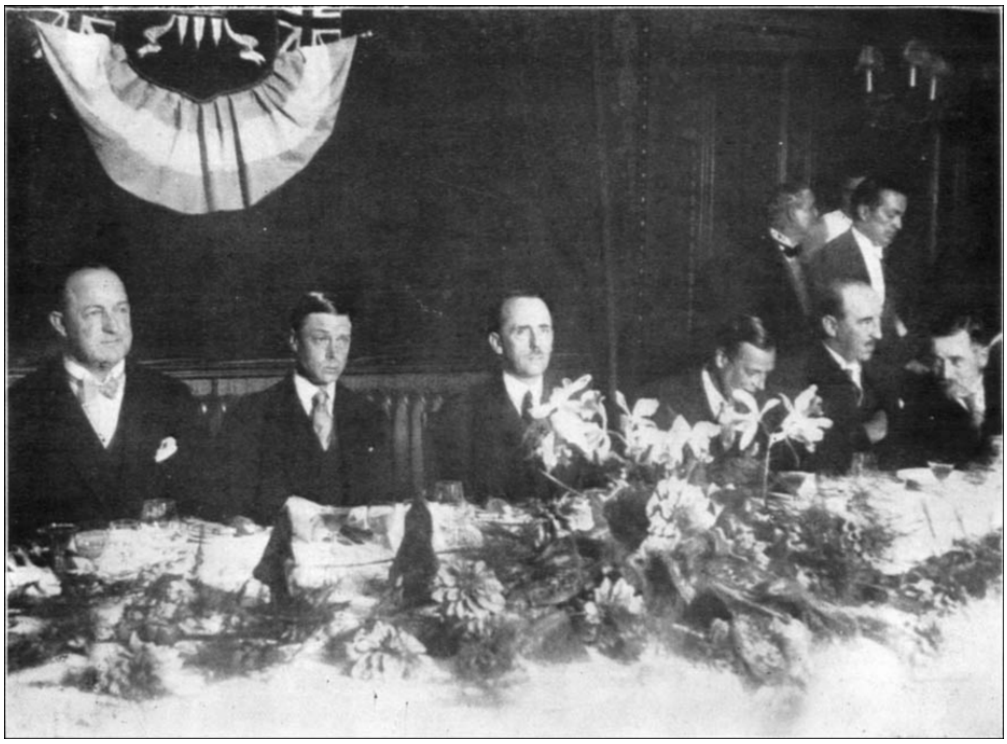

FIGURE 1. Luncheon for the Prince of Wales and Prince George in Argentina [39, p. 131].

with the main mechanical engineers and career superintendents of the different railways in Uruguay and Argentina, it was decided to proceed with the creation of a section that would have permanent communication with the main headquarters in London and its objective would be that:

"This arrangement will mean that all interested railway men, no matter how humble their position, on the different roads, both in this country and in Uruguay, will have an opportunity of hearing the ideas of other railway men, [...] *that preference will always be given to the discussion of matters of local interest, not of course confining ourselves to the Argentine."* [32, p. 303].

Hence, with the chief mechanical engineer of the F. C. C. A., M. F. Ryan as the first president of Central South America, it was established in 1920 in Argentina and its first General Assembly was held on June 4 of that same year:

"This Centre was formed in 1920 on the initiative of Messrs. M. F. Ryan [Chief Mechanical Engineer of the Central Argentine Railway, and Chairman of the South American Centre of the Institution of Locomotive Engineers] *and the late J. G. Mayne. The first General Meeting was held on 4*$^{\text{th}}$ *June 1920.* [...] *The first Paper was presented by Mr. F. Gee, entitled Oil Fuel and its Application to Locomotives, at a meeting held at the workshops of the B. A. Great Southern Railway, before an attendance of 104 members."* [40, p. 229].

At first, the locomotive superintendents of the Great British railways looked down on the newly-established Institution centre, until the useful work it was doing and how popular it was becoming among the younger members changed that negative perception [42, p. 304]. This centre was seen as an opportunity for the exchange of experience and the advancement of this specialised branch of the mechanical engineering profession and, in turn, to work for "British capital." During the sessions the call was made: "I appeal to all present to join and to do everything possible to make ourselves into a real live body, which will result in cementing the good feeling and unity of purpose which already exist among railway engineers of all grades and nationalities in these great South American Republics." [42, p. 306]. The Committee consisted of the highest-level staff of the British-owned railways and representatives of commercial companies. In 1929, there were seven centres of the South American branch linked to engineering development: Institution of Locomotive Engineers, Institute of Transport and four specific centres of British electrical, civil, mechanical, and signal engineers. These associations decided to form a single federation called the *South American Centre of British Institutions of Transport and Engineering* with around eight hundred members in 1931, and which enjoyed the active support of the British railway companies, which provided transport subsidies and allowed the use of the companies' installations for the meetings (see Figure 1). However, the ILocoE was not an isolated institution, as they also came into contact with several North American firms and institutions. Proof of this is the participation of Mr. R. P. C. Sanderson, the representative of the American the *Baldwin Locomotive Works*, in the discussions of the documents presented at the sessions. Furthermore,

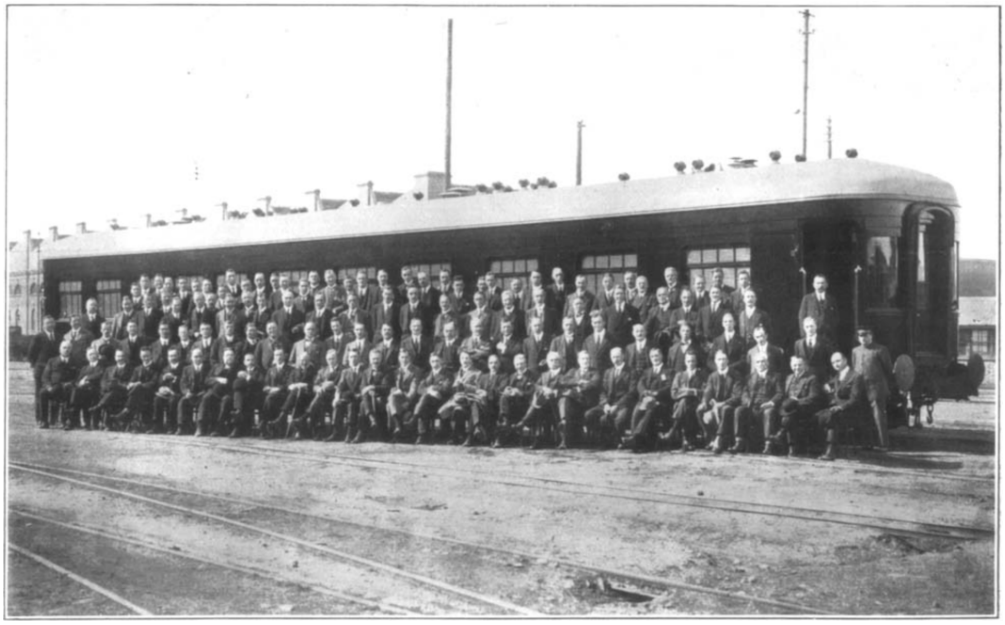

Figure 2. Meeting of South American Branch, Buenos Aires [41, p. 606].

this centre made possible the recognition of local engineers such as the aforementioned case of Patrick Joseph Grennon and the possibility of obtaining the membership of some section supervisors who, although they were not engineers, had technical knowledge acquired in daily practice [13, p. 143]. The coverage of the network of these engineers was extended to more than forty localities, among them: Buenos Aires, Córdoba, Junín, Rosario de Santa Fé, Pérez, Ameghino, Remedios de Escalada; Maceio in Brazil; Montevideo and Peñarol in Uruguay; Santiago Chile. The entry to the association was mediated by the approval of the Central Council in London, nonetheless, all South American members were required to pay their fees to the local treasurer, independently of whether they joined in England or South America. By 1921, the entrance fee was £ 250 4 s. 2 d. and membership certificates cost £ 6 17 s. od [43, p. 409], with which they had to cover operating expenses and printing of material for discussion at their sessions, among others.

A significant event was the luncheon for T. R. H. The Prince of Wales and Prince George at Retiro, organised by the members of the Centre of British Engineering and Transport Institutions of the River Plate to honour of the honourable visitors (see Figure 2). The Prince of Wales remarked on the splendid example of the spirit of cooperation [39, p. 131]. This is significant, as this visit legitimised the existence of the institution and gave it notoriety. Among some of the local collaborators who supported the South American centre were: the Buenos Aires and Pacific Railway and the Argentine Central Railway; the Buenos Aires Herald and The Standard (which published the notices of the meetings); the Saenz Peña Golf and Athletic Club, La Casa Club, the Club Atlético Ferrocarril de Miguelete, and the Club Náutico Argentino. They also had the support of the British Ambassador, the Commercial Attaché of the British Embassy, the Acting Consul General, the Secretary of the Commercial Department of the British Embassy, the Trade Commissioner of the Government of Canada, and the Secretary of the Commercial Department of the British Embassy [44, p. 79].

Some of the topics discussed were: technical-mechanical aspects of the locomotive, such as the superheater, pipe fittings, boiler, firebox, smokeboxes; resource aspects, such as water, steel; types of fuel, oil, coal; locomotive repair and locomotive running department shop organisation, locomotive design, industrial standardisation, railway workshops in war time, and diesel electric locomotive.

By 1949, the South American centre of the Institution of the Locomotive Engineers, after 29 years of operation, closed its doors and put an end to its activities: The decision was taken at the Annual General Meeting of the members of the Centre, held on January 26, 1949, after careful consideration of the difficulties and restrictions imposed on the members in the matter of meetings since the transfer of the Argentine Railways to State ownership:

"It is with the greatest regret that it is necessary to report to the members the closing down of the South American Centre of this Institution. The decision was arrived at, at the Annual General Meeting of the members of the Centre, which was held on 26th January 1949, after a careful review of the difficulties and restrictions imposed upon the members regarding meetings since the transfer of the Argentine Railways to State ownership, that no useful purpose would be served by continuing." [40, p. 229].

7. Conclusion

The diaspora of British engineers in South America was fundamental for its impact in different areas, from the economic point of view, since it favoured the incorporation to international markets through railway development, which in turn favoured the creation of jobs. It had a political impact, since there is no doubt about the relationship between power and economic development, and the intervention of the State and the political manoeuvring of its agents in the development of the railways, either to hinder or to take advantage of the arrival of foreign capital, etc. It had strong repercussions at the intellectual level since it ended up consolidating local engineering and strengthening the engineering education institutions, both for the transfer of knowledge and for having produced the awakening of a conscience in this sector of local professionals.

There is no doubt about the contribution of geopolitical analysis to the history of South American technology, since by articulating the different actors involved in its objective and subjective dimensions, it was possible to capture elements that contribute to a deeper understanding of the impact of the diaspora. Unfortunately, the transfer of knowledge did not crystallise into absorption, since the South American states did not have the financial capacity or the political will to capitalise on the knowledge of the representatives of the diaspora, i.e. the underdevelopment that persists to this day prevailed.

The South American centre of the *Institution of the Locomotive Engineers* played a key role in the creation of an international network through which circulated not only individuals, but also know-how that had a great impact, both in the transmission of knowledge and technology transfer, as well as in the creation of job opportunities, and in the imperialist project, which, paradoxically, contributed to its debacle by providing tools to the locals with which it allowed them, at least, to awaken their conscience.

List of symbols

F. C. C. A. Ferrocarriles Centrales de Argentina

ICE Institution of Civil Engineers

ILocoE Institution of Locomotive Engineers

IMechE Institution of Mechanical Engineers

JILocoE Journal of the Institution of Locomotive Engineers

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