

œuvre - sa personnalité,' *Revue scientifique* (1917), **25**, 769-779.

6. See *L'enseignement supérieur devant le Sénat, discussion extraite du 'Moniteur' avec préface et pièces à l'appui*, J. Hetzel, Paris, 1868.

7. For example, the clergy denounced Naquet who, in a lecture, had claimed that the body was an accumulation of atoms and compared man with a battery, movement and thinking being caused by electricity. See Jean-Paul Chabaud, *Alfred Naquet, 1834-1916 : parlementaire comtadin, père du divorce*. Études comtadines, Mazan, 2002. (Annexe 6).

8. H. de Castelnaud, 'Chroniques médico-pharmaceutique,' *Moniteur scientifique (Paris)* (1868), 2nd semestre, 581-583.

9. Alfred Naquet, 'Le dernier ouvrage sur Charles Gerhardt,' *Moniteur scientifique* (1900), 785-796.

10. AN: AJ16/6566, Rapport de Wurtz au conseil académique pour l'année 1871-1872.

11. Charles Hermite, 'Lettres de Charles Hermite à Gösta Mittag-Leffler (1874-1883),' *Cahiers du séminaire d'histoire des mathématiques* (1984), **5**, 70. (Lettre du 5 avril 1880) [on-line: http://numdam.org/item?id=CSHM_1984_5_49_0, accessed 15 December 2006].

12. Gautier, *op. cit.* (5); 'Les médecins du dictionnaire encyclopédique des sciences médicales' de Dechambre, **5**, 2^{ème} série, 605.

13. Natalie Pigeard, 'Chemistry for women in nineteenth-century France,' in *Communicating Chemistry* (ed. A. Lundgren and B. Bensaude-Vincent), Science History Publications, Canton MA, 2000, 311-327.

14. He mentions the need to increase the number of physicians, and of allowing certain women to abandon their social condition with dignity, but that is all we can know about his position on this question.

15. AN: AJ16/6255, procès verbal de l'assemblée des professeurs du 1 septembre 1870.

16. *Journal de médecine et de chirurgie pratiques*, avril 1871, article 9080, 190. Please give the bibliographic reference in full.

17. Paris, Arch. pref. police: BA 1300 dossier Wurtz. Rapport du 7 mai 1875.

18. Paris, Arch. pref. police: BA 1300 dossier Wurtz. Rapport de 1876.

19. Strasburg, Bibliothèque Nationale et Universitaire de Strasbourg: MS 5983. Letter from Wurtz to Scheurer-Kestner, 20 January 1880.

20. Paris, Arch. pref. police: BA 1300 dossier Wurtz. Rapport du 4 octobre 1872 :

'M Wurtz, for six years Dean of the Faculty of Medicine, is highly regarded and respected by his students. However, this respect is based on his scientific worth rather than on his role as Dean of the school. We know that he does not pay particular attention to the interests of the students. It is the secretary to the Faculty, a creature of the Empire, who is the true administrator. In case of trouble at the Faculty, Mr. Wurtz lacks resolution and always tries to reconcile the students and professors involved. This conciliating but nevertheless hesitating spirit led some to suppose him a Bonapartist during the final years of the Empire. But it is almost sure that Mr. Wurtz, above all a man of science, does not really know what his political opinions are.'

21. In fact from 1856 to 1865 Wurtz published, in the *Comptes rendus hebdomadaires de l'Académie de sciences*, *Annales de chimie et de physique* and *Bulletin de la Société chimique de Paris* (c. 1858), 105 articles, that is ten articles per year on average. From 1866 to 1875, this output decreased to six articles per year.

Spaces and collections in the portrayal of the chemist José Júlio Bettencourt Rodrigues

Ana Cardoso de Matos

This chapter aims at portraying José Júlio Bettencourt Rodrigues (1843-1893), professor of chemistry at the Lisbon Polytechnic School, by cross-checking information obtained from documentary and material sources; archives, the space of the *Laboratorio Chimico* and the chemistry collections kept by the Museum of Science of the University of Lisbon (MCUL). Despite the difficulties such an approach might pose, namely the fact that these collections have not yet been wholly catalogued, it is worth attempting a convergence of 'words' and 'objects.'¹

In the last decades of the twentieth century, interest in scientific and technical heritage derived directly from new trends in the history of science and technology, which began to value the material culture² of scientific and technological research and teaching, in particular the role of instruments in the shaping and development of experimental practices, and of the relationships between science and industry.³

In today's society, discussions on the pros and cons of technological development, and the need to involve the public in political and social options – which requires an understanding of the role of science and technology in society – have led to a wider concern with scientific teaching.⁴ Since the last decades of the twentieth century, scientific and educational policies in the USA and in the majority of European countries have been paying particular attention to the public understanding of science. In Portugal, the need 'to break from scientific isolation,' essential 'to the creation of a scientific country,' together with need to engage the public with science and technology became part of governments' agendas.⁵

The construction of a scientific culture entails an understanding of scientific and technical evolution, for which venues and objects associated with the production of science and technology are essential elements. The preservation of scientific,

technological and industrial heritage and its communication take on a key role in the (re)construction of the scientific and technical memory. Furthermore, the fact of a museum of science, technology and industry being *'en soi un artefact, témoin de l'environnement matériel et intellectuel qui l'a vu naître'*⁶ makes these museums also important to the history of science and technology.

Today, the museum of science and technology is not the only place to obtain information on the past, but it has become a place of awareness and construction of a present day scientific and technical culture. In this context, the museum that exhibits scientific and technological heritage *'n'est plus uniquement un lieu d'information historique tourné vers le passé, mais il devient un lieu d'acquisition et d'élaboration d'une culture scientifique et technique actuelle.'*⁷ The role that museums started to play in the construction of a scientific culture⁸ has entailed a re-thinking of not only the way scientific and technical artefacts are displayed and presented in museums, but also the social and cultural role of scientific and technical museums and of 'science centres' in today's society.⁹

With the increasing importance of material culture as a source in the history of science and technology, and in understanding the past, new museological perspectives began to assign greater importance to the 'musealisation' of spaces of scientific, technical and industrial production.

The laboratories devoted to fundamental research, teaching, and industry were, and still are, privileged sites of scientific and educational endeavour, and fundamental to the improvement of industrial processes and the development of new industrial areas. However, it is rare to find a nineteenth-century laboratory that has been kept nearly unaltered. This is why the *Laboratorio Chimico* of the Polytechnic School of Lisbon is highly relevant: virtually unchanged since its renovation in 1890, it has been recently restored and integrated into a museum, gaining a prominent place in the international scientific and technical heritage.¹⁰

As part of an institution for higher education, the *Laboratorio Chimico* played an important role in the teaching of chemistry. The way in which the space was organised, together with the process of acquisition of its collection of instruments and reagents, unveils the methods used for teaching chemistry and how they evolved, in the second half of the nineteenth century.¹¹ However, the laboratory was not solely used for teaching purposes. Material evidence points to the fact that various research projects were undertaken in its premises, in particular on specific industrial products, as well as analyses to ascertain the quality of water.¹²

The renovation of the laboratory, in 1890, was closely associated with Rodrigues. Thanks to his various visits to foreign laboratories, he was aware of the requirements a laboratory should fulfil in order to provide appropriate teaching. The renovation was carried out according to the highest standards, including the use of electricity then expanding and whose advantages Rodrigues knew well.

Rodrigues was an advocate of experimental teaching and of the applications of science to economic development and to the promotion of standards of living. He combined teaching duties at the Lisbon Polytechnic with industrial ventures and research on the development of new photographic processes,¹³ as well as with positions in administration and politics.¹⁴ Material evidence of his scientific and technical endeavours can be found in the collections and historical archive of the MCUL.

José Júlio Bettencourt Rodrigues: a chemist with a diversified career

After graduating in mathematics and philosophy at the University of Coimbra,¹⁵ in 1868, Rodrigues was appointed teacher of physics and chemistry, and natural history in a Lisbon *lycée*, and substitute-lecturer for António Augusto de Aguiar of the 6th chair – Inorganic Chemistry – at the Lisbon Polytechnic School.¹⁶ In these schools he introduced teaching methods based on experiment and passed on to the following generations the view that applied science was essential to the development of economy and to people's welfare.

As a member of the *Academia Real das Ciências de Lisboa* (Royal Academy of Sciences of Lisbon), he released various articles in the *Jornal de Ciências Matemáticas, Físicas e Naturais* (Journal of Mathematical, Physical and Natural Sciences), published under the auspices of the Academy.¹⁷ As a distinguished member of the *Sociedade de Geografia Lisboa* (Lisbon Geographical Society), in which he played a key role in the Central Council and in the Permanent Central Commission for Geography,¹⁸ José Júlio Rodrigues contributed towards knowledge on the Portuguese African colonies and the exploitation of their natural resources.¹⁹

The acknowledgement of his scientific reputation by the Portuguese government was pivotal to his nomination to lead the Photography Section of the *Direcção-Geral dos Trabalhos Geodésicos* (General Directorate of Geodesic Works, DGTGGP), in 1872²⁰. In 1876, together with the Marquis de Sousa Holstein, he was entrusted with the organisation of the service for scientific, literary and artistic exchange between Portugal and other countries. Subsequently, he took on other roles, as President of the *Conselho do Mercado Central de Produtos Agrícola* (Council for the Central Market of Agricultural Produce),²¹ and as technical inspector of indirect taxes.²²

He joined Parliament in 1890, following his election to the constituency of Madeira.²³ In the parliamentary chamber, he advocated the interests of the region, by proposing measures such as the establishment of better communications for the inner part of the island.²⁴

In order to disseminate scientific knowledge, José Júlio Rodrigues organised scientific and teaching lectures, like many of his fellow intellectuals. The majority of these lectures took place not only in learned societies to which he belonged – such as the Royal Academy of Sciences of Lisbon or the Lisbon Geographic Society – but also in associations encouraging trade, industry and agriculture, such as the *Associação Comercial de Lisboa* (Commercial Association of Lisbon) or the *Real Associação de Agricultura Portuguesa* (Royal Portuguese Agricultural Association). In order to reach wider and more heterogeneous audiences, he also organised lectures in venues normally used for leisure, such as the *Teatro do Príncipe Real* (The Prince Royal Theatre), the *Teatro de D. Maria* (D. Maria Theatre) or the *Teatro da Trindade* (Trindade Theatre)²⁵, and published in the *Colecção Biblioteca do Povo e das Escolas* (Library Collection for People and the Schools).²⁶

The renovation of the *Laboratorio Chimico*: a space for experimental teaching

José Júlio Rodrigues firmly advocated the experimental teaching of chemistry and of its applications, as he voiced, in 1890, in a Parliamentary speech:²⁷

Our country is one of the few where modern science is taught in higher education through textbooks written in foreign languages, generally French. [...] Amongst the most important and pressing measures that our new Minister of Education should adopt, compulsory practical teaching with absolutely mandatory attendance is in my view one of the most urgent. Without this kind of teaching we may have an abundance of good graduates—excellent for somewhat philosophic explanations—but we will lack technicians in factories and workshops. After all, Science is a flair for work, wealth and fortune.

When Rodrigues took on the professorship of Inorganic Chemistry at the Lisbon Polytechnic, one of his main concerns became the modernisation of the *Laboratorio Chimico*, which was then outdated in comparison with similar foreign laboratories. Thanks to his intervention, the laboratory underwent major alterations. From the gallery 'intended for the practical course',²⁸ which was then built, the students could follow the experiments being carried out in the main room where teachers, assistants and students worked.²⁹

The way in which Rodrigues organised the laboratory was perhaps influenced by visits to foreign laboratories and his contacts with chemists in Germany and France. As he was also entrusted the organisation of the toxicological service in Portugal, Rodrigues commissioned August von Hofmann (1818-1892) and the Portuguese ambassador in Berlin, the Marquis of Penafiel, to find a toxicologist whom he intended to contract and urged the government to establish a competent laboratory.³⁰ The renovation of the *Laboratorio Chimico* was praised by Hofmann,³¹ who visited Lisbon in 1890, probably following this commission.

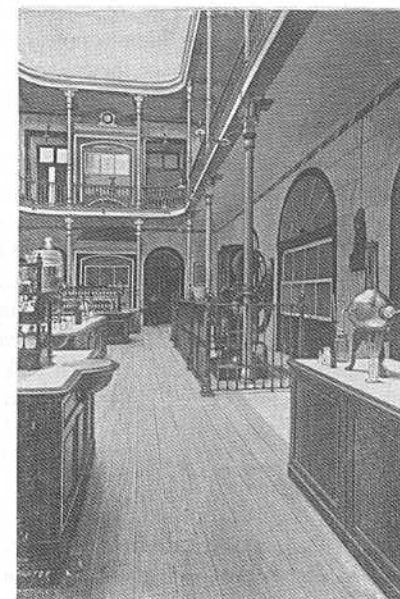
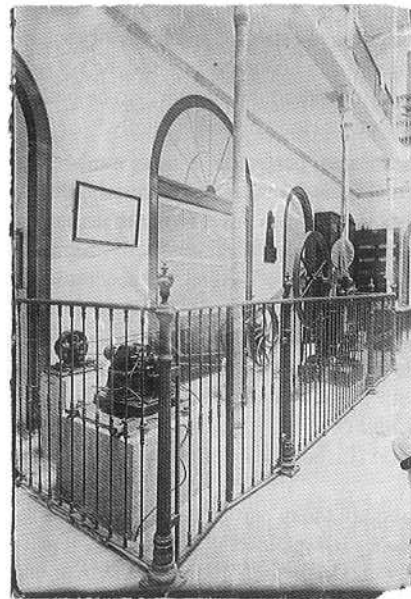
In order to publicise the modernisation which had taken place in the *Laboratorio Chimico*, Rodrigues sent four plates of the laboratory, which he described as 'galvanoplastic reproductions of four wood-cut images, made in the workshops of the Royal Mint'³² to the magazine *O Occidente*, in January 1891. These plates were part of a collection which, together with various drawings and upright projections, was to feature in a small booklet that the chemist was writing with the purpose of making the Polytechnic School and its laboratory known abroad.³³ On 21 May of the same year, *O Occidente* published four more plates; two of the lecture theatre, and two of the laboratory.³⁴

Electricity and gas in the renovation of the laboratory

With the renovation of 1890, the chemistry laboratory started to use electric light, supplied from a dynamo ordered from the *Société Anonyme d'Électricité de Paris*³⁵, and gas supplied by the *Companhia do Gás de Lisboa* (Lisbon Gas Company).

The introduction of electricity in the laboratory is striking because its use was not yet widespread in Portugal, and the network was limited to a small area of Lisbon, but Rodrigues' innovation probably derived from his experience at the Photographic Section of the *Direcção-Geral dos Trabalhos Geodésicos*, which he headed. Thanks to him, the Photographic Section had been equipped with a Gramme dynamo,³⁶ in 1872, which was driven by a vertical steam engine constructed by the workshops *Leleu et Clavier de Paris*.³⁷ This dynamo was among the first to be installed in the country. Rodrigues' acquaintance with this kind of equipment resulted from his travels abroad, namely to Paris,³⁸ during the establishment of the Photographic Section of the *Direcção-Geral dos Trabalhos Geodésicos*, although a demonstration of the Gramme dynamo³⁹ had taken place in 1871 at the Royal Academy of Sciences⁴⁰, of which he was a member.

The dynamo introduced in the chemistry laboratory has not survived, but the photographs kept in the MCUL archive and the plates published in *O Occidente* vouch for its existence (FIGURES 1 and 2) as well as of gas equipment, which together with electric lamps are now part of the collection of the museum.⁴¹



FIGURES 1 and 2. Photo and engraving from the *Laboratorio Chimico*, both dated 1891 (respectively MCUL Historical Archive and *O Occidente*, XIV, 447, 1891, 117).

In order to supply gas to the *Laboratorio Chimico*, Rodrigues requested the Lisbon Gas Company⁴² for a plan of the pipe network,⁴³ which was then being constructed, and decided to connect the building with it. Once again, the installation of gas in the laboratory benefited from Rodrigues' experience as head of the Photographic

Section of the *Direcção-Geral dos Trabalhos Geodésicos*, where gas was in current use, and the experiments he had carried out back in 1873, on behalf of the *Câmara Municipal de Lisboa*⁴⁴ (Lisbon Municipality), aimed at deciding which photometer should be adopted to measure the light power of the gas supplied by the *Companhia Lisbonense de Iluminação a Gás* (Gas Light Company of Lisbon).

Leaflets about gas and electric lamps which were then fitted in the laboratory are today part of the MCUL's historical archive, and various gas taps and other material evidence remain in the Museum's collection.

The *Laboratorio Chimico* and the development of new industrial ventures

In the second half of the nineteenth century, a significant increase in the publication of monographic works, magazines and newspapers⁴⁵ resulted in a larger consumption of printing press ink, which up to the 1880s was mainly produced in France and Germany. The need to import printing press ink had rendered Portugal dependent on the vagaries of international trade and made journalistic ventures difficult. Rodrigues saw this situation as an incentive to establish an ink factory whose raw materials would rely on the natural resources of the country. In 1881, he set up a 'very small laboratory', which 'was simply a pilot for the future factory' to be built in Lisbon, under the company Rodrigues & Rodrigues, belonging to his family.⁴⁶

In this factory Rodrigues developed and perfected a new method for producing printing press inks, in which he used various domestic raw materials. During the first months of 1882, he carried out several experiments to this end, which demanded great effort of him: 'To such a hard task I had to combine my teaching activities at the Polytechnic School, the *lycée* and the Industrial Institute of Lisbon, all accumulating with the management of the business of the *Rodrigues & Rodrigues* firm.'⁴⁷

In 1888, at the *Exposição Nacional das Indústrias Fabris* (National Exhibition of Manufacturing Industries) which took place in Lisbon, Rodrigues presented the inks manufactured in his factory together with the raw materials that he used in its production: resin from *Real Fábrica da Marinha Grande* (Royal Factory of Marinha Grande), tar from *Companhia de Gás de Lisboa* (Lisbon Gas Company), and mineral oil from England.⁴⁸

The flasks displayed in this exhibition are today part of the collection of the *Laboratorio Chimico* at the MCUL. Their presence is explained by both the fact that his factory closed down soon afterwards, probably due to the importation of German inks at more competitive prices, and as a demonstration to his students of the potential of an industry mainly based on national raw materials. A bottle labelled, 'Thick resin oil used in the manufacture of normal typographic ink. Odourless. Obtained by dry distillation of Marinha Grande resin. José Júlio Rodrigues process' (FIGURE 3), and various other bottles containing different oils also obtained from Marinha Grande resin (FIGURE 4) are examples of items now on display at the MCUL.



FIGURES 3 and 4. Flasks and bottles from the *Laboratorio Chimico*'s collection (photos C. Tavares, courtesy MCUL).

The concern over making new agricultural businesses more profitable – those that would be susceptible to adapting to the Portuguese climate and soil characteristics – sparked in Rodrigues an interest in the possibility of producing sugar from sugar beet grown on mainland Portugal. With this purpose in mind, he initiated in the *Laboratorio Chimico* a series of experiments towards obtaining sugar from beet, following his return from a journey around Europe, in July 1888. Rodrigues set up 'a small office of saccharimetric studies,' led by Charles Lepierre,⁴⁹ 'a young chemist of great merit who assists me at the *Instituto Industrial e Comercial de Lisboa* (Industrial and Commercial Institute of Lisbon).'⁵⁰ The sugar beet tested in these experiments had been produced from seeds imported to Portugal by the end of 1887, which had been handed over to several farmers willing to participate.

The positive results obtained from these experiments led Rodrigues to associate with Joseph Görz in the establishment of a company to produce sugar-beet sugar, an initiative that met with a good reception from the government. On 13 August 1888, a provisional contract for the introduction and development of the manufacture of sugar from sugar beet on mainland Portugal was signed between these two businessmen and the government.⁵¹

It is possible that vestiges of the apparatuses used by Rodrigues in these experiments are kept at MCUL, but the fact that many pieces have yet to be catalogued prevents definitive claims.

Photography in the *Laboratorio Chimico*

Throughout his life, Rodrigues had always shown great interest in photography, which led him to develop new photographic processes in the Photography Section of the *Direcção-Geral dos Trabalhos Geodésicos*. While setting up this section, Rodrigues travelled abroad on various occasions, namely to Paris,⁵² and developed a series of studies and experiments focussing on the reproduction of images. As he mentioned:⁵³

In the few months which I devoted to the experimental study of photography, I was compelled to test what would best suit the purpose I had set out to achieve. I am pleased to have been persuaded that the system that I adopted and that is now used at the Photographic Section is, of all that I know, the simplest, the most reliable and the cheapest.

In this context, he developed a photolithographic process, 'essentially Portuguese,' considering that he was the first to establish 'on a secure basis the use of metallic, very thin blades, which worked excellently in various methods of photo-chemical printing.'⁵⁴ Rodrigues also developed methods of reproducing geographical maps and images through photography, by using rubber and stamping with printing press inks⁵⁵.

The importance of his work in photography and printing was internationally acknowledged. In 1879, the French publisher Gauthier-Villars – who had published a series of books on photography – published Rodrigues' book titled, *Procédés photographiques et méthodes divers d'impressions aux encres grasses*.

The quality of his work was further acknowledged in the exhibitions of the French Society of Photography, in 1874 and 1876, the 1876 Philadelphia World Exhibition, and the International Congress of Geographical Sciences held in Paris, in 1875. For this reason, journals such as the Parisian *Moniteur de la Photographie*, the *Bulletin de la Société Française de Photographie*, and the Viennese *Photographische Correspondenz* requested from him prints to include in their publications.⁵⁶

Rodrigues' interest in photography also materialised in the area he allocated to photography, in the renovated *Laboratorio Chimico*, beneath the seats of the amphitheatre (FIGURE 5).

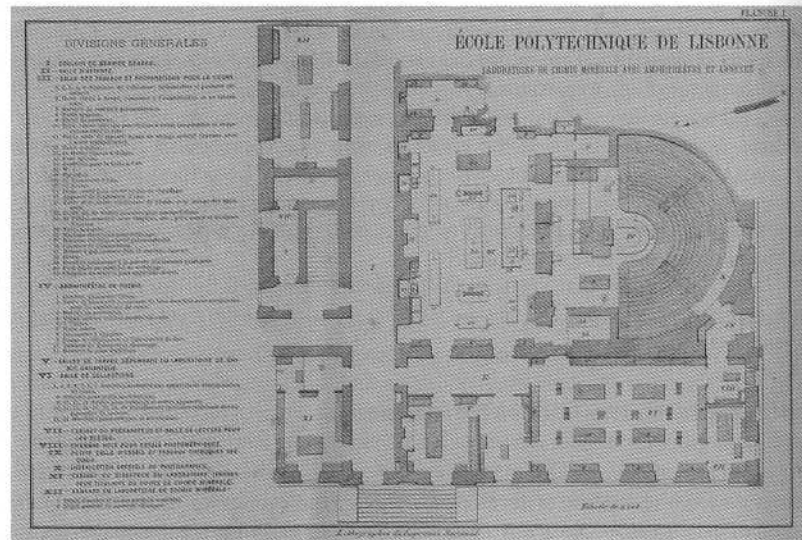


FIGURE 5. Floor plan of the *Laboratorio Chimico* of the Lisbon Polytechnic School (1890). The *Installation Spécial de Photographie* is indicated as 'X' in the caption.

The photographs of the laboratory and amphitheatre in the historical archives of the MCUL and referred to, in 1891, in the magazine, *O Occidente* as 'copies of photographs taken by the technical staff of the 6th chair'⁵⁷ (Chemistry chair at the Lisbon Polytechnic), are material evidence of his endeavours in this realm (FIGURE 1). Other material evidence of photography as practised at the Polytechnic School is the cameras and archival material kept in the MCUL collections. However, a comparison of these cameras with adverts and leaflets brought from his firm is still required to determine which cameras were used by Rodrigues (FIGURES 6 and 7).



FIGURE 6. Advertisement for the firm Rodrigues & Rodrigues, published in several issues of the newspaper *O Interesse Público*.

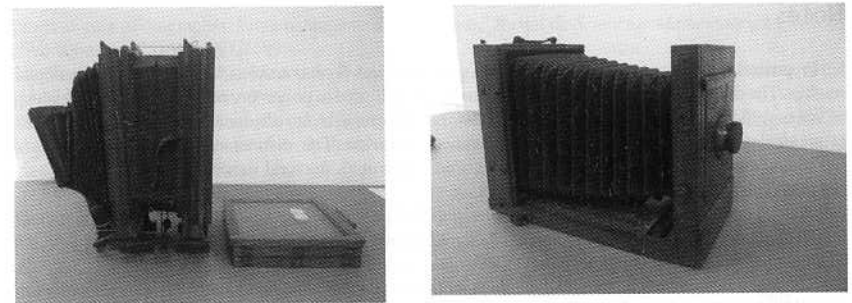


FIGURE 7. Two cameras from the Museum of Science collection, respectively MCUL222 and MCUL1283 (photos by F. Veiga, courtesy MCUL).

Rodrigues' expertise in photography and in advancing printing methods probably led his family firm Rodrigues & Rodrigues to specialise in import/export associated with these areas.

Conclusion

A man of science, Rodrigues combined scientific work with an active participation in politics, administration and the economy of the country. He played a key

role in technical teaching, both at the Industrial Institute and the Lisbon Polytechnic School, where he renovated the *Laboratorio Chimico* and introduced new teaching methods.

In addition to written sources, historians now have at their disposal material evidence for Rodrigues' multiple activities in the *Laboratorio Chimico* of the Lisbon Polytechnic School and its collections, and by cross-checking information obtained from documentary sources, spaces and material objects a more refined portrayal of the chemist emerges.

Although spaces like the *Laboratorio Chimico* together with its collections of documents, instruments and reagents are no longer used in modern scientific teaching and research, they are an archive of the past. As such, they are important tools in understanding the evolution of science and can play an important role in both historical and scientific teaching and research.⁵⁸

The preservation and display of spaces and objects associated with past scientific production are fundamental tools in the construction of a scientific culture and in awakening public awareness and engagement with science. The musealisation of the *Laboratorio Chimico*, and the ongoing inventory, classification and study of its collections are essential to the preservation of local scientific and technical heritage, but its relevance transcends Portuguese national borders.⁵⁹

Acknowledgements

I wish to express my gratitude to Ana Carneiro for her comments and suggestions.

Notes

1. 'In general, historians mainly work with words. They use books, articles, letters, and other archival sources. The divorce between "words" and "object" is not limited to university collections or to the history of science.' M.C. Lourenço, *Entre deux mondes. La spécificité et le rôle contemporain des collections et musées des universités en Europe* (Between two worlds. The distinct nature and contemporary significance of university museums and collections in Europe), doctoral thesis, *Conservatoire national des arts et métiers*, Paris, 2005.
2. Interest in material culture has led to the publication of various books on this topic, in which interdisciplinary investigations are presented. See M. P. Julien and C. Rosselin, *La culture matérielle*, La Découverte, Paris, 2005.
3. P. Brenni, 'L'importance des instruments scientifiques comme témoignages matériels de l'histoire des sciences et des techniques,' in *Le Patrimoine Scientifique et Technique Contemporain* (ed. C. Cuenca and Y. Thomas), L'Harmattan, Paris, 2005, 32. Prior to these recent trends in the history of science, scientific instruments were usually considered as accessories to intellectual work and their preservation was justified by their rarity or shape. *Ibid.*, 31-33.
4. D. Thoulouze, 'Pour une véritable culture scientifique et technique,' *La Revue. Musée des arts et métiers*, (2005), 43/44, 9; E. H. Koster, 'Vers une éducation scientifique et technique permanente' in *La révolution de la muséologie des Sciences* (ed. B. Schiele and E. H. Koster), PUL, Paris, 1998, 141-157; B. Schroeder-Gufehus, 'Problématique,' in *La Société industrielle et ses musées. Demande sociale et choix politiques 1890-1990* (ed. Brigitte Schroeder-Gufehus), Éditions des Archives Contemporaines, Paris, 1992, 13-15.
5. J. M. Gago, *Manifesto para a ciência em Portugal. Ensaio*, Gradiva, Lisbon, 1990, 101.
6. Schroeder-Gufehus, 'Problématique,' in Schroeder-Gufehus, *op. cit.* (4), 13-14.
7. Thoulouze, *op. cit.* (4), 8.
8. A. Delicado, 'Os museus e a promoção da cultura científica em Portugal,' *Sociologia, Problemas e Práticas* (2006), 51, 53-72.

9. F. B. Gil, 'Museus de ciência. Preparação do futuro, memória do passado' in *Colóquio /Ciência* (1988), 3; CNAM, *Actes du Colloque: Les Arts et Métiers en Révolution. Renaissance d'un Musée*, CNAM, Paris, 1993; B. Schroeder-Gufehus (ed.), *La Société industrielle et ses musées. Demande sociale et choix politiques 1890-1990*. Éditions des Archives Contemporaines, Paris, 1992; B. Schiele and E. H. Koster (eds), *La révolution de la muséologie des Sciences*, PUL, Paris, 1998; *Museums of Science and Technology, Lisboa* (coordinated by M. A. A. Ferreira and J. F. Rodrigues), Fundação Oriente, Lisbon, 1998.
10. Regarding the historical importance of this laboratory and its recuperation, see F. B. Gil, *Museu da Ciência da Universidade de Lisboa. Das origens ao Pleno reconhecimento Oficial*, Museu de Ciência da Universidade de Lisboa, Lisbon, 2003; G. Santa-Barbara and V. Leitão, 'O Laboratório Chimico da Escola Politécnica de Lisboa (1857-1890; 1998-2006),' *Boletim da Sociedade Portuguesa de Química* (2006), 201, 45-54.
11. The importance of the university collections and museums led to the creation of an International Committee of the ICOM, the UMAC.
12. In the classification of university museums proposed by Marta Lourenço, this museum can be considered a 'historical teaching and research collection: collections of historical instruments, other equipment and specimens formerly used for teaching and research that were organised in collections after becoming obsolete.' M. C. Lourenço, *Between Two Worlds. The distinct nature and contemporary significance of university museums and collections in Europe*, CNAM, Paris, 2005, 34 (unpublished).
13. It was precisely because he believed that certain men reflect an era that Bruno Jacomy chose to write a history of the techniques based on three key aspects – a panorama, an object, a man – for the various historical periods. B. Jacomy, *Une histoire des techniques*, Éditions du Seuil, Paris, 1990, 11.
14. Regarding Rodrigues' diverse career, see A. Cardoso de Matos, 'Entre o laboratório, a indústria e a intervenção política e administrativa. O químico José Júlio Rodrigues na sociedade portuguesa da 2ª metade do século XIX' in José Vicente Serrão, Magda de Avelar Pinheiro e M. de Fátima Sá Melo Ferreira (org), *Desenvolvimento Económico e Mudança Social. Portugal nos últimos dois séculos. Homenagem a Miriam Halpern Pereira*, Lisboa, ICS, 2009, 173-189.
15. José Júlio Rodrigues was born to a Madeira family on 8 May 1843.
16. In 1887, with the death of António Augusto de Aguiar, he became the professor holding this chair.
17. See 'Processo fácil para tornar mais suaves os contrastes, que geralmente caracterizam as copias de pinturas pela photographia. Envernizamento das estampas,' *Jornal de Sciencias Mathematicas, Phisicas e Naturaes*, (1875) V - XVIII, 99.
18. He was appointed to this council on 3 April 1875 together with the geologist Carlos Ribeiro and the geographer Gerardo Augusto Pery.
19. He published various works on African expeditions. See, for example, José Júlio Rodrigues, *Les colonies Portugaises. Extrait des Bulletins de la Société Royale de Géographie d'Anvers*. Imprensa Nacional, Lisbon, 1888.
20. *Rapport sur les Travaux Géodésiques, Topographiques, Hydrographiques et Géologiques du Portugal*, Lisbon, 1878, 7.
21. José Júlio Rodrigues was appointed to this position in 1888 and presided over it until 1892.
22. In 1890, in this capacity he was entrusted with an inquiry into the industry of producing alcohol, which he carried out in Madeira and Azores.
23. Regarding his parliamentary activity, see F. Figueiredo, 'Rodrigues, José Júlio (1843?-1893)' in *Dicionário Biográfico Parlamentar 1834-1910* (coord. M. F. Mónica), ICS/ Assembleia da República, Lisbon, 2006, vol. III, 490-492.
24. For example, the law on the exploration and construction of a railway on the island of Madeira, from the city of Funchal to the north of the island, dates back to 1891. *Diário da Câmara dos Deputados*, 4 March 1892, session 37.
25. J.J. Rodrigues, *Simple Apontamentos de Alguns Trabalhos e Serviços, durante 28 anos de vida pública*, Tip. da Academia Real das Ciências, Lisbon, 1892, 10.
26. This small size and low cost collection was aimed at a large audience. Some books by José Júlio Rodrigues were published in this collection, including *Lisboa e a Cholera*, Lisbon, 1884.
27. *Diário da Câmara de Deputados*, 10 May 1890, session 168.
28. *O Occidente*, 14º Ano, no. 434, 11 January 1891, 13.
29. A. L. Janeira, 'A Escola Politécnica de Lisboa (1837-1911). Organização do espaço, produção do discurso e sistema epistémico,' in *O Laboratório de Química Mineral da Escola Politécnica de Lisboa (1884-1894)* (ed. A. L. Janeira, M.L. Maia and P. Pereira), Escolar Editora, Lisbon, 1996, 29-51; M. L.

- Alves, 'O Curso prático no ano lectivo de 1889-1890,' in *ibid.*, 69-84.
30. *Diário da Câmara dos Deputados*, 16 June 1891, session 10.
31. *O Occidente*, 14^o Ano, no. 434, 11 January 1891, 13.
32. *Ibid.*, 12.
33. *Ibid.*
34. *O Occidente*, 14^o Ano, no. 447, 21 May 1891, 113 and 116.
35. In the MCUL archive there is an invoice from the *Société Anonyme d'Électricité – Éclairage Électrique* for two dynamos, one rheostat, one switch, lamps, portable candelabra, and two porcelain lamp shades. M. da G. I. Ramalho, *Contributo para a Recuperação e Integração Museológica do Laboratório e Amphiteatro de Química da Escola Politécnica de Lisboa*, FCSH-UNL, Lisbon, 2001 (unpublished).
36. This machine had the following dimensions: width 0.60 m x 0.75 m; height 0.64 m. Its normal speed was 1160 rotations per minute.
37. José Júlio Rodrigues, *A Secção Photographica ou Artística da Direcção Geral dos Trabalhos Geodésicos no dia 1 de Dezembro de 1876*, *Notícia*, Tip. da Academia Real das Ciências, Lisbon, 1876, 17-18.
38. H. G. Mendes, 'As origens da Comissão de Cartografia e a Acção Determinante de José Júlio Rodrigues, Luciano Cordeiro e Francisco António de Brito Limpo,' *Revista do Instituto Geográfico e Cadastral* (1982), 2, 32.
39. This dynamo, patented by Zénobe Gramme (1826-1901) in 1870, began to be manufactured in 1871 by the factory owned by the *Société des Machines Magnéto-électriques Gramme*. This factory resulted from the association of Z. Gramme with the engineer Hippolyte Fontaine.
40. The Gramme dynamo was demonstrated to this Academy by the French physicist Jules Célestin Jamin (1818-1886), then professor at the Polytechnic School of Paris.
41. The study of this collection is fundamental to the understanding of the laboratory space, for its 'musealisation,' and for the exhibitions that may be held about this museum in the future. See P. P. Medeiros, 'A coleção do Laboratório Chimico da Escola Politécnica de Lisboa. Novas perspectivas,' *Boletim da Sociedade Portuguesa de Química* (2006), 103, 71-74.
42. This company was established in 1887. In 1891, it merged with *Companhia Lisbonense de Iluminação a Gás*, resulting in *Companhias Reunidas de Gás e Electricidade* (CRGE).
43. Ramalho, *op. cit.*, 43.
44. Agostinho Vicente Lourenço and António Augusto de Aguiar were also members of this commission. The three professors of the Lisbon Polytechnic pronounced themselves in favour of the photometer of Dumas and Regnault.
45. Rodrigues recognised that: 'The passion for reading has only recently developed in Portugal and prior to 1860 not even half of the amount [of printing press ink] mentioned was used in the Portuguese regions.' José Júlio Rodrigues, *A Fábrica Nacional de Tintas de Imprensa. Contribuição para a História da Indústria em Portugal. Descrição, Notícia e Comentários*, Tipografia Universal, Lisbon, 1884, 11.
46. *Ibid.*, 27. In 1888, the annual production of black printing press ink from this factory reached 26,000 Kg and was all sent to mainland Portugal, Madeira, the Azores and Brazil, but the factory closed soon after.
47. Rodrigues, *op. cit.* (45), 90-91.
48. Associação Industrial Portuguesa, *Catálogo da Exposição Nacional das Indústrias Fabris realizada na Av. da Liberdade em 1888*, Lisbon, 1889. Vol. III, 917.
49. Charles Lepierre was born in Paris in 1867, and in 1887 he graduated in engineering from the *École de Physique et de Chimie Industrielles*. Upon the recommendation of Roberto Duarte Silva, who had lectured him chemistry in Paris, he was contracted by the Portuguese government as chief laboratory assistant at the Polytechnic School of Lisbon and at the *Instituto Industrial de Lisboa* (Industrial Institute of Lisbon). He arrived in Portugal in 1888.
50. José Júlio Rodrigues, *O Assucar Portuguez da Beterraba. Episódios de uma indústria no seu periodo de gestação*, Tip. Universal, Lisbon, 1889, 70.
51. According to the conditions specified in this contract, the grantees committed to setting up a company with an effective capital of 500,000 pounds sterling. However, nothing can be said as to whether or not the company was ever actually created.
52. During this trip he visited the photographic service of the French War Museum. Mendes, *op. cit.* (38), 32.
53. Rodrigues, *op. cit.* (37), 30.

54. Direcção-Geral dos Trabalhos Geographicos Portuguezes. *Secção Photographica. Primeira Exposição Nacional inaugurada no dia 15 de Abril de 1875. Photographia applicada aos trabalhos geograficos. Processos de Impressão photographica com tintas gordas. Noticia abreviada*, Lisbon, 1875, 8.
55. The quality of the photographs in the Photographic Section of the DGTGGP was noticed at the Photography Exhibition organised by José Júlio Rodrigues at Convento de Jesus. F. M. Pereira da Silva, *Relatório do Anno de 1875. Direcção Geral dos Trabalhos Geodésicos, Topographicos, Hydrographicos e Geológicos do Reino*, Lisbon, 1876, 37.
56. *Ibid.*, 13.
57. *O Occidente*, 14^o Ano, no. 434, 11 January 1891, 13.
58. As mentioned by S. de Clercq and M. Lourenço, 'Collection-based research, together with teaching and research will hence doubtlessly continue to form a part of the triple mission of university museums.' S. de Clercq and M. Lourenço, 'A note on Museum Research,' *ICOM News*, (2004), 2, 8.
59. Hence, 'Now concentrating more on "narrative" displays of historically significant objects, these museums are perhaps less focused upon teaching and research, but more oriented to informing and attracting broader segments of the general public,' *Museologia* (2003), 3, 24.