Introduction
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Interest in the organization, preservation and public access of Brazilian collections of scientific instruments has been growing in recent years. Given its geographical scale, Brazil has surprisingly few museums of science and technology. The public understanding of science movement has been strong in Brazil since the 1990s but, like in so many other countries, its impact on museums and collections has been limited. Only recently has progress been made on this front, largely through the initiative of the Museu de Astronomia e Ciências Afins [Museum of Astronomy and Related Sciences] (MAST), and the collaborative partnerships it has established with multiple academic, scientific and cultural institutions, in Brazil and abroad.

The MAST opened to the public in 1985. It is a research institute pertaining to the Brazilian Ministry of Science, Technology and Innovation. One of its most important missions is to preserve its collections and heritage, especially the most remarkable, the collection of scientific instruments, which grants MAST a special role and identity as a museum of science and technology. The Museum is located on the campus of the old National Observatory and it occupies several historical buildings. The whole site, including the collections, is listed and preserved by Federal Law since 1986. MAST's main building houses the Museum's storage, which is open to the public and where part of the collection of historical scientific instruments is displayed.

The MAST holds one of the most important collections of scientific instruments in South America, with c. 2,000 objects. Around 1,600 instruments belonged to the former National Observatory of Brazil. They were used for research and services of great significance, such as the determination and
broadcasting of the official time in Brazil, forecasting the weather, the study of astronomical phenomena, the delimitation of Brazilian borders, the magnetic mapping of Brazilian soil, among others. Most instruments date to the nineteenth and early twentieth centuries, though some of the more aesthetically interesting pieces, such as the quadrant by J. Sisson and the G Adams theodolite, are from the 1700s. Many of the objects are connected to astronomy, topography, geodesics, geophysics, meteorology, weather and optical measurements. However, the collection also comprises other scientific areas, such as electricity, magnetism, mineral technology, nuclear engineering and chemistry. As a collection, it has always grown, albeit not always regularly.

Today, the MAST collection contains objects from multiple national research institutions. Its most recent accessions come from the Instituto de Engenharia Nuclear [Institute of Nuclear Engineering], the Centro de Tecnologia Mineral [Centre of Mineral Technology] and the Centro Brasileiro de Pesquisas Físicas [Brazilian Center for Physics Research], all also research institutes under the Brazilian Ministry of Science, Technology and Innovation. The collection is the target of a comprehensive preservation programme.

The MAST also preserves a major historical archive comprising manuscripts, iconography and other documentation from different scientific institutions in Brazil and from some of the country’s leading scientists. Finally, the Museum preserves outstanding in situ architectural heritage – functional buildings specially constructed for astronomical observations, whose design is typical of the turn of the twentieth century.

It was in this context that the MAST hosted the 31st edition of the Symposium of the Scientific Instrument Commission (IUHPS/DHST). The conference took place between 8 and 12 October 2012 and it included visits to important collections of scientific instruments in the state of Rio de Janeiro (MAST, Museu Nacional/UFRJ, Observatório do Valongo/UFRJ, Museu Histórico Nacional and Museu Imperial in Petrópolis). It was the first time a SIC Symposium was organized in the Southern hemisphere.

The conference was attended by 130 participants, particularly researchers and students from multiple institutions in Brazil and abroad. Sixty oral papers and 20 posters were presented. This volume results from a selection of these papers and posters. We are grateful to the members of the Scientific Committee who accompanied all the review process: David Pantalony (Canada Science and Technology Museum), Jim Bennett (Science Museum London), Paolo Brenni (Fondazione Scienze e Tecnica Florence/CNR), Peter Heering (University of Flensburg), Richard Kremer (Dartmouth University) and Silke Ackermann (Museum of the History of Science Oxford). More generally, we are grateful to the SIC international community for coming to Rio and the members of the SIC Board – Paolo Brenni, Sara Schechner and Hans Wooijmijers – for their commitment and support.

Papers and discussions addressed issues and challenges pertaining to research, interpretation, and promotion of scientific instruments, with emphasis on their use, trade, and transfer between Europe and the Americas. The book mirrors these topics, with 19 chapters organized in four sections: ‘Transfer of
Scientific Instruments between Europe and the Americas', 'Recent Heritage of Science', 'The Scientific Heritage of Education' and 'Scientific Instruments for Teaching, Research and Innovation'.

The transit of objects, people and practices between countries has raised considerable interest in recent humanity studies. Rather than a mere unidirectional transmission from the so-called 'centers' of makers and trade to vague and indistinct 'peripheries' of users, instruments are increasingly perceived as vehicles of knowledge adaptation and negotiation. Moreover, the role of local makers and regional trade is increasingly valued by the history of science community and by museums that want their collections well documented. Silvia Figueiroa's chapter discusses the relation between global and local in scientific instruments in South America, with a focus on Brazil. The state of the art she presents on instrument studies and its relation to the history of science is comprehensive and covers the most important concepts and methods in recent historical and epistemological literature.

Oscar T. Matsuura and Huib J. Zuidervaart highlight early transfers of scientific instruments between Europe and South America. They present results of recent studies on the Astronomical Observatory created in 1638 in Recife, Brazil, by the astronomer, naturalist and cartographer Georg Marggrafe under the patronage of Governor of Dutch colonial Brazil, count Johan Maurits van Nassau. More or less around the same period, but in Portuguese colonial Brazil, namely Bahia and Pernambuco, the Moravian Jesuit Valentin Stansel designed instruments that have been considered 'useless' by some historians. Using Stasel's case as a point of departure, Samuel Gessner explores the concept of purpose in scientific instruments. The method he proposes in his chapter for analysing complex and multidimensional uses is likely to have applications beyond seventeenth century instruments.

Moving on to North America, Sara Schechner follows the introduction and diffusion of the telescope in North America after its invention in Holland in 1608. She examines the period between the establishment of Plymouth Plantation until the first hundred years of Harvard College, identifying for the first time the earliest telescopes in North America. Nowhere were instruments more in transit than in expedition ships across the world. Richard Dunn examines the journal and correspondence of George Vancouver's expedition to the Pacific (1791-1795) on the Daedalus, particularly the daily use of instruments on the ship and in the field.

Two chapters address the transit and use of scientific instruments in Brazilian border demarcations. Isabel Malaquias focus on the demarcations of Southern Brazil by Portugal and Spain following the Santo Ildefonso Treaty in 1777. J. H. de Magellan, based in London, prepared 11 collections of scientific instruments for both the Portuguese and Spanish expeditions. More than a 100 years later, scientific instruments were again used in the demarcation of the border between Brazil and Argentina. Bruno Capilé and Moema Vergara discuss these expeditions, with a focus on an instrument developed in France, the phototheodolite. Issues of national identity, economic development, power struggles and technical innovation are discussed in both chapters.
Transit and trade of commodities between countries typically involves tariffs and scientific instruments are no exception. Richard Kremer examines protectionism tariffs on the import of scientific instruments in post-World War I Britain. Perceived as critical for national security, the British Parliament considered that scientific instruments should be manufactured locally. Kremer examines the Parliamentarian debates and discusses economic, social and political implications of the UK Safeguarding of Industries Act between 1921 and the 1930s.

Scientific instruments are traded, transferred and used for research and teaching in schools, universities, workshops and laboratories. Much more research needs to be done on the uses, re-uses, appropriations and adaptations of scientific instruments at local level. After they were acquired, what happened? Who used them? Were the uses expected or unorthodox? How were instruments absorbed by the social, political and scientific conditions of the institutions that acquired them? Did they act as catalysers for local innovation and change? Did they stimulate local instrument making, industry or trade? How did this happen in different countries, different institutions, and different environments?

Recent heritage of science is benefiting from a growing interest from scholars. Fluidly defined by post-WWII scientific instruments, it raises new issues both in its study and its preservation. This volume presents four cases, all American. Valéria Freitas and Márcio Rangel illustrate how the Brazilian industry stimulated instrument innovation and trade. The gas chromatograph developed by scientist Rômulo Ciola in the late 1950s was used in chemical analysis of organic compounds in the petrochemical industry. A few years later, Ciola and Ivo Gregori created and managed Instrumentos Científicos C. G. to supply the needs of gas chromatograph in Brazilian universities and industrial laboratories. It operated until the 1980s and one of the gas chromatographs produced is now at the MAST collection.

Adriana Mortara Almeida examines local uses and training associated with the first electron microscopes installed in Brazil in the late 1940s and early 1950s. She focuses on a Siemens UM 1000, acquired in 1952 for virology studies at the Instituto Butantan in São Paulo. The electron microscope is part of the collection of the History Museum of the Instituto.

Adriana Minor analyses the complex relations between science and geopolitical alliances between neighboring countries, namely the United States and Mexico between 1932 and 1951. Using two examples as a point of departure – the 1930s Compton cosmic rays expedition and the intervention of US Rockefeller and Guggenheim foundations in early physics research in Mexico – Minor convincingly argues that there was a deliberate geostrategic interest from the US in developing science in Mexico, particularly theoretical and applied physics. Instrument transit, training and development were integral parts of that strategy.

To close the section on recent heritage, Marcus Granato and his colleagues present the methods and tools used in the Brazilian survey of
cultural heritage of science and technology, coordinated by the MAST, as well as some impressive preliminary results. A more in-depth study resulting from this survey – the collection of physics from the Colégio Pedro II in Rio – opens the next section, ‘The Scientific Heritage of Education’, in a chapter by Marcus Granato and Liliane Bispo dos Santos.

In the case of Brazil, historical scientific instruments in secondary schools have raised considerable interest recently. Often preliminary in nature and requiring further collaborative research involving historians and collection/museum professionals, these studies are beginning to lift the veil on the uses and practices of scientific instruments in secondary education. This volume presents four contributions under this scope, from three schools in São Paulo (the Colégio Culto à Ciência, the Colégio Marista Arquidiocesano and the Escola Estadual Bento de Abreu in Araraquara) and one in Rio de Janeiro (the Colégio Pedro II), respectively by Reginaldo Meloni, Katya Braghini, Maria Cristina Zancul and Elton Barreto, and the above mentioned Marcus Granato and Liliane dos Santos. In essence, the four chapters follow the same research approach: on the one hand combining material and archival sources, particularly old lists and inventories, on the other hand combining historical research methods with collections documentation, preservation and museology.

Concerning the local uses of scientific instruments in research and development, this volume presents three fine case-studies. Maria Estela Jardim and Marília Peres provide a synthesis of innovation at instrumental and technical levels in microphotography applied to medicine and biology in the nineteenth century, as well as their introduction and dissemination in Portugal.

Télio Cravo examines the use (and re-use) of scientific instruments by engineers in infrastructure development in nineteenth-century Minas Gerais, Brazil. Using an important historical source – the complete development processes of all the bridges and roads made in Minas Gerais between 1840 and 1889 – Cravo examines which instruments were used, the conditions of their maintenance and repair, as well as the books that complemented use.

Finally, Pedro Paulo Soares and Inês Nogueira discuss the challenges of preserving the history and memory of an important Brazilian research institution devoted to health and Medicine: the Oswaldo Cruz Foundation.

This volume and more generally the SIC Symposium in Rio reinforced two conclusions that the international community of scientific instruments had already identified and debated in previous meetings. The first is that scientific instruments need to be studied and documented in order to be adequately preserved. It is no longer enough to merely identify function and maker. Instruments are bought, developed, cannibalized, put aside and trashed by researchers, students, engineers, technicians, industrials, and professors. They travel from Colombia to Canada, from the US to Europe, from Japan to Iceland. They are transferred from universities to secondary schools and often live 'second' and 'third' lives. They shape institution policies and geopolitical strategies. Museums and historians alike increasingly want to know more about the intricate lives of objects.
The second conclusion is that much more research being done at local level needs to be better known, published and integrated in the mainstream. The symposium in Brazil unequivocally confirmed our suspicions. In Brazil, Mexico, India, and so many other countries, important research on scientific instruments is being done that we all need to know about. This volume aims to be a contribution to that knowledge. We hope many more follow.

Notes

¹ IPHAN, Instituto do Patrimônio Histórico e Artístico Nacional [Institute of the National Historic and Artistic Heritage].