Photographic views of railroads: recording public works in nineteenth-century Brazil

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Abstract

This article analyzes how railway engineering was connected to the production of photographs in mid-nineteenth-century Brazil. The hypothesis is that growing demands related to the execution of projects and new cartographic knowledge required more visual records, which was supplied and leveraged with the emergence of photographic techniques. Data was collected on photographic records of railroads taken in Brazil after the 1850s to analyze the characteristics of these images. This analysis was further extended in a series of photographs by Marc Ferrez, since this collection contains the most views of railways currently accessible, permitting the recognition of patterns in these images to identify them as "photographic project records."

Keywords: civil engineering; photography; Marc Ferrez (1843-1923); nineteenth century; railroad.

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This study focuses on the interactions between scientific and technological knowledge and a new means of iconographic production (photography of public works projects) in Brazil starting in the mid-nineteenth century. Perusal of the many images produced in the previous century produces countless representations of engineering works: thousands of buildings, certainly, but also viaducts, dams, ports, roadway reconstruction projects, and especially railways. First these were reproduced as lithographs and printed in book form, such as *Voyage au Brésil* (1865-1866) by Louis Agazziz, or *Doze horas em diligência* (*Twelve hours of carriage*) (1872) by Henrique Klumb; later they were gathered into albums of urban landscapes, such as *Álbum de panorama do Rio de Janeiro* (*Panoramic album of Rio de Janeiro*) (1880) by Marc Ferrez. Finally, they were grouped thematically into albums of photographs showing railways under construction. For example, there are at least six albums of this type with photographs produced by Marc Ferrez. This extensive volume of iconographic material leads us to question how and why technical and scientific knowledge drew upon photography in constructing these diverse civil engineering projects.

A relationship between iconography and scientific knowledge can be found in the material produced during the scientific expeditions of the early nineteenth century. In *Vue des monuments cordillères et des peuples de l'Amérique* (1810) by Alexander von Humboldt (1759-1869), landscape painting had the ability to "combine the visible and the invisible in our contemplation" (Humboldt quoted in Diener, 2015, p.58) to reveal to the observer the bond between what is shown (physical nature) and what is hidden (a natural order).[1] The naturalist followed the aesthetic principles of Jacob Hackert (1737-1807) with regard to landscape painting; these involved the artist knowing the details of physical nature (organization and characteristics) to produce an image-synthesis of nature (Mattos, 2008, p.38, 50). Would this naturalist relationship between image and knowledge (of the image-synthesis, from a rational perspective) extend to new photographic records of public works conducted during the second half of the nineteenth century?

In this sense, our questioning of photographic production is considered from the bias of the history of science and technology; better stated, it is important for research to understand how scientific practices became permeable to photography. This questioning also implies verifying whether the directives of the photographic record were not encouraged by new scientific practices or services during the second half of the nineteenth century (geological commissions, studies to construct railroads, explorations of new means of communication, surveying and colonization projects). Finally, the objective of this article is to detail how engineering connected with the production of photographic views of railroads in Brazil in the second half of the nineteenth century.

Photographic views of railroads in the international context

Some international examples can be cited to demonstrate the broad use of photography in railway engineering projects. Notable in the United States are records of the construction of the transcontinental Union Pacific and Central Pacific Railroads (1868-1869), which recorded by the Union Pacific's official photographer, Andrew Joseph Russell (1832-1909) (Hannavy, 2008, v.2, p.1225-1227). The large-format images Russell produced in

Utah, Wyoming, and Nebraska became ubiquitous documents of both American history (including the reconstitution of the joining of the two railroad lines in Promontory, Utah) and the heroic representation of railroad workers (Sandweiss, 2002). Charles R. Savage (1832-1909) was another photographer for the Union Pacific who produced images depicting construction of the railroad, as well as the places where it passed during the following decades; these included *Cape Horne* (1871-1873) and *Scene in Truckee Canon* (1871-1873) (Figures 1 and 2). Frank Jay Haynes (1853-1921) was a photographer for the Northern Pacific Railroad for many years (1876-1905) and worked for the Canadian Pacific Railway Company (1881) while that line was being constructed. These images, which were distributed by the Northern Pacific Railroad Company, helped stimulate nascent tourism (Hannavy, 2008, v.1, p.643-644). William Henry Jackson (1843-1942) was hired by the Baltimore and Ohio Railroad and other railroads in the west (Hannavy, 2008, v.2, p.765-766). Before these engagements, Jackson had worked as a photographer for the US Geological and Geographical Survey (1870-1879) under the direction of Ferdinand Vandeveer Hayden (Hales, 1988). He was hired by a number of railway companies between 1879 and 1892 in order to photograph landscapes along the line for tourism advertising materials.

In other countries, photographers were also sought out to document engineering projects. The Frenchman Édouard Baldus (1813-1889) worked first as a painter and later as a photographer to inventory architectural monuments for the Commisson des Monuments Historiques (1851). His photographic records of these monuments earned him a reputation as an architecture photographer (Hannavy, 2008, v.1, p.107-112). Baldus was contracted to produce an album for the Compagnie des Chemins de Fer du Nord (1855) and photographed stations, railway installations, ports, and cities along the railway between Paris and Boulogne-sur-Mer, and an engraved copy was presented to Queen Victoria. In 1861, the Chemins de Fer de Paris à Lyon et à la Méditerranée Company commissioned another album. Also in France, the photographer Auguste-Hipollyte Collard (1812-c.1887) dedicated himself to recording various engineering works (bridges, viaducts, railroads). His work stands out for his collaboration with the Administration des Ponts et Chaussés, mainly in recording the expansion of railways in France alongside with Baldus (Hannavy, 2008, v.1, p.308-309). As we can see, in the international context this type of iconographic material about engineering has already been identified and analyzed in several studies.

In Brazil, these images are recognized as a documentary source and are seen as illustrations of the history of engineering and architecture (Toledo, 1987; Reis Filho, 1989), and for this reason can even be examined as a detailed record of urban transformations and architectural interventions (Ferrez et al., 1983; Kossoy, 1984). At the same time, some relevant work has been done on the photographic record of engineering projects (Turazzi, 1996, 2006, 2012; Mello, 2015), scientific expeditions (Thielen et al., 2002; Mello, Pires-Alves, 2009) and movements toward a visual representation of the city and its reception (Lima, Carvalho, 1997). However, in this country there have been no systematic studies along this line of research with regard to the visual standards adopted in engineering, including photography as a technical resource. The problem presented here is the analysis of engineering knowledge with respect to the guidelines for utilizing the image, with potential implications in the interaction between the object and the subject of knowledge.

The problematization of photography as a historic document has been undertaken in some Brazilian studies which were intended to discuss whether photography proposes representations of reality (Lima, 1991) or cognitive apprehension (Menezes, 2003), or if the image is a support for social relations (Mauad, 2008, 2013; Mello, 2015) or social identity (Mauad, 2004). However, analyzing photography as a visual vector of the social imagination is a different perspective than examining it with respect to its epistemological problems. As mentioned initially, the issues in this article deal with the relationship between image and knowledge. Although the theoretical ties between naturalist illustrations of natural history studies from the early nineteenth century may be clear to the historiography of science, the connections between photographic records and engineering could stand to be more clearly demonstrated. Therefore, the analysis proposed in this present article does not concern the social reception of photography, at least not the wide social dissemination that photographs of public works later obtained as postcards, tourist propaganda, or official publications (Hannavy, 2008; Taylor, 1997) – which was the case for some of the photographic works cited above. We are not convinced that the demand by the railway companies followed the unique path of diffusion by means of postcards or tourist propaganda. In fact, this demand existed, and it was even one of the predefined purposes. However, as we shall see, another important part is comprised of those images that seem to have been created exclusively to portray the construction process.

The photographic series that interest us here are those related to architecture and engineering projects which had a specific audience: viewers with a professional interest (engineers, builders, architects, and restorers), a technical/aesthetic interest (art critics such as John Ruskin or Jacob Burkhardt) (Boyer, 2006), or even a diplomatic interest (ministerial reports, expeditions) (Baillargeon, 2013; Nilsen, 2011). Notable among these series are the iconographic *corpora* involving the image and knowledge (whether technological or aesthetic) which developed an epistemological relationship different from that formed for communication (for example, illustrated tourist guides). It should be remembered that photographic imagery was employed in scientific studies of the nineteenth century, both in Brazil and abroad, for example in criminal anthropology, anthropometric studies, and legal medicine (Bennet, 2004; Schwarcz, 2002; Silva, 2014; Ryan, 1997). Although these images were used to justify colonialism, and were even associated with a discourse of political legitimacy, they were produced as scientific knowledge at the time, even when linked to racial theories. Just as illustrations were an instrument for Humboldt to grasp natural laws through the synthesis of images, photography also played a role in anthropological and geographic explanations to classify "racial types" (Ryan, 1997). However, today we know that photography stood out in engineering projects of the time as a record of the architecture, the process of construction, restoration techniques, or to promote the business itself, not only as possible images of "men working" or inaugural photos (Crimes, 1989; Bertels, 2016).

In this sense, attention is called to photographic production as a record of the public works – or, in the English of that time, "records pictures" (Collins, 2004). In the mid-nineteenth century, photography became a professional instrument for civil engineers, as has already been pointed out in some studies (Crimes, 1998; Howe, 2003; Collins,

2004; Nilsen, 2011; Bertels, 2016). The École Nationale des Ponts et Chaussées (Paris) put together a photographic record of engineering projects at the end of the 1850s; during the following decade, the British Institution of Civil Engineers (London) began to keep records of architecture and art, while the Royal Engineers Course (Chatham) also incorporated the use of photography in the training of its students in 1851 (Palmquist, Kailbourn, 2000, p.184-185). Civil engineering projects began to include photographic documentation (Hannavy, 2008; Turazzi, 1996). Notably, the engineer Charles Vignoles (a designer of the Bahia and San Francisco Railway, 1859) was the main booster in the use of photography in recording the construction of railways. In Brazil, during the engineering course at the Polytechnic School of Rio de Janeiro (Escola Politécnica do Rio de Janeiro) (1878-1889), the students came into contact with photography: its principles were included within studies of experimental physics (Turazzi, 2012). Therefore, it is important to clarify the conditions in which these photographs were created, and their connections with the knowledge held by the engineers who designed and built railways.

Photographic views of railroads in Brazil

Many photographers in Brazil were known to offer their services to produce "views" or portraits (Zenha, 2004; Mauad, 2004), and at different times during their careers they were also hired to record engineering projects. In Brazil, there are albums of photographs depicting public works which are recognized for their documentary importance, but the reasons and conditions surrounding these photographic services do not seem to be sufficiently explained. Here we refer to series on urban reforms and infrastructure: Henry Klumb recorded the renovations of the Rio de Janeiro sewer system by the Rio de Janeiro City Improvement Company (1860), the Petropolis Railway (*Débarcadère du Chemin de Fer Mauá,* 1860) (Figure 5), the Estrada União e Indústria (1872), as well as views of repairs to the Passeio Público and Campo de Santana (1878); Augusto Stahl's images of the construction of the Recife and San Francisco Railway Company (*Estrada de Ferro do Recife ao São Francisco: construção,*1858) (Figure 6), the construction of the Gas Establishment (Estabelecimento de Gás) (1857) and work on the Santa Isabel Bridge (1861); the English civil engineer and photographer Benjamin Robert Mulock (1829-1863) recorded the construction of the Bahia and San Francisco Railway (1859-1861) (*Entrance to Mappelle Tunnel: Bahia and San Francisco Railway*, 1859-1861, and *Workshop at Peripiri-Bahia and San Francisco*, 1861) (Figures 3 and 4); Augusto Amoretty (*Chemin de fer de Rio Grande à Bage*, 1881-1884) (Figure 9); Ignacio F. Mendo and the Paulo Afonso Railway (*Quilômetro 26*, 1880) (Figure 10). There are photos by C.R. Winfield of earthworks and railbed preparations for the São Paulo Railway Co. (1861) and Augusto Militão portrays the completion of construction and beginning of operations (1865); photos by Alberto Cohen depict the São Paulo and Rio de Janeiro Railroad (Estrada de Ferro São Paulo e Rio de Janeiro) (1877) (Brasil, 1981); Augusto Malta recorded renovations in Rio de Janeiro (1903-1904), and there is also an album of depicting construction in the Port of Rio de Janeiro (1904-1910), with photographs by Emigdio Ribeiro (Turazzi, 2012).

After 1860, the photographer Guilherme Gaensly (1843-1928) also produced numerous records of public works in Salvador (lighthouse, canals, hydraulic lift, water reservoir,

roadway), as well as buildings (churches, chapels, a theater, a convent) and urban views (a public promenade, main streets, port, nearby villages) (Kossoy, 2002; Brasil, 1981). In the 1870s, he also produced images of the Central Imperial Road in Bahia (Imperial Estrada Central da Bahia) (*Viaduto do Batedor: em construção*, 1870) (Figure 8) and the Bahia and São Francisco Railway (Estrada de Ferro da Bahia a São Francisco) (*Trapiche em Jequitaia – [Estação marítima de Calçada, Salvador],* s.d.) (Figure 7), showing both infrastructure (station, workshops, viaducts) as well as the places where the railway passed. After moving to São Paulo, Gaensly (2001) photographed countless urban views between 1899 and 1925, and worked for the Light and Power urban transport company, recording infrastructure and trams.

Marc Ferrez was one of the photographers who produced the most images and albums for the railway companies. Some outstanding examples of his photographs include the following albums: *Estrada de Ferro Minas and Rio* (*Minas and Rio Railway*) (1881-1884), *Estrada de Ferro Príncipe Grão Pará* (*Príncipe Grão Pará Railway*) (1882); *Estrada de Ferro do Paraná* (*Paraná Railway*) (1880-1884); *Estrada de Ferro do Corcovado* (*Corcovado Railway*) (1884); *Estrada de Ferro D. Thereza Christina* (*D. Thereza Christina Railway*) (1884); *Great Southern Railway* (1889).[2] Ferrez also took photographs for the Dom Pedro II Railway (Estrada de Ferro Dom Pedro II) (1882). He was active in photographing public works and engineering, such as: *Obras do novo abastecimento de água do Rio de Janeiro. Empresa de A. Gabrielli* (*Work on the new water supply in Rio de Janeiro. A. Gabrielli Company*) (1876-1882); *Obra de canalização provisória do rio São Pedro* (*Temporary channel work on the São Pedro River]* (1888); photographic documentation for the Nova Capital Construction Committee (Comitê de Construção da Nova Capital) (Belo Horizonte, MG) em 1894; the valuable volume on urban reform in Rio de Janeiro, *Avenida Central, 8 de marco de 1903-15 de novembro de 1906* (1907). Ferrez also produced the *Álbum panoramas do Rio de Janeiro* (*Album of panoramas of Rio de Janeiro*) (1890), and various other individual photos and collections that included urban views and railroads.

Finally, an event allows us to highlight the proliferation of this type of photographic production. In 1886, the Engineering Club (Clube de Engenahria) was recommended by the Imperial government to organize the section on railway projects for an exhibition commemorating 50 years of railways in France, in September 1887. Ferrez presented a proposal along with E. de Mascheuk for the Brazilian Railway Exhibition (Exposição dos Caminhos de Ferro Brasileiros) (1887), which was endorsed and promoted by the Engineering Club of Rio de Janeiro as a preliminary experience prior to the international event (Clube..., 14 dez. 1886). Although Brazil's official participation was canceled, the Brazilian Railway Exhibition took place in the Liceu de Artes e Ofícios from July 2 to August 2, 1887. Participants included 19 railway companies, engineers, the Engineering Club of Rio de Janeiro, the Board of Public Works and the Polytechnic School, printers, and mining companies. The exhibition was comprised of maps and profiles, rolling stock and technical material, machinery, and samples of wood (for railroad ties, furniture, cars, and wagons), as well as photographs. Marc Ferrez presented a collection of 15 photographs of several railways, a "very important collection of photographs, which has a large number of the country's railways" (Exposição..., 14 ago. 1887, p.170-171). However, several other companies also presented collections of photos,

totaling 459 pictures, which does not include the 15 photos by Ferrez and others which went uncounted. This indicates that there is thought to be significant production of this type of photographic material in the 1870s, even if the photographers were less famous or even unknown.

Finally, as has been identified in the foreign studies cited above, the extensive production of this type of iconographic material in Brazil deserves further analysis on different aspects of how it was generated on the job site. Here we should highlight three of these aspects: the specific demands of civil projects (what to register, and for whom), some formal requirements which were established by civil engineering (how to register), and the purpose of each record (technical or not), even distinguishing whether the movement circulated within the project or beyond it. This type of analysis is what we intend to suggest in the following items, including a brief examination of photographs depicting the construction of railways taken by Marc Ferrez.

The requirements of recording engineering projects

As noted above, photographic records of engineering works had been common since the mid-nineteenth century. In Brazil, it is known that the work of Mullock, Stahl, and Winfield cited above was done at the request of the railway companies, but some scholars allege that the formal standard is eminently aesthetic, referring to the neoclassical pattern of everyday scenes or representation of physical nature (Barbosa, Medeiros, 2010, p.18-19, 36).

However, the illustrated record of engineering works in itself was not a novelty. This had already been the case since the late eighteenth century, whether to illustrate a technical activity, such as in d'Alembert's *Encyclopédie* (1751-1772), or the operation of machinery, or in detailed aspects of the construction of the first railroads, as in *A series of lithographied drawings of the London and Birmingham Railway* (1839) by the artist John Cooke Bourne, created at the request of John Britton, a surveyor and "enthusiast of this new era" (Daniels, 2017). At the same time, production of detailed technical engineering drawings had been enhanced with the definition of scale and identification of material, in order to allow its implementation (in shipbuilding, for example). Since its invention, photography has been used on the job site as a way to record construction, replacing illustrations quickly and in quantity. In England, William H. Fox-Talbot used the calotype to document the construction of Nelson's Column (1843). An extensive set of photographs was produced by J.C. Bourne and Roger Fenton (1847-1852) depicting the Kiev suspension bridge designed by Charles Vignoles. Between 1853 and 1855, Philippe Delamotte recorded the entire construction of the Crystal Palace at Sydenham. The Royal Engineers included these photographs in the training of military engineers, who began to use them in several projects, such as the construction of the South Kensington Museum (1856). In France, the works to identify historical monuments which were known as the Mission Heliographique (1851) (and also involved participation by Édouard Baldus) inspired architects and restorers with details of ornamentation they "had never recognized with their own eyes" (Boyer, 2006, p.47). Also in France, photography was used in civil construction from the very beginning, such as Édouard Baldus's images of the new Louvre (1854-1857). Photography was included in the

training for engineers in the École Nationale des Ponts et Chaussées. Engineers and restoring architects considered photography's potential as a new technique for creating visual records of these projects, in addition to other practical applications. Charles Vignoles was the first to defend it, at the Royal Photographic Society (London, 1853): "great services which the new art would be likely to render to engineers and others having to superintend important works they could only occasionally visit, or having to make intelligible to foreign employers … the details … of complicated constructions" (quoted in Anderson, 1989). Monitoring construction work and practical guidance are the reasons given by Charles Vignoles, who a few years later would ask the engineer Benjamin Mullock to send photographic records of the railway lines constructed in Bahia.

The potential of these photographic records was even broader for those engineers who were trained in the Royal Engineers, which can be seen in the list of the applications of photography compiled by Captain Henry Schaw, chief instructor for Telegraph and Photograph:

> obtaining exact records of the progress of public Works in the course of construction ... copying plans and maps; obtaining minutely accurate pictures of architectural subjects of acknowledged excellence, to assisted designing new works and buildings; preserving exact details of failures in building from defective foundations or others causes; recording the results of all sorts of experiments in mechanical constructions or new inventions; illustrating the methods of making military bridges; in surveying boundaries of different countries, photographs of remarkable natural feature of the country, … will tend to fix the position of the line with greater certainty (cited in Howe, 2003, p.231).

In summary, photography permitted a precise record of the execution of construction work, evaluation of the integrity of the buildings, architectural detail, illustration of how mechanisms functioned, and demarcation of borders.

The positivity of exact photographic records was considered an operational condition which would support scientific engineering practices. The ideal of objectivity was certainly stimulated by the scientific knowledge which came alongside engineering (cartography, physics, geology) and resources to survey and record with high degree of accuracy (for example, the theodolite and astrolabe). Within this conception, photography could be adapted to the knowledge and instruments used. The supporting argument was that the photographic record allowed a "truthful and accurate idea" (cited in Howe, 2003, p.231) of a spatial position, of construction progress, or could be part of a geographical record. For engineering, the image obtained the status of authenticity and accuracy which was adjusted to the technical plans for these projects (completed project/planned project) or the geographic knowledge that needed to measure and represent the space. If photography was considered another instrument at the service of engineering, we can say that the photographic record of projects had a privileged observer: the engineer.

In the case of various photos within the Brazilian albums mentioned above, particularly those by Marc Ferrez, this engineer was Pereira Passos. Francisco Pereira Passos graduated from the Military School (1856) and studied at the École Nationale des Ponts et Chaussées in 1858, when he had the opportunity to see the works on the Paris-Lyon Railway

(which were recorded in an album by Édouard Baldus in 1861) and the urban reforms by Eugène Hausmann (Benchimol, 1992). Back in Brazil, in 1862 he served on commissions investigating the extension and the monitoring of work on the Dom Pedro II Railways, and also acted as an inspecting engineer for the work on the line connecting Santos to Jundiaí (1864-1867). He also was the engineer-director for the Dom Pedro II Railway from 1876 to 1880 and again from 1897 to 1899. Furthermore, Pereira Passos was responsible for the engineering design for other companies: the Curitiba-Paranaguá Railway (constructed from 1881 to 1884); the extension of the Petrópolis Railway, in the stretch spanning from Raiz da Serra do Mar to Petrópolis (1881-1883), and the Corcovado Railway (1882-1884).

Other figures can also be listed as observer/engineers for the photographs of engineering projects; these include the engineers Antônio and André Rebouças, who also utilized photographic records in the construction of the Paraná Railway in 1884. André Rebouças was a member of the Engineering Club, was present at the Railway Exhibition, and taught at the Polytechnic School, where photography was part of the curriculum. The engineer Jerônimo Rodrigues de Moraes Jardim graduated from the Central School (1862) and assisted André Rebouças in 1870. Jardim designed and carried out the work on Rio de Janeiro's water supply (1876), which included construction of the São Pedro and Rio de Ouro pipelines, and the construction of the Pedregulho reservoir (which was photographed by Ferrez). He was a member of the Rio de Janeiro Improvement Commission (Comissão de Melhoramentos do Rio de Janeiro) and the Brazilian Railway Exhibition. The engineer Paulo de Frontin, president of the Avenida Central Construction Commission, hired the photographer João Martins Torres to record all the stages involved in constructing the avenue (Turazzi, 2006). After it was completed, Marc Ferrez was also contracted by the commission to produce a detailed album of the avenue and the new buildings constructed there.

Railway engineering required detailed images of evolution in engineering works (buildings for passengers, tunnels, bridges, embankments, railway earthworks). This can be confirmed in a survey of photographs from the 1887 exhibition; the images emphasized buildings for passengers and artistic constructions (bridges, viaducts, and tunnels), in addition to the railway tracks and workshops. The volume and repetition of themes indicate two likely objectives in the production of images, as well as the most immediate audience: the primary observer was the engineer, who used the photographic records for technical supervision of construction works and earthworks. The other probable observers were company shareholders and directors (especially foreigners), who sought to verify that the investment was trustworthy.

In fact, Marc Ferrez was hired to photograph the construction of projects designed by Pereira Passos, among other railways. Whether because of training, participation in social networks of engineers, Marc Ferrez's professional competence, or the requirement to supervise the project, the use of photography to document this construction was not foreign to engineering activities. Ferrez himself was aware of this, and his services were specialized for the demands of engineering.

Moreover, his work photographing engineering was already recognized. At that time, the photographer declared his own "skill in views of Brazil," stating that the techniques he dominated (platinum and *gelatino-bromure*) were the most suitable for producing "scientific

and industrial illustrations" because they permitted the "inalterability and beauty of details" (Noticiário, 11 nov. 1884; Clube..., 28 nov. 1884; Prospecto..., 1884). A news piece from 1886 reported that had returned to Europe for further training, including in the ferro-prussiate process (heliography) for affordable reproduction of plans and engineering drawings (Fotografia..., 15 abr. 1886, p.84). In fact, in an advertisement in the same publication in late 1886, he declared himself an "expert in images of railways and major public works in general," as well as a specialist in the reproduction of plans and images for reports (Ferrez, 28 dez. 1886, p.2). In the following years, Ferrez produced images depicting the constructions of railways and public works (sanitation, urban reforms), as well as urban views of Rio de Janeiro.

We believe that Ferrez contributed to the way in which photography in Brazil adapted to engineering, and the explanation for this comes from a photograph produced from the perspective of the cartographer/engineer. Ferrez refined this perspective in the expeditions coordinated by the American researcher Charles Hartt, when he took photographs for the Brazilian Geological Commission (1875-1877). Ferrez also assisted in Charles Hartt's scientific conference by projecting images of the sites visited using a stereoscope device, which created the illusion of depth (Turazzi, 1995).

In order to develop a more profound analysis of the interrelation between the photographic record and engineering projects at that time, it is necessary to understand the relevance of scientific knowledge with regard to geology and land surveying. Modern cartography was designed for military engineers to measure political-administrative territories in France and England in the eighteenth century. This type of work would also be used for mapping surveys with more practical purposes, such as establishing means of communication and identifying resources. In the United States, extensive geological surveys were carried out by the Corps of Topographical Engineers (1833) for exploration and to produce maps of the American West as well as to construct public works; this is when the word topography was vulgarized to designate spatial surveys based on geodetic coordinate systems. Using the geodetic system (which conceives terrestrial space as a network of meridians and parallels), terrain could be represented in a two-dimensional form: a topographic map. In the nineteenth century, these topographic surveys began to be applied in the planning for construction of civil engineering and public works.

In this aspect we should mention the directions given by Frank de Yeax Carpenter, an American geographer and member of the Imperial Geological Commission, which was headed by Charles Hartt and included Ferrez among its members (Carpenter, 15 ago. 1880). According to Carpenter, engineers could obtain a correct topographic survey of the land which represents space using triangulation. Searching for the highest points of a mountain provides each of these triangulation stations. At the peak, engineers can produce an outline of the terrain profile. However, the "picturesque effects" of painting should be avoided, as these may cause the representation to omit "what is of vital importance to the project" (Carpenter, 15 ago. 1880, p.134-138). "Relief drawing" can also be produced from a "station" or "triangulation," but these drawings only allow a "copy of the country as it seems to be," because the artist's view can be affected by illusions of perspective and "only the reading[s] of the theodolite are to be accepted in fullfaith" (Carpenter, 1878, p.71). Photography, in turn, could "more safely" represent the details of geological structures, the nature of

surfaces and ground conditions, or a geographical area with an emphasis on the details of the physical surface of the terrain (Carpenter, 1878, 15 ago. 1880). Under the guidelines of the pictorial picturesque, the artistic composition was not desirable for geological ventures or for drawing or photography, because it lacked truth. Among the instruments and procedures available, photography was considered an additional and more reliable tool in geological representation. According to Carpenter's explanation (1878, p.71), through these safe means, topographic survey allowed "a contour sketch is accepted as truthful evidence of the ground as it really is." Photography was understood to be a type of scientific record for cartographic knowledge, because it provided more three-dimensional information to two-dimensional representation, which is one of the objectives of topographic mapping. It was according to these scientific guidelines and service requirements that Ferrez would have produced the photographs for the Geological Commission.

Marc Ferrez and photographic records of railways

What we have emphasized up to this point is that the production of images of public works had its own rules, which were dictated by the services to be provided to civil engineering. For an aesthetic analysis or one guided by a symbolic interpretation, photographs of these projects were meant to create a monument to the railroad and exalt the technique, recording the transformation of nature by the work of man (Carvalho, 1991, p.217-225). In contrast, according to the line of analysis in this article, engineering knowledge is believed to have established its own parameters for reading and creating conditions for the photographic record.

Note that the images in the albums depicting the *Estrada de Ferro de Paranaguá a Curitiba* (*Paranaguá-Curitiba Railway*) (1884) and the *Minas and Rio Railway* (1882-1884), which were produced by Ferrez, show different stages of construction: earthworks and backfill (Figure 16), construction of bridges and viaducts (Figures 14 e 15), construction of tunnels (Figure 12), laying of tracks, and the beginning of operations. This is not a photographic series that was created at one instance, but rather over the months of construction, as can be observed in the images of the recently graded land, the wooden scaffolding, the excavations or incomplete sections; other images of different stages, are also contained in other collections (Instituto Moreira Salles). The various steps were even commissioned by different builders and needed to be monitored in terms of how they corresponded to the original design and monthly payment for the service. After this first series of records of the stages of construction, some images could be selected to illustrate the most important construction work and different points of the line, which could result in the album cited.

Many photos show a man alongside the construction operations. Considering that the purpose was to record the work, we interpret these images using a technical assumption: the presence of a man helped the viewer interpret the scale of the project by comparison, just like a scale legend in topographic surveys for leveling the track (cf. Passos, 1912). Including people or objects in the composition as a parameter for comparison does not seem unusual or exclusive to only Ferrez, as this can also be seen in other images by foreign photographers such as Savage (Figure 1), Mullock (Figure 3, showing the theodolite

pedestal), Auguste Collard, or the Dom Pedro II Lines (*Linha Central: ponte n.2 da Cachoeira, Cachoeira do Inferno: quilômetro 263,720,* 1881) (Figure 11). This guarantees that the pictures fulfill their utilitarian goal of monitoring the project by allowing the engineer to verify that the work performed corresponded to the plan.

This scale resource can be seen in various photographs taken by Marc Ferrez which are part of albums showing the construction of railroads, showing both nature (*Cachoeira de Paulo Affonso*, 1875) and urban views (*Allée des palmiers au Jardin Botanique*, 1880) (Figure 13), as well as the images of engineering work (*Estrada de Ferro de Paranaguá a Curitiba: túnel n.7 do pico do Diabo* (*Paranaguá-Curitiba Railway: tunnel no. 7, Pico do Diabo*), 1884) (Figure 12). Anonymous workers or the photographer's own assistants could serve as the scale for the main object in the photo (column, tunnel, bridge, or waterfall). They sometimes positioned themselves in front of the object (facing forward or backward) to measure height; other times, they were shown sideways, as a parameter of the width of the structure (*Minas and Rio Railway: Ponte sobre o rio Verde, km 74* (*Bridge over the Verde River, km 74*), 1882) (Figure 14). In some cases, the inclusion of a train parked on the track ("inaugural train") could also serve as proof that operations had begun and that the work was functioning safely (*Estrada de Ferro de Paranaguá a Curitiba: viaduto sobre o rio São João k[m] 62,210* (*Paranaguá-Curitiba Railway: viaduct over the São João River k[m] 62.210*), 1884 [Figure 15] and *Pont du Silvestre*, 1884 [Figure 18]). This provides the photographic record the characteristic of showing the truth in a way that supports cartography, allowing the viewer to be physically present on the job site but in a way that is rationalized by visual geometry. At the same time, the record of construction is one of the purposes of these images, as a way to remember and follow along with the work (tunnels excavated, earth leveled, tracks laid, bridge structures erected), especially if the images were seen by an engineer who was a designer or administrator of the company.

On the one hand, the viewpoint of engineering is privileged in the overviews of earthwork and embankments, with images containing a topographic bias. At times, the perspective of the topographic survey prevails when the work is examined. The camera was placed tangent to the curve (in a "station") (*Estrada de Ferro de Paranaguá a Curitiba: aterro da Volta Grande* [*Paranaguá-Curitiba Railway: Volta Grande earthworks*], 1884; *Minas and Rio Grande Railway-Brazil: aterro grande 9 K[M] 800* [*large earthworks 9 km 800*], 1881) (Figure 16). As a result, the space was repositioned with the two elements in a geometric arrangement in relation to the tangent; in the images mentioned above, for example, the triangulation points are an umbrella or a man (the first point) and a train (second point).

At other times, the natural views sought out details of the vegetation, the expanse of the forests, the heights of the mountains, and the coastal formations; in other words, it placed full emphasis on the physical geography, since it was important to record the nature of the soil and the existing vegetation along the line being constructed (*Estrada de Ferro de Paranaguá a Curitiba: vista geral da linha, tirado do k.[m] 63 [Paranaguá-Curitiba Railway: overall view of the line taken from km 63],* 1884) (Figure 17). These images permit the viewer to assess whether the physical nature contributes to landslides in the earthworks, as taught by Pereira Passos (1912). The flora was interesting because it had an impact on the project. For the same reason, the fauna was absent in Ferrez's photographs of the construction.

The images were produced to provide a "topography view" of the physical geography (the relief of the terrain, geology, or vegetation).

The photographic records and their uses in railway engineering

By examining the photographs taken by Marc Ferrez, we sought to highlight the primary technical purpose of the photographic record: to provide guidance (on topography, texture, perspective, or scale), to ensure the quality of the materials employed, and ensure the use of appropriate techniques, since control of these factors was the responsibility of a committee of engineers in charge of the construction or extension of the railroad lines (Figueira, 1908). However, this is only one of several purposes which were also attributed to these photographic records at the time.

A second purpose is linked to the administrative management of the projects. On the one hand, the visual record allowed construction to be monitored at different stages, mainly to pay for construction or for the services performed by workers (Figueira, 1908; Barbosa, Medeiros, 2010). It also served as proof of the railway undertaking to stimulate shareholders, with regard to the viability of the investment or its execution. In this case, Ferrez's images of the railway connecting Curitiba to Paranaguá (1883-1884) appeared at the same time as the *Estudo do prolongamento da Estrada de Ferro Paraná* (*Paraná Railway Extension Study*) (1883), outlining the project, its likely traffic (passengers and cargo) or its "suitability for [agricultural] crops;" a structure which followed, in turn, the federal contract for the line and the French manuals on the railroad layout. The opening of the line between Curitiba and the coast permitted the "export of magnificent pine" for half the price of pine abroad. The penultimate image in the album (*Araucaria*) shows precisely how "the pine forests are vast and magnificent; ... inexhaustible sources of enormous wealth that the railway will bring value to." (Passos, 1883, p.VII). In other words, this image in the album would support the expectations of the cargo that would ensure returns on the construction investment and the profitability of the railroad.

While the image of the pine trees in *Album de vues du Brésil* (1887), distributed by the Imperial government to coincide with the International Exhibition in Paris (Rio Branco, 1889), suggests "symbolic components of the Brazilian nation" (Kossoy, 1999, p.111), we emphasize that the original reason for the image is associated with the potential for return on investment, as a proof of estimated rail traffic, which is corroborated by the statistical information in the *Estudos de prolongamento* (*Extension studies*)(1883). The viewer of the *Album* (the audience at the International Exhibition) was not the same as the viewer of the *Memória descritiva* (investors or railroad administrators). Furthermore, if the *Album* was created to promote the Brazilian Empire and a national image abroad, the photograph was created with another purpose and within the technical context of recording construction, directed at the engineer in charge and the shareholders, as discussed above.

A third purpose for the photographs of public works is connected to the wider dissemination of the projects. At times this may have occurred, as in the case of Ferrez's album depicting the Avenida Central (although its construction was recorded by another photographer). But at other times, propaganda may not have directed the production of

the original images, only subsequent compilations. The albums cited herein are part of the Tereza Cristina Collection (within the Brazilian National Library) and were bound with the Imperial Seal, suggesting that they were offered as gifts to the emperor, who visited or inaugurated these railroads. They were offered as gifts from the engineer (Pereira Passos) or the foreign companies (Compagnie Générale des Chémin de Fer Brésilien and Minas and Rio Railway-Brasil) to the governing body; distribution of the albums registering construction worked as both a form of public relations and a way to promote these works to agencies, investors and engineers. It was a realistic situation which had already occurred previously: the Compagnie des Chemins de Fer du Nord album was presented by Baron Rothschild to Queen Victoria, to cite just one example. This function involving promotion could guide the compilations of images and their later dissemination. However, it does not explain the motive for the original photographic records; furthermore, the compositions are less than ideal for dissemination because they show unfinished works, views of terrain cut with earthworks, and uneven lighting.

The use as official propaganda also places these photographic records of construction within a secondary work or a context which differs from the original purpose of their production, which appears to be the case for the album produced by Marc Ferrez on the opening of Avenida Central in Rio de Janeiro (1907). This differs from cases in which photographs were produced specifically to manage the construction, which had a direct observer (the engineers or shareholders), such as the images produced by José Martins Torres for the Construction Commission or by Ferrez for the work on the Paraná and Minas Gerais Railways.

Lastly, what we are trying to understand here is how the visual representation of engineering projects in the nineteenth century were produced, highlighting the work of Marc Ferrez. Considering that hundreds of other photographic records of construction work were taken by other photographers, the recognition of a pattern for recording the engineering of that time is most relevant to understanding this type of representation. After all, it is through this pattern of photographs recording public works that we can understand how engineering appealed to the image for its own purposes.

Final considerations

Despite sharp criticism in the area of visual arts against the idea of documentary photography as "true photography" (Rouillé, 2009), the evidential character of the image took on a growing function in practical applications of technology and science in the twentieth century. The use of photography in experimental scientific methods to establish results and evidence appears to date back to the second half of the nineteenth century (Tucker, 2006). Photography takes on a pragmatic function to be highlighted, not exactly as a "historical document" (which provides access to the meaning of historical events, as we read in the classic manual by Charles Seignobos from 1897), but as experimental evidence that can be presented in scientific debates, such as the proof of invisible microscopic organisms ("bacteria") in the study by Robert Koch. The image is included in the context of the debate on objectivity in experimental methods and the best form of representing scientific results (Daston, Galison, 1992). Currently, in various scientific

specialties (astrophysics, biomedical optics, physics, optical engineering), the image has come to provide an effective capture of physical reality; for optics, when light transmits attributes of matter, and in biomedicine, the techniques that generate images of the human body. Something similar seems to have occurred with civil engineering, with respect to the type of evidence (the photographic image) that was increasingly accepted as scientifically reliable in comparison with other means.

The photographic record of construction work, in particular, is increasingly recurrent in civil engineering projects: all monitoring of work produces a "photographic report of project monitoring" which accompanies the technical report for the project. The current terms that best correspond to this purpose are "photographic project records" or construction photography,[3] encompassing a large market for professional services and principles and involving photographs as well as additional equipment (such as drones). Photography can also be used in architecture to document architectural results, namely the attributes or the final outcome of a composition, where architectural photography says more about the demonstrating the "authenticity of the building" (the values inherent to the building) and which composition techniques should be used to achieve this purpose (Schutz, 2015, p.8). A civil engineer or architect/restorer would not disqualify "photographic records" without risking professional procedures, and the photographer cannot express an artistic bent it is necessary to document the architecture, even knowing that the photo is an illusion (Schutz, 2015). Photography has shown itself to be a convenient technique for a wide range of scientific knowledge and professional practices, such as the visual record of construction and topographic surveys in the nineteenth century.

The use of photography was disseminated in French and English engineering schools starting in 1850 and in Brazil after 1878; in Brazil, the practice of documenting engineering works became widespread, as demonstrated by the Commemorative Brazilian Railway Exhibition in 1887. This explains why the Brazil Central Railway created a photographic studio attached to its Materials Testing Section in 1903, for "all the most important works of the Railway to be photographed at various stages of construction" (Figueira, 1908, p.739). Together with the testing section, the photographic record would serve as supplementary documentation for the construction management (administrative function) by ensuring the technical quality of the material (technological function). Consequently, photography guaranteed technological and administrative efficiency in the project.

With the photographic record of public work, we observed that the relationship between image and knowledge was distinct in terms of the naturalistic relation recognized at the beginning of the nineteenth century. The perspective of the naturalist scientist was ratified by panoramic images (composed using optical effects), and the privileged observer of Ferrez's images analyzed in this text was the engineer. In terms of technological efficiency, the photographic record in engineering is capable of decoding physical scale (in construction works) and geophysical characteristics (of terrain), monitoring work progress, measuring the potential for using land, timber, and hydraulic power, viewing the urban topography of the city, and permitting materials inspections (from an architectural or structural or structural point of view). It does not seem to be a coincidence that the urban views produced within these criteria are still so appreciated by architects today (whether

restorers or conservationists) for allowing them to recognize the geometric perspective of a building or the morphology of the city.

At the same time, this topographic vision was not confused with that of naturalist painters, the followers of Humboldt, who were expected to produce an image-synthesis of nature. Photographic reproduction permits administrative efficiency. The wealth of detail in Ferrez's "scientific and industrial illustrations" allowed viewers to estimate the technical feasibility of implementing and economically measuring public works. In the same way that topographical photographs were convenient for recording project details, heliography permitted easy reproduction for reports. Photographic services were located here within a moment of executing one economic activity among others (construction), but it was still one step within a sequence of large economic activities involving the transport of people and goods. In other words, photographic production corresponds to an industrial record in content and in form: photography as a new technique of cheaply producing and reproducing records within a new industrial system. The construction of railway infrastructure was one of the activities involved in this industrial system of transport.

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NOTES

[1] In this and other citations from the Portuguese, a free translation has been provided.

[2] In October 2016, we found a copy of the album *The Great Southern Railway* in the library at the Polytechnic School at the University of São Paulo, with the emblem of Casa Ferrez and *passe-partout* identical to those of the other albums. The material was cataloged for decades as a photo album, but with no mention of the photographer. But when we consulted the album, all the photos had been cut out and stolen from the album; only the cover remained on the bookcase. The crime was discovered months before, according to information from the librarian.

[3] See, for example: <http://www.constructionphotography.com>.

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APPENDIX – FIGURES

Figure 1: Charles R. Savage, *Cape Horne (1871-1873)*; albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 2: Charles R. Savage, *Scene in Truckee Canon* (1871-1873); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 3: Benjamin R. Mullock, *Entrance to Mappelle Tunnel: Bahia and San Francisco Railway* (1859-1861); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 4: Benjamin R. Mullock, *Workshop at Peripiri-Bahia and San Francisco* (1861); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 5: Revert Henry Klumb, *Fragozo: Débarcadère du Chemin de Fer Mauá* (1860); stereographic albumin print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

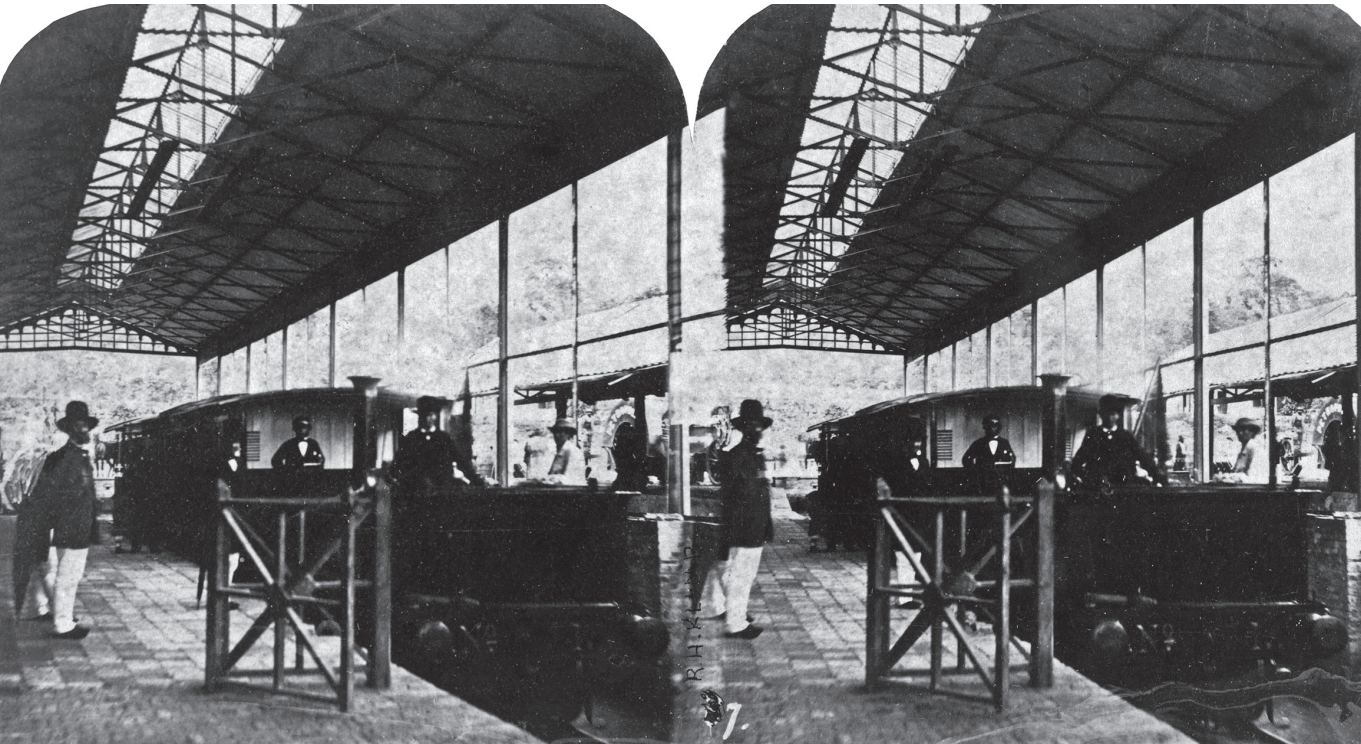

Figure 6: Augusto Stahl, *Estrada de Ferro do Recife ao São Francisco: construção* (1858-1860); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

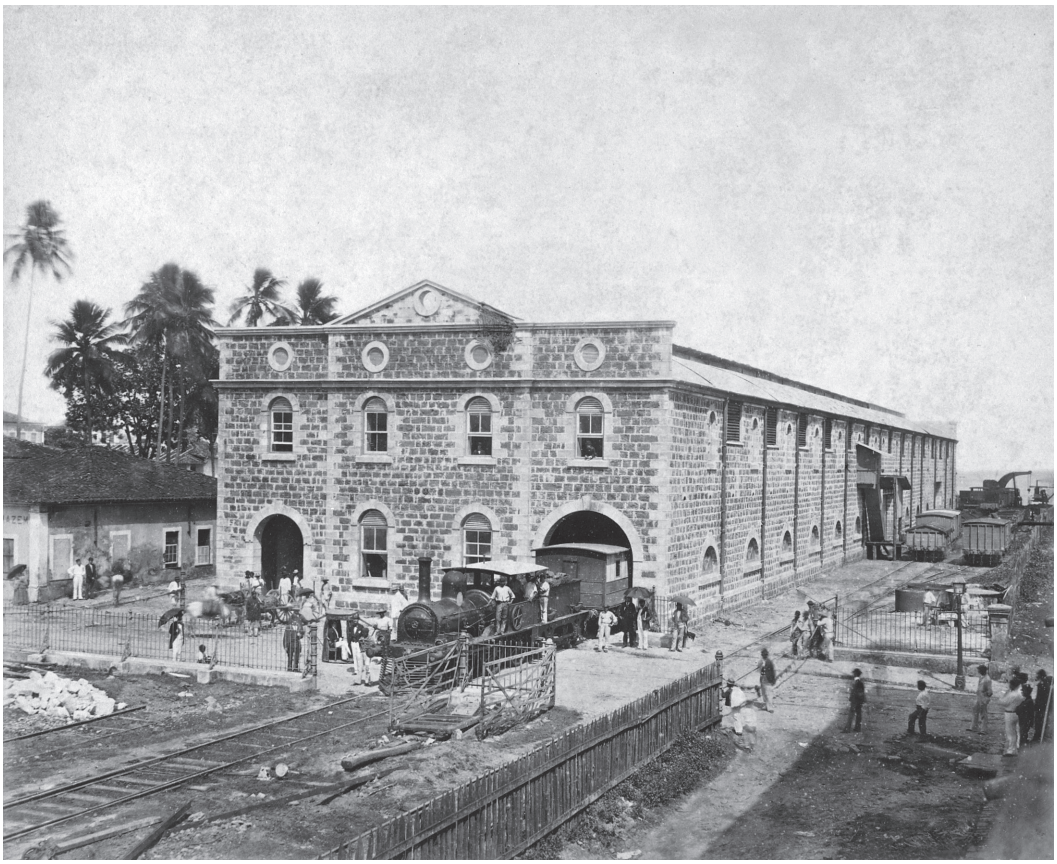

Figure 7: Guilherme Gaensly, *Trapiche em Jequitaia* [Estação marítima de Calçada, Salvador], *Bahia and S. Francisco Railway* (s.d.); cabinet card, albumin print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

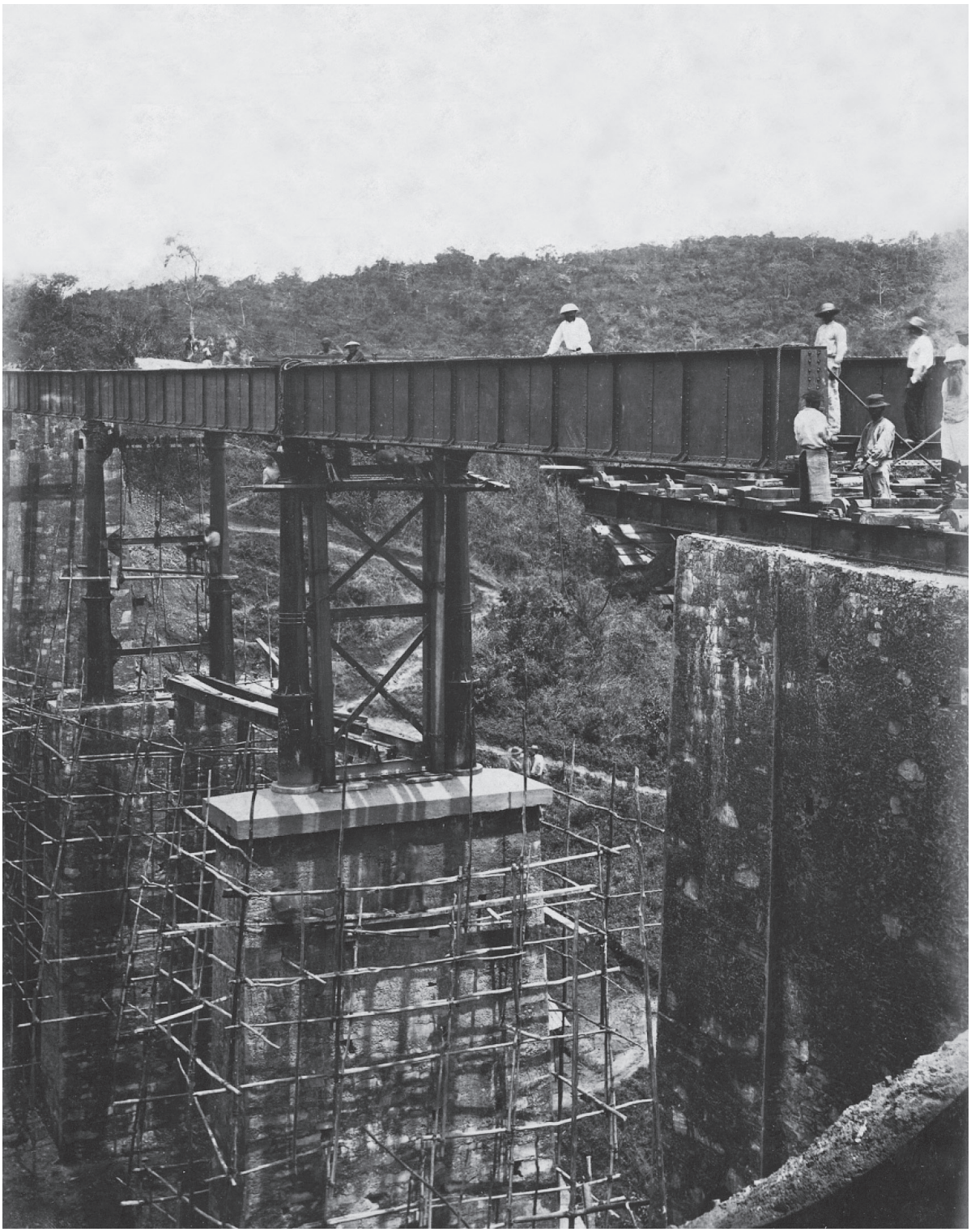

Figure 8: Guilherme Gaensly, *Viaduto do Batedor (em construção), Imperial Estrada de Ferro Central da Província da Bahia* (1878); cabinet cards, albumin print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 9: Augusto Amoretty, *Chemin de Fer de Rio Grande à Bagé* (1881-1884); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 10: Ignácio F. Mendo, *Estrada de Ferro de Paulo Afonso: Quilômetro 26* (1880); colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

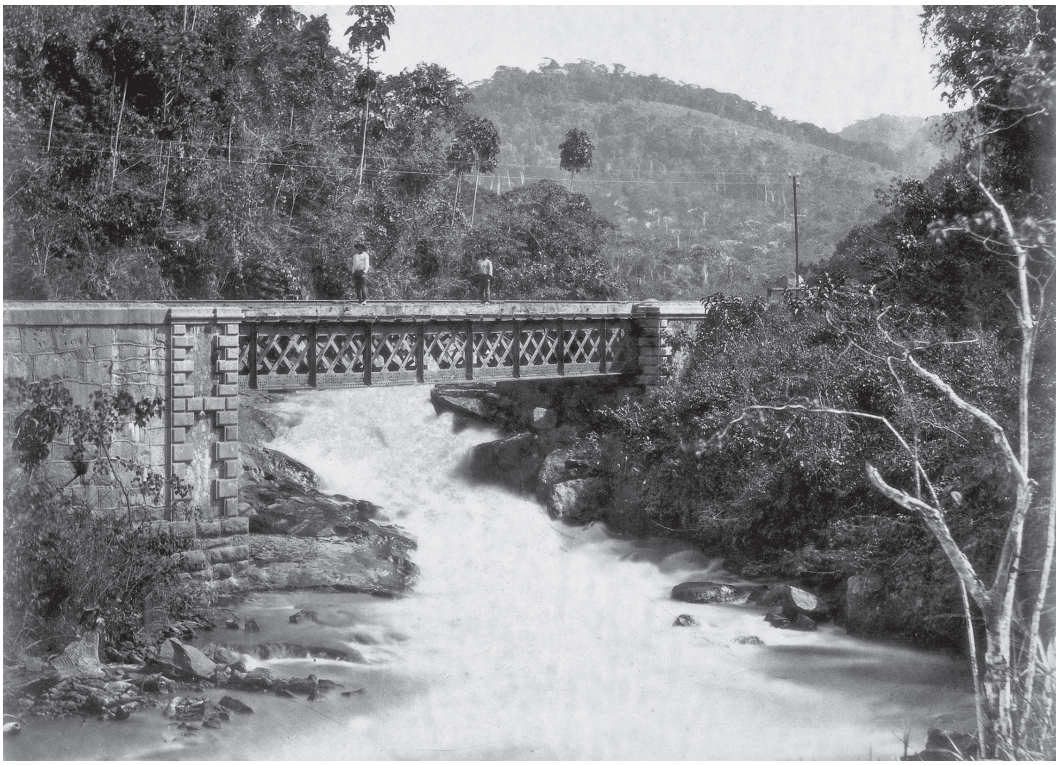

Figure 11: Author unknown, *Estrada de Ferro Dom Pedro 2: Linha Central: ponte n.2 da Cachoeira, Cachoeira do Inferno: quilômetro 263,720* (1881); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 12: Marc Ferrez, *Estrada de Ferro de Paranaguá a Curitiba: Província do Paraná: túnel n.7 do Pico do Diabo* [1880-1884]; colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 13: Marc Ferrez, "Allée des palmiers au Jardin Botanique", *Album de vues du Brésil* (Rio Branco, 1889); print (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 14: Marc Ferrez, *Minas and Rio Railway: Ponte sobre o rio Verde, km 74* (1882); colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 15: Marc Ferrez, *Estrada de Ferro de Paranaguá a Curitiba: viaduto sobre o rio São João k.[m] 62,210* (1884); colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 16: Marc Ferrez, *Minas and Rio Railway-Brazil: aterro grande 9 K[m] 800* (1881-1884); colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 17: Marc Ferrez, *Estrada de Ferro de Paranaguá a Curitiba: vista geral da linha, tirado do k.[m] 63* (1884); colloid, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)

Figure 18: Marc Ferrez, *Estrada de Ferro do Corcovado: Pont du Sylvestre: rampe 25%* (ca. 1884); albumen print on paper, black and white (Coleção Thereza Christina Maria, Biblioteca Nacional)