XXIX Symposium of the Scientific Instrument Commission

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ABSTRACT

Session I
INSTRUMENTS ON DISPLAY

Marco Beretta
The Collections of the Museo Galileo: 80 Years of Historical Reassessments
Museo Galileo, Florence, Italy

The collection of instruments on display at the Museo Galileo is the result a long history of reassessments on the cultural value of a unique scientific heritage and its relations to the history of science.
In my presentation I will examine the values behind the choices which inspired different exhibition policies and which both ensured the preservation of the collections and engendered a widespread interest in the history of scientific instruments.

Silke Ackermann
"The Instruments Belong in the Science Museum!" 250 Years of Scientific Instruments in the British Museum
British Museum, London, United Kingdom

Since its founding in 1753 the British Museum in London has had a collection of mathematical and optical instruments. The justification for their presence has often been questioned and the rationale for their display – both in permanent and in temporary exhibitions – has changed considerably over the years.
This paper will explore the history of this (now significantly increased) collection and the role that the instruments play in the Museum today. It will highlight the changing attitudes towards these objects over the decades and how these can be seen to reflect the much bigger question of the changing identity of the museum as a whole.

Sarah-Jane Patterson
University Instrument Collections: Instruments, Displays and Teaching
Institute for the History and Philosophy of Science and Technology, University of Toronto, Canada

At the Institute for the History and Philosophy of Science and Technology (IHPST) at the University of Toronto, graduate students have been central to the creation of the University of Toronto Scientific Instrument Collection (UTSIC). This collection has been a collaborative, bottom-up, multi-disciplinary effort encompassing multiple departments across the university. The UTSIC has opened up opportunities for enriching the graduate experience at IHPST through its potential for exhibitions, outreach, virtual catalogues and displays, object-driven research, interdisciplinary debate as well as generating new possibilities for teaching and learning for instructors, teaching assistants and undergraduates alike. In this talk, I will be focusing on teaching with a university instrument collection, particularly with respect to displays and their contributions to the construction of idiosyncratic histories of science.
The UTSIC has the potential to transform teaching at IHPST. We have access to the instruments in our physical possession in the UTSIC as a teaching collection, and so we are able to bring these objects directly into the classroom to give students a hands-on experience of the history of science. A wide variety of instruments have ended up in the UTSIC cataloguing area, however many of the objects in the UTSIC remain in permanent displays on the premises of several of the science departments across campus. Teaching with a university collection does not just entail teaching with the objects in the care of UTSIC or the objects in these departmental displays, but also with the displays themselves.
The displays, both individually and collectively, offer a unique view of how history is constructed. What is saved and what is displayed tells a very specific, and very local, story of what, why, and how a science is construed as historically important. Just as the similarities and differences of instruments in a display create a narrative, so too do the different displays from different departments of a university. A critical examination of displays at a local level can provide students with some insights into this social and contingent aspect of the history of science, presenting the prospect that it is not the victors that write the histories, it is rather the hoarders: displays are not just collections of instruments – they are historical compasses pointing to the people who collected and compiled those instruments.

Richard A. Paselk
The Display of 20th-Century Instruments at Humboldt State University
Humboldt State University, Arcata, California, USA

Why save and display artefacts? Many collections include few if any unique and/or culturally important objects. Rather they are often saved because someone thought they were interesting or aesthetically pleasing. Unfortunately, that is not sufficient in many cases to justify storage space, curation or other expenses. At Humboldt State University our collection of 20th-century scientific instruments and museum displays are justified as part of our institutional history, with added impact due to Humboldt's

In collaboration with:

Biblioteca degli Uffizi - Soprintendenza Speciale per il Polo Museale della città di Firenze

Gabinetto Scientifico Letterario G.P. Vieusseux, Florence

Istituto Italiano di Scienze Umane (SUM), Florence

Istituto Nazionale di Studi sul Rinascimento (INSR), Florence

focus on the natural resources and sciences.
With this in mind, new displays have been created in satellite locations near academic laboratories that would have used them at an earlier time. Our latest two display cases highlight the balances used in chemistry 1950-1980 and a group of high-quality, state-of-the-art instruments used in our physical chemistry laboratory in the 1960's.
The web sites for these displays are designed to enable complete access via hand-held devices (WiFi or 3G) to the collection documentation for visitors. As with our other collections this includes digital photos of instruments and components, curator discussions & descriptions, vendor catalogues, descriptions, manuals, brochures and other literature when available. Students and others can now not only marvel at the equipment used by their predecessors, they can also explore the use, maintenance and other aspects of these tools of education and discovery.
Recent actions in the state of California have set deadlines for making all on-line materials accessible to people with disabilities in accordance with national and international standards. I will also discuss briefly the actions I have been taking to make our web museum more accessible to impaired or disabled users.

Session II
INSTRUMENTS ON DISPLAY

Suzanne Débarbat, *Laurence Bobis*, *Amelia Laurenceau*
Collections and Instruments on Display at Paris Observatory
Observatoire de Paris, Paris, France

The first to think of a museum at the Observatoire de Paris was Cassini IV at the end of the 18th century; he installed it in large room situated on the second floor of the building now named Bâtiment Perrault and the room bearing nowadays the name of this family. This long room of 32 metres houses the meridian line representing the Méridien de Paris created in1667 at the time the building began to be built. This line is associated to a gnomon allowing to catch the image of the Sun when crossing the meridian at noon, in local true solar time. One century later, in 1879, the Admiral Mouchez – then director of the Paris Observatory – created the modern Musée de l'Observatoire de Paris. It was installed in the Grande Galerie on the first floor and, at the same level, in the East (Rotonde Est) and West (Rotonde Ouest) parts of the towers, flanking the central part the Bâtiment Perrault. The evolution of the rooms will be given and the way in which instruments, covering the period from the end of the 17th up to the 19th century, are on display in the building and on the site of the Observatory.
Nowadays the Grande Galerie, formerly the Salle du Conseil and the Salle Picard (North tower), are fulfilled with what is on display for visitors of the Observatory. The Rotonde Est is the room in which researchers have access to the part of the Bibliothèque named Salle de lecture (reading room) of the library. This room preserves two antennas employed for the reception of time signals; they are from the time this room was the seat of the Bureau international de l'heure. This bureau had been created in 1919 and was there, up to December 31, 1987, but the antennas were not more in use for a long time...
Similarly remain four groups of three metal pieces on the southern facade of the building. From 1967, the year celebrating the tercentenary of the Observatory, showcases have been added allowing visitors to watch, not only at displayed instruments, but also at objects, manuscripts, rare books... from its collections. From about 1982, the are changed every year, according to some special events, persons, discoveries... associated to the Observatory. As an example, for the year 2009-2010, catalogues up to the one issued from the astrometric satellite Hipparcos mission. For 2010-2011, will be on display some books, manuscripts... recently entered in the Observatory collections. In the Salle Cassini, large exhibitions can be presented to the public; among the most recent ones, "Foucault, le miroir et le pendule" (2002), "Arago et l'Observatoire de Paris" (2003).
Visitors will have several different opportunities to come to the Observatoire de Paris and, among them; besides the exhibitions, guided tours for organized groups of thirty people, special occasions such as colloquia, Journées du Patrimoine... As an example, and for the last such Journées, from 13 to 18 hours, on Saturday and Sunday, more than 6000 people came. The last Journées have been held on September 18-19, 2010.

Hans Hooijmaijers, *Ad Maas*
Bling-Bling or Key Pieces: The Objects in Museum Boerhaave
Museum Boerhaave, Leiden, Netherlands

In the first part of this presentation, Ad Maas will set out his view on scientific objects in a museum. He will argue that scientific objects should not first of all be regarded as showpieces, which captivate museum visitors because of their attractive or intriguing appearance. They should rather be considered as 'key-pieces', as the 'key' to the story behind the object. He will then discuss the consequences of such a (changing) view of objects for exhibiting them, for the research on them and for their acquisition.
In the next part Hans Hooijmaijers will consider a new exhibition-policy for Museum Boerhaave. To start with he will look back at the original displays when the Museum opened almost 80 years ago. He will discuss the place of the objects in the current (larger) Museum, which opened in 1991. He then shows that the temporary exhibitions over the past 10 years started to focus increasingly on stories of a cultural-historical nature and on human interest. Finally he will explore the ideas for the future refurbishment of Museum Boerhaave, wherein the objects get their place in a story.

Steven Turner
"Permanent Demonstrations": The Science Teaching Museum of the University of Chicago
Smithsonian Institution, Washington DC, USA

Around 1930, as part of its "new curriculum" initiative, the University of Chicago began to offer a new undergraduate survey course on the natural sciences. The course sought to integrate astronomy, mathematics, physics, chemistry and geology into a single year long class, and to support it the university established a new museum to present the observables – the objective facts on which scientific understanding is based. There were "demonstration laboratories" for physics, chemistry, and geology and at its height the physics room alone had nearly 240 "permanent demonstrations". The museum was widely viewed as a success and was visited by over 40,000 students in its first seven years. Although it faded during World War II, the museum pioneered many of the methods now common in Science Centers and interactive science exhibits.

Anne Fellinger
Exhibiting Contemporary Instrumentation: Displaying to Save?
Université de Nantes; Musée des arts et métiers, Paris, France

This contribution examines the role and place of exhibitions in the program of safeguarding contemporary scientific and technical heritage in France. Since 2003, the Musée des arts et métiers of Paris has been commissioned by the French Ministry of Research to set up a national plan of preservation of contemporary heritage. This program aims to alert research institutions and enterprises on the disappearance of their recent heritage. The network developed by the Musée currently groups 14 project managers based in various universities, engineering schools and scientific museums all around France. Following a common methodology, they are in charge of locating, making the inventory and saving scientific instruments of research institutions in their own region. They also build up documentation and carry out interviews with researchers to preserve evidences of scientific know-how and practices. The collected resources are incorporated into a national data base and are visible by a wide public on a website.
While the cultural, symbolic and scientific values of contemporary heritage seems nowadays established for most professional of scientific museums and historians of sciences, the interest of preserving scientific objects is much less obvious for a majority of researchers, enterprises and academic institutions. In lots of cases, contemporary instruments are still viewed as an unaesthetic obsolete material intended to disappear. In order to mobilize these actors and to make them aware of the potential contribution of their own heritage to their present work and to future innovation, the Musée thus encourages project managers to promote the locally collected instruments.
Based on the example of a current project of instruments exhibition in the Faculty of science of the Université de Nantes (France), this paper aims to analyse what is at stakes when it comes to displaying contemporary instruments in a university: Why and how exhibit these instruments? For whom? To what extent does such a project help to ensure actions of preservation of scientific heritage? Most of the time, exhibitions are a mean to enhance the collections and scientific research. Addressing these questions amounts to wondering whether it may also play the reverse role, helping to extend the safeguarding action by involving scientists and having them appropriate scientific heritage.

Session III
INSTRUMENTS ON DISPLAY

Marcio Rangel, *Cláudia Penha dos Santos*
Scientific Instruments: Different Perspectives
Museu de Astronomia e Ciências Afins, Rio de Janeiro, Brazil

This paper aims to provide support to the display of a tide predictor in the long-term exhibition of the Museum of Astronomy and Related Sciences - MAST (Museu de Astronomia e Ciências Afins, Rio de Janeiro, Brazil). The exhibition focuses on the knowledge about Brazilian territory, linking scientific knowledge and topics in History of Science through different strategies, trying to explore the thematic potential of MAST collection's objects. The project of the exhibition (which is a work in progress) recommends the use of scientific instruments (considered revealing of important issues in the history of science and technology) and takes into account the relationship between objects and their contexts, avoiding its reduction to mere illustrative resources. The tide predictor was commissioned in 1925 to the firm Kelvin Bottomley & Baird (Glasgow and London, UK) by the National Observatory (Observatório Nacional, Rio de Janeiro, Brazil), which received the instrument two years later and used it to predict tides in the main Brazilian ports. The institution already carried out the service since 1911, with a simpler model, able to sum 11 tidal constituents.
In 1925, the Annual Report announced the replacement of the old instrument by a new one, in order to improve the accuracy of the results. Since 1928, the Observatory started to predict the tides of thirteen ports in Brazil using a new 23-component version. Both devices are based on the model developed by William Thomson (Lord Kelvin), who used the method of harmonic analysis to solve the problem of tidal prediction. We argue that objects must play a central role in museum exhibitions.
The display and interpretation of the tide predictor (or Kelvin machine) associated to different strategies (such as multimedia resources, games, texts etc) or other collection's objects will allow us to introduce a great range of scientific concepts and topics in History of Science. To exemplify the variety of themes to be explored from the instrument, a conceptual map was created, including topics ranging from ports of Brazil to the manufacturing of scientific instruments in England, from the phenomenon of tides to the law of universal gravitation, from Isaac Newton to Lord Kelvin, from Royal Society to the National Observatory.
As the title suggests, we start from the principle that rather than offer answers or illustrate textual narratives, the objects on display (particularly in long-term exhibitions) should raise questions. Museums are not three-dimensional books, and objects can be excellent starting points to explore complex and multifaceted subjects.

Richard Dunn
"More Artistic than Scientific": Exhibiting Instruments as Decorative Arts
National Maritime Museum, Greenwich, United Kingdom

Museums of the decorative arts are not often considered as a significant context for presenting and interpreting scientific instruments, yet a number do have collections of note. The Victoria and Albert Museum, London, presents an interesting example, since it grew out of an institution that acquired instruments for several different collections, and which also gave rise to the Science Museum. A consideration of how instruments have been displayed there can help reveal some of the differences between the two types of museum, therefore, as well as illustrating how displays in the decorative arts have evolved more generally.
This paper will focus on some case studies that show how the collecting and display of scientific instruments at the Victoria and Albert Museum evolved from its foundation to the present day as a way of looking at this significant alternative context for their interpretation. In doing so, it will attempt to consider some of the different motives and practices evident at South Kensington and what this can tell us more broadly about different museum contexts.

Inga Elmqvist Söderlund
Collections and Instruments on Display in 17th-Century Books on Astronomy

Observatoriemuseet, Stockholm, Sweden

Many European books on astronomy from the 17th century are richly illustrated with astronomical instruments. This paper is concerned with how illustrations of instruments in books are related to consumption, identification and display.
The depicted instruments, were produced, traded, used, collected and displayed in among other places *Kunstkammern*. They were admired for their scientific value, the beauty of the craftsmanship and, not least, their costliness, as instruments made of precious metals they were highly valued. Whereas some illustrations seem to depict factual objects, present realistic manuals as to their production, others depict objects that are in their sheer size, multitude, and described fantastic qualities perhaps more intended as fictional. Some illustrations seem to be intended to promote consumption. This paper explores by what means the instruments are made visually attractive.

Jozef Uyttenhove, *Danny Segers*
Einstein in the Low Countries: How to Make an Instrumental Exhibition About the Great Theoretical Physicist
Universiteit Gent, Museum voor de Geschiedenis van de Wetenschappen, Ghent, Belgium

In the Museum for the History of Sciences (University of Ghent, Belgium) it is customary to illustrate the evolution of science by means of scientific instruments. In the case of Albert Einstein it was not obvious to follow this practice, because the definite theoretical character of his work. In this contribution is explained how we conceived in 2005 – the UNESCO World Year of Physics – our exhibition “Einstein in the Low Countries” with a lot of Einstein related instruments on display. This concept made our exposition unique among other Einstein related exhibitions in 2005-2006 (Berlin, Kronprinzenpalais and Bern, Historisches Museum).
Our exhibition, in collaboration with the Museum Boerhaave (Leiden), showed instruments and documents concerning Albert Einstein in The Netherlands and in Belgium with emphasis on the special ties between Einstein and the Low Countries.
Very special are some unique and never displayed items concerning the stay of Einstein at the Belgian seaside village De Haan, in the cottage “Savoyarde” in 1933. From there, Einstein left for the United States in September 1933 via a short stay in England; he returned never back to Europe.
It is not widely known that Albert Einstein also has developed some instruments, in addition to his theoretical work. The most famous instrument is probably his “Maschinchen” (small engine), an attempt to improve the sensibility of the electro-meter by using the electrical influence principle. We studied the working principles of Einstein’s “Maschinchen” with the help of a replica and presented the replica and our preliminary results on the XXV Scientific Instrument Symposium (Krakow, 2006). The results were published later in final form in the *American Journal of Physics* 77 (2009).

Session IV
INSTRUMENTS ON DISPLAY

Lavinia Maddaluno
Fruit on Display and Display of Fruit: The Case of the Whipple Museum’s Pomological Models
Department of History and Philosophy of Science, Cambridge University, United Kingdom

In the display which the Whipple Museum has devoted to botany, a cabinet exhibiting twenty-four wax models of apples is located. The label of the object suggests some association with Francesco Garnier Valletti (1808-1889), an artisan and a wax modeller in 19th-century Turin.
By examining these objects, I have attempted to discern the role of displaying wax models of fruit in 19th-century Turin. I have found that models of fruit were displayed in agricultural fairs and expositions as instruments for the identification of species and varieties. They substituted the putrefiable originals; furthermore, they were an alternative to the large number of botanical illustrations needed to represent single aspects and details of fruit.
As I will show with the aid of some images, the models are movable and not labelled. Although their labels may have gotten lost in time, this characteristic echoes an impermanence in the taxonomic language, whose structures change over time, according to scientific developments in the knowledge of the order of nature. This arbitrary arrangement might have historical precursors in those 17th- and 18th-century cabinets which hosted artificial and natural curiosities, *artificialia* and *naturalia*, and where shells, corals, orreries, automata, paintings and horns of mythical unicorns were displayed one next to the other without clearly established criteria.
Later on in my paper, I will focus on the fact that pomological models can also be comprehended in the light of the relation between art and science, making and knowing. We can in fact interpret the models of apples as the outcome of a handicraft activity at the service of pomological classification. The scientist benefited of the work of the artist, who fashioned models of fruit out of inorganic materials, creating physical as well as philosophical bodies of pomological knowledge.
As talking objects, to use Lorraine Daston’s words, the models can tell us a great deal about classificatory issues as well as about the complex interactions between art and science, artisans and scientists. In fact, they do not only illustrate specific traits of species and varieties of fruit, but they also reliably reflect agricultural practices, technological improvements and craft skills developed in 19th-century Turin.
As instruments on display, they are a “place of knowledge”, namely, a physical room where the abstractions of classificatory criteria are embodied by a material organization of objects. In their objectivity, they aspire to be universal and definitive illustrations of nature, implicitly determining scientific standards of observation, description and classification.

Ari Gross
When is a Body not a Body? Plastination and representation on Display in Gunther von Hagens’ “Body Worlds”
University of Toronto, Canada

For over a decade, several iterations of Gunther von Hagens’ “Body Worlds” and similar exhibitions have travelled the globe, pushing the bounds of science and art and bringing anatomy to the masses. In displaying real, “plastinated” corpses, both in sections and in their entirety, these exhibits have provided international audiences with a seemingly unmediated view of the internal structure of real human bodies, a view normally afforded to a rather limited segment of the population.

However, plastinated bodies are not merely human bodies laid bare for all to see. The process of plastination itself fundamentally alters the body, transforming wet and decomposing corpses into dry, firm, durable objects, ready for display and occasional handling. In addition, the colour of bodies and body parts are altered: cardiovascular and respiratory systems are died, human fat is rendered white, and muscle tissue is substantially darkened. Indeed, the process of plastination and the presentation of plastinates actively transforms real anatomical specimens into highly mediated scientific objects. The ways in which this is done and the likely reasons behind this transformation will be the focus of this paper.
Drawing on recent scholarly interest in these exhibitions (e.g. The Anatomy of Body Worlds, 2008), primary sources on plastination written by von Hagens, and the exhibitions themselves, "When is a body not a body?" will probe how the internal structure of the human body is both physically and conceptually mediated by the process of plastination and the curatorial techniques involved in presenting plastinates. This paper will pay particular attention to the coloration of the plastinates, exploring the ways in which corpses are dyed to conform to contemporary aesthetic standards, ease visitors' interactions with the plastinates (i.e. make the plastinates appear "alive"), and transform bodies so that they resemble anatomical models. This last point is of particular note: as bodies are altered to correspond with conventional anatomical representations, we observe the power of well-established visual traditions to alter "naked", meaningless objects, into highly mediated entities of epistemic (and aesthetic) significance.
Focusing on the physiological alterations plastinated corpses undergo in order for exhibition and the curatorial decisions involved in their display, this talk will shed light on how human corpses are transformed into pieces of art and science, and what this transformation can tell us about both our own conceptions of the human body, the interactions between science and the public, the nature of scientific representation, and the display of the strangest of scientific instruments: the human body.

Session V
INSTRUMENTS ON DISPLAY

Richard L. Kremer
Scientific Collections and Instruments on Display at the American Centennial Exposition of 1876
Dartmouth College, Hanover, North Hampshire, USA

The first of the 19th-century world exhibitions to be held in America, the 1876 Centennial Exposition in Philadelphia provided an occasion for Americans to measure themselves against other nations, both in terms of economic development to date and of utopian visions for the future. Driving the Exposition was the ideology of technological and scientific "progress," viewed as a competition among nations. This paper will examine how the presentation and display of scientific instruments contributed to that ideology at the Exposition.
The Philadelphia organizers invited exhibits in ten categories: raw materials, materials and manufactures used for food or in the arts, textiles, furniture and dwellings, tools/machines/ processes, motors and transport, apparatus/methods for the increase and diffusion of knowledge, engineering and public works, plastic and graphic arts, objects illustrating efforts to improve the physical and moral condition of man. Scientific instruments, evoking different meanings and values, appeared in several of these categories; yet the theme of instruments and progress remained central throughout the five main exhibit buildings, the seventeen state buildings, the Turkish Coffee Building, the Woman's Pavilion, the Singer Sewing Machine Building, and the many other exposition spaces.

David Pantalony
Re-Examining Icons on Display
Canada Science and Technology Museum, Ottawa, Canada

Narratives about science and technology are often defined by icons on display at our museums. This is especially the case at national museums. Our choices, interpretations, and silences matter. Our failure to revisit and probe these icons also matters. In this talk I shall critically examine some signature artefacts on display at the Canada Science and Technology Museum – Canada's first nuclear reactor (1945), Canada's first satellite for testing the ionosphere (1962), and a Sputnik replica in our main space exhibit (1977).
In more detail, I shall describe the Theratron Junior, a sleek green radiotherapy machine from 1956, displayed in a permanent exhibit of innovation milestones in Canada. In stark contrast to its current, fairly limited display context, the Junior brims with features and history that demand more attention. The striking "sea foam" green paint, for example, has inspired an independent exhibition at the museum about the colour green in medicine. In addition, research into the former life of the specific model on display (serial no. 15), including company, government and museum records, and oral histories with people who made it, sold it, serviced it and used it, has produced a reinvigorated artefact biography that enriches and challenges conventional narratives from Canada's early atomic era. The lessons from these intense icon re-examinations are readily clear – we are missing opportunities by taking for granted the most familiar items on our museum floors.

Alison Boyle
Science for the Nation: Changing Trends in Instrument Displays at the Science Museum
The Science Museum, London, United Kingdom

This paper will survey how the Science Museum has displayed scientific instruments over the past century, from taxonomic displays designed to illustrate 'the steps by which progress has been made' to narrative-led exhibitions with increasingly lower object density. It will look in some detail at the current trend for using new media to interpret displayed objects (with varying degrees of success) and discuss new opportunities and challenges for instrument displays posed by the Museum's major future project, a synoptic gallery on Making Modern Science.

Maria Lucia de Niemeyer Matheus Loureiro, *Cláudia Penha dos Santos*, *Márcio Ferreira Rangel*
Why Put Scientific Collections and Instruments on Display? Questions Raised by a Tide Predictor
Museu de Astronomia e Ciências Afins, Rio de Janeiro, Brazil

This paper aims to discuss the many ways of reading a scientific instrument on display. In our view, the scientific instruments in museums become museum objects. They no longer have the utility value, but acquire historical value as an information source. We consider these museum objects/instruments as documents with of different meanings. Objects featured in exhibitions evidence aspects related to their origin, function, shape, material, manufacturing, among others. They point to the complex reality in which we live. These points were addressed in the exhibition Scientific Instruments: different perspectives, developed at the Museum of Astronomy and Related Sciences, a research institute located in Rio de Janeiro, under the Ministry of Science and Technology of Brazil. The exhibition, which happened between the years 2001/2002, was structured in four modules.
In the introductory module we propose some reflections on the difference between scientific instruments and utensils.
In the second module, instrument, art and design, we present scientific instruments from different nationalities in order to analyze possible differences related to its aesthetic origins. In addition, were exhibited reproductions of Brazilian paintings which had representations of scientific instruments.
In the third module, instrument and memory, an astronomical pendulum acted as mnemonic reference of the successive periods of its operation, establishing a relationship of memory over time.
Finally, we built a reading module that was to make the visitor look closely at a scientific instrument, previously selected, and from reading a script provided freely develop their own reading. Museums are places of possible resurrections, although mediated and contaminated by the visitor's eyes. From visitor's interaction with the museum object appeared a variety of possible interpretations. This experience had an effect on subsequent exhibitions developed in MAST.

Session VI
INSTRUMENTS ON DISPLAY

Gudrun Wolfschmidt
Presenting Instruments in Baroque Observatories
Institut für Geschichte der Naturwissenschaften, Mathematik und Technik, Universität Hamburg, Germany

Jesuit college observatories and monastery observatories have good collections of instruments, I will show some of the best examples like Prague Clementinum (Czech Republic), Mannheim (Germany), Eger (Hungary), and Kremsmünster (Austria). In these Baroque tower observatories exist collections of scientific instruments, not only astronomical but also meteorological, geomagnetic and seismological instruments. In addition cabinets of curiosities – typical for the Baroque time – exist with a collection of automats, minerals, botanic and zoological specimens as well as ethnographic exotic objects. A *Wunderkammer* or a cabinet of rarities of the Baroque period were a microscopic image of the macroscopic world. Some of these observatory museums provide an integral picture of the scientific practice of baroque time, practically not changed until today; in addition the close connection between science and religion is shown.

Ingrid Jendrzejewski
"Exceedingly Ridiculous": Telescopes on Display on the 17th-Century Stage
Independent scholar, Cambridge, United Kingdom

In 1610, Galileo published *Sidereus Nuncius* in which he described his telescope-based observations of the Moon and other heavenly bodies. Almost immediately, Sir Henry Wotton, serving as ambassador to Venice, wrote to King James I of England that Galileo "hath first overthrown all former astronomy" and that Galileo would become either "exceedingly famous or exceedingly ridiculous".
Among those who found much that was 'exceedingly ridiculous' in Galileo's work were a number of playwrights who wrote for the English stage. In the years following the publication of *Sidereus Nuncius*, playwrights began to include descriptions of, references to, and, in some cases, physical representations of Galileo's telescope in dramatic productions, usually in the context of parody, Early theatrical responses to Galileo's work include academic comedies like Thomas Tomkis' *Albumazar* (1615) and Barten Holyday's *Technogamia: or The Marriages of the Arts* (1618), both of which explicitly engage with astronomical themes. Ben Jonson's masque, *News from the New World Discovered in the Moon* (1620) and, much later, Aphra Behn's farce, *Emperor of the Moon* (1687) both imagine civilisations that supposedly live on the Moon. In *The Virtuoso* (1676), Thomas Shadwell invokes Galileo and his telescope in his critique of the Royal Society.
References to Galileo and his telescope are not limited to plays that feature astronomers or astronomical themes; the telescope is used in humorous dialogue and situational comedy in works such as Ben Jonson's *The Staple of News* (1626), Margaret Cavendish's *Love's Adventures* (1662) and D'Urfey's *A Common-Wealth of Women* (1686), among others.
Since a play's text is intended for live performance, the playwright is constrained to language and subject matter that can be communicated to an audience during a single performance; therefore, an examination of the way telescopes were presented on stage offers a unique glimpse into the way 17th-century audiences engaged with astronomy.
In this paper, I explore the ways in which 17th-century English theatre responded to and engaged with advances in astronomy. I will trace dramatic references to the telescope through the century, and examine how playwrights appropriated it as a comic object.

Ileana Chinnici, *Donata Randazzo*
Old Astronomical Instruments on a Movie Set: The Case of the "Leopard"
INAF - Osservatorio Astronomico di Palermo, Italy

The paper deals with a successful temporary exhibition currently held at the Museum of the Palermo Astronomical Observatory, where some astronomical instruments once belonging to the Prince Tomasi di Lampedusa and used for the set of the famous movie *The Leopard* in the 1960s are on display.
The manner of displaying has been inspired by the reconstruction of the movie set where they were used as scene material together with furniture, books and archival papers. Some passages of the novel commented the material on display, while some sequences of the movie were shown during the visit to the exhibition. This exhibition represents an interesting case of interdisciplinary approach in displaying as it shows the evocative potentialities of the connections among instruments, literature and cinema.

Valeria Zanini
The "Specola" Museum's Experience: Between Current Efforts and Future Hopes
INAF - Osservatorio Astronomico di Padova, Italy

The museum section of the Astronomical Observatory of Padua (that is one of the main structures of the INAF – National Institute for Astrophysics), now named "the Specola Museum", was officially founded in 1994. The museum preserves the old instruments used for 150 years by the Paduan astronomers. Telescopes, quadrants, pendulum clocks, chronometers, chronographers and many others accessories are on exhibit in the original rooms where the 18th- and 19th-century astronomers observed the sky and the stars.
A lot of instruments, that were fallen into disuse and neglected in the old medieval tower, used as storeroom and archive, are been restored by the Observatory in the last 20 years.
Now the Museum receives more than 4000 visitors (school and organized groups, families and individuals) every year, and shows them an important part of the history of the city.
The aim of this paper is to point out the efforts in the museum management, especially because of lack of specific funding and personnel, but also to emphasize hopes and opportunities for a future improvement.

Session VII
INSTRUMENTS ON DISPLAY

Tacye Phillipson
In the Eye of the Beholder
National Museums Scotland, Edinburgh, United Kingdom

To an astronomer bigger frequently is better, and telescopes are sited at ever more remote locations, from mountain tops to heliocentric orbits. These telescopes are frequently eulogised, or displayed, in their necessary absence by means of astronomical images. However, the visual appeal of the images is not always in direct relation to their scientific importance. In the last couple of decades in particular an ever increasing array of images has been available for public consumption, both the visually appealing and the useful. I will look at the development of astronomical imaging and its use in the presentation of telescopes as working, and no-longer working objects.
One of the many new galleries opening at the National Museum of Scotland in 2011 will present a small, but choice, selection of telescopes and also an interactive exhibit which will highlight a few astronomical objects and look at how their depiction depends on the technology used, where possible relating directly to telescopes in the gallery.

Bruce Stephenson
Displaying a Newly Acquired "Gothic" Astrolabe
Adler Planetarium and Astronomy Museum, Chicago, Illinois, USA

"Instruments on display" from museum collections normally share certain crucial attributes. Among these is authenticity, for surely the core functions of a museum include collecting, preserving, and displaying real, genuine artefacts. A newly acquired late-Gothic astrolabe at the Adler Planetarium raises several questions about the place of authenticity in a museum.
The provenance of this astrolabe does not meet the standards we prefer. We purchased it not from a known dealer in scientific instruments, but from a shop near the Grand Bazaar in Istanbul – certainly an odd place to find what seems to be a medieval, Latin astrolabe. The price, while higher than that of most objects in the shop, was a good deal lower than one would expect to pay for a Gothic astrolabe.
The workmanship is fine, and the object comfortably resembles other published astrolabes. Indeed, it fits well into a known group of "late-gothic" instruments identified by J. Baddeley and A.J. Turner. The resemblance to one of those astrolabes, in particular, is close enough that the two might very plausibly have been made by the same (unknown) person. And so the Adler purchased it, at quite a reasonable price, and began displaying it, privately, to friends of the collection.
Meanwhile we began a more serious investigation, before placing the new acquisition on public display. Our investigation continues.
This artefact highlights several issues that a museum should consider when deciding whether to display newly acquired objects, and how, and when, and to whom. How strongly should an unverifiable source count against an otherwise appealing object? When is resemblance to a published artefact reassuring, and when can it become a danger sign? Under what circumstances does a low price make the acquisition of a doubtful object compelling?
Should such issues be included in the display?

Peggy Aldrich Kidwell
Slide Rules on Display in the United States
National Museum of American History, Smithsonian Institution, Washington DC, USA

Although the slide rule was invented in the 17th century, it did not become generally known in the United States for over two hundred years. Both those who made slide rules and those who purchased them showed them off. To understand early public exhibition of slide rules in the US, one looks at reports of fairs and photographs, and at a few examples proudly displayed by their owners. Some slide rules were exhibited by the US Patent Office in the second half of the 19th century and then found their way to the Smithsonian Institution. Others were shown in 20th-century industrial museums. Far more were displayed by students studying technical subjects, who marked them with their names and carried them in cases suspended from their belts. Demonstration slide rules appeared in classrooms, and were regularly redesigned to reflect both changes in slide rules and new educational technologies. A 1966 Smithsonian exhibit could proclaim that "since the 18th-century, use of the slide rule has increased continuously; and numerous improvements have been made."
Manufacture and purchase of slide rules declined precipitously after the introduction of handheld electronic calculators in the early 1970s. However, they have retained a place in historic exhibits, attract the attention of collectors, and are now widely displayed on web sites. This overview of the slide rule as an object of display in the US draws heavily on collections of the National Museum of American History.

Robert D. Hicks
Interpreting Electrotherapy and the Civil War Body
The College of Physicians of Philadelphia, Pennsylvania, USA

The years from 2011 to 2015 mark the sesquicentennial of the American Civil War. The College of Physicians of Philadelphia plans a permanent exhibit on Civil War medicine, "With Tenacity for their Lives": Medical Care during the Civil War and The College of Physicians of Philadelphia, to debut in 2013, the 150th anniversary of the opening of the College's Mütter Museum. Unlike most exhibits of Civil War medicine that explore the industrial scale of warfare and the heroic treatments afforded mass casualties of disease and wounds, "With Tenacity" presents a medical story from the body outward to larger ideas and themes. Poet Walt Whitman, who volunteered in military hospitals throughout the war, provides the exhibit's voice as he introduces three people, a white solider, an African-American soldier, and a young woman who volunteered as a nurse, all of whom have Philadelphia connections. The bodies of all three provide narrative foci as the exhibit examines their health, physicians' perceptions of their bodies, and expectations of mortality. Their episodes of disease, malnutrition, injury, or wounds join themes of physiological ideology and medical intervention through primary documents of selected College Fellows who were distinguished in their war work.
The most sophisticated and unpredictable technology applied to soldiers was electrotherapy at America's first neurological hospital, Turner's Lane in Philadelphia. The pioneering work at Turner's Lane conducted by physicians S. Weir Mitchell, William W. Keen, and George R. Morehouse in studying diseases and wounds of the nerves will receive particular emphasis in the exhibit. The regimen for treatment of nerve injuries was comprehensive and employed the first machines for diagnosis and therapy in American medicine, "faradisation" and "galvanisation" devices, now dismissed as quack therapy.
"With Tenacity" aims to present electric technology in a new light, by examining it through the experiences of soldiers who were thus treated, contextualizing their fears, injuries, views of medicine's promise, and most importantly the physician's articulation of the body and its healing, a process requiring a dialog between patient and doctor. Through the case history of one soldier treated at Turner's Lane, the exhibit engages visitors to imagine themselves participants in a clinical dialog with the physician administering electricity. This presentation examines the anticipated mode of interpretation of electric technologies used at Turner's Lane.

Session VIII
INSTRUMENTS ON DISPLAY

Ivano Dal Prete
Count Gazola's Scientific Instrument Collection: Between the Ancien Regime and the Napoleonic Age
University of Minnesota, Minneapolis, USA

Count Giambattista Gazola of Verona (1757-1834) is well known by students of early modern natural history, thanks to the outstanding collection of fossil fish that he gathered in the 1780s and 1790s. On the contrary, little research has been done so far on the important cabinet of scientific instruments that the nobleman acquired in the same years. In this paper, I will take advantage of a recent survey conducted on the museum and on the archives of Liceo Maffei, Verona – which received Gazola's cabinet in 1802 – to outline the history and the main features of that collection.
I will argue that scientific instruments and their display played a significant role in the self-fashioning of late 18th-century ruling classes in provincial Italy, and in their appropriation of contemporary scientific practices and debates. In the early Napoleonic age, the handover of Gazola's cabinet to the newly-founded local "Liceo" represented a momentous transition, with deep implications for the characteristics, intended use and public role of Italian scientific instruments collections.

Paola Bertucci
Architecture of Display: The Tarsia Museum and Scientific Culture in 18th-Century Naples
Yale University, New Haven, USA

Palazzo Tarsia was one of the main attractions for Grand Tour travellers arriving in Naples. The magnificent building was designed by the famous architect Domenico Antonio Vaccaro and it belonged to the prince of Tarsia, Ferdinando Vincenzo Spinelli (1691-1753). One of the wings of the palace was dedicated to a Museum that hosted the prince's collections. It consisted of four rooms, which included a public library and a physics cabinet. The paper offers an interpretation of the representational role of the instruments' spatial disposition in the four rooms of the Museum.
I suggest that books, art objects and instruments were arranged in space so as to represent Spinelli's vision on the role of Naples in contemporary culture.
I show that the Tarsia Museum was a prominent space for experimental practice and that, albeit for only a short period of time, it was one of the most active cultural sites in mid-18th -century Naples.

SPECIAL FILM PRESENTATION

Pierre Lauginie
All about the Film ***Wizards of Light***: Evolution of Foucault's Spinning Mirror from a Qualitative to a Metrological Experiment (1850-1862)
Université Paris-Sud, faculté d'Orsay, GHDSO, France

The film *Wizards of Light* (*Les magiciens de la lumière*) – a collaboration between the SCAVO* and the GHDSO – is an historical reconstruction tracing the main historical measurements of the speed of light, from the 17th to 19th century. The film focuses on Foucault's famous spinning-mirror experiment in 1862.
With Foucault's 1850 and 1862 experiments, the scientific status of the velocity of light undergoes dramatic changes: while, for long ago, only an item of intellectual curiosity, it becomes, with Foucault's former air-water comparison in 1850, a criterion to "decide" about the structure of light – waves or particles –, an essentially qualitative experiment. But, from the first accurate

terrestrial measurement of the velocity of light by Foucault in 1862 – a typical metrological experiment – it will soon become the new standard for the measurement of the solar system and, beyond, the Universe. The role of Arago in motivating both experiments in order to answer very different questions is underlined.
Thus, we intend to show the evolution of a given instrument handled by the same experimenter, from a qualitative use in 1850 to a metrological one in 1862. Though both mirrors look very similar, we note:
– very important improvements of the driving turbine itself: twelve injection holes instead of two and new design of the blades, thus multiplying the efficiency;
– use of compressed air instead of steam to drive the turbine, thus eliminating condensation problems;
– special organ bellows built by the famous organ builder Cavaillé-Coll, allowing a very efficient air flow control and a very smooth operation; we shall answer a very puzzling question: why do Cavaillé and Foucault paradoxically tell of "high pressure bellows" while, indeed, thanks to the turbine improvements, the pressure has been reduced from 5 metres of water (1/2 atmosphere) in 1850 to about 30 cm in 1862?
– use of aluminium, the metal newly prepared by the chemist Sainte-Claire Deville – a friend of Foucault – in order to improve the very critical equilibrium of the mirror axle;
– a "chronometric toothed wheel" – a kind of stroboscope – built by Froment to measure accurately the spinning rate, instead of a tuning fork;
– a chain of spherical mirrors, in order to "convey the image without loss in intensity" over the 20 metres distance towards the final fixed mirror;
– a very finely divided reticle, again due to Froment's skilfulness.
We shall underline that the whole set of instruments appearing in the film are original ones, lent by the Musée des Arts et Métiers, the Musée de l'École polytechnique and Paris Observatory; thus watching the film is partly like visiting a scientific museum.
We expect that, besides this presentation, a full projection of the film will take place as an optional activity during the symposium (60 min, English subtitles).

* Service de création audiovisuelle de la faculté des sciences d'Orsay (SCAVO)

Session IX a
INSTRUMENTS ON DISPLAY

Sara Raquel Dias de Sousa Carvalho, *Isabel Marília Peres*, *Fernanda Madalena Abreu Costa*
Displaying Historical Scientific Photography through Material Culture
Centro de Ciências Moleculares e Materiais, Universidade de Lisboa, Lisbon, Portugal

Scientific Photography has the same historical background as Fine Art Photography. However, Scientific Photography had to answer to different purposes in order to serve new ways of scientific visualization and documentation. From its invention in the 19th century it was used as an "instrument" of study for all the spectrum of sciences: medical, oceanographic, meteorological, cartographical, astronomical and others. This need led to the invention of new photographic instruments (cameras, lenses, self-recording instruments like electrographs, magnetographs, physiographs, etc.), and new chemical-physical processes (early photographic processes, organic developers, indirect printing of colour, photomechanical processes and X-ray photography). The evolution of Scientific Photography had certainly a contribution for the advancement of Science, but its role was also of major importance in the public understanding of science through its use in world exhibitions, periodicals, public conferences and projections, thus allowing a new way of communicating science.
In this paper we try to understand how the material culture (instruments, iconography, etc) related to the History of Scientific Photography is displayed in museums and what are the museum practices adopted to achieve the public understanding of this subject, both physically (museum exhibitions) and virtually (online exhibitions), making a parallel between different case-studies. The main challenge is to understand how is, or can be told the History of Scientific Photography, both through the displaying of instruments and the final result, the captured image. We will focus mainly on European collections, in particular the Portuguese collections from the period of 19th - early 20th centuries.

M.E. Jardim (a), *I.M. Peres (b)*, *F.M. Costa (b)*
The Oceanographic Instrument Collection of Prince Albert I of Monaco and King Carlos I of Portugal: A Case Study in Scientific Photography
a) Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal
b) Centro de Ciências Moleculares e Materiais, Universidade de Lisboa, Lisbon, Portugal

In the second half of the 19th century, as the most advanced nations felt the need for the installation of submarine telegraphic communications, knowing the bathymetric and topographic charts of the oceans, became imperative. It was, however, after the famous Challenger Expedition's observations in marine physical and biological sciences from 1872-1876, that other nations were encouraged to take interest in oceanographic research and to organize their own expeditions.
Since 1885, Prince Albert I (1889-1922) of Monaco conducted oceanographic campaigns (1885-1915), publishing the accounts of these scientific results in the *Résultats des campagnes scientifique* and in several articles and books. He had the collaboration of some of the best scientists in marine biology and physics oceanography (Pouchet, Regnard, Richard and Buchanan). Oceanographic maps and charts were recorded. Many techniques and instruments were also devised for this oceanographic work. In his first campaign to the islands of Azores he and his team discovered fifteen new species living in low-sea conditions near the shore. The intense scientific activity of Prince Albert, certainly contributed to stimulate the interest of King Carlos I (1863-1908) of Portugal for the study of the oceans, its cartography and marine species. Although some oceanographic work had already been done off the coast of Portugal by the Challenger in 1873 and the prince of Monaco in 1894, King Carlos felt the need for a methodical study of the distribution and habitat of fishes, research on new marine species as well as the construction of bathymetric charts. He engaged the collaboration of a fine naturalist Albert Girard in all his expeditions (1896-1906).The general results of his campaigns were published in two works. Two scientific publications were also written by King Carlos, one on Algarve tuna (1899) and another on sharks (1904). The two monarchs exchanged information concerning the instruments and methods used in their oceanographic work which is well shown in an abundant correspondence between King Carlos and Prince Albert during the years 1894-1907. They both shared the need to use

photography to document and further their research. King Carlos took the first photomicrographs of plankton done in Portugal and in several expeditions organized by Prince Albert, photography was used in physical oceanographic determinations as well as in the anatomical studies of marine species (photomicrographs). The collections, instruments and biological species, the result of their oceanographic expeditions, were presented in several national and international exhibitions, thus contributing to the public awareness of marine life and conservation problems.
In this paper we will analyse how these two instrument collections reflect the contribution to the development of oceanography given by both monarchs and their scientific teams, focusing mainly on its photographic instruments, methods and iconography.

Flora Paparou
From the History of Ideas to the History of Places, Institutions, Instruments, and Scientific Cultures
Department of Chemistry, University of Athens, Greece

In the Deutsches Museum, one can visit the reconstruction of Galileo's laboratory and see the inclined plane, inside it. In the same area of the museum, just outside the historical laboratory, exhibits showing Archimedes's buoyancy experiment and free-fall experiment inside a Newton's tube are placed. This object-arrangement brings to mind the storyline that links Archimedes, Galileo and free-fall experiment. It also remind the philosophy-of-science scenario, according to which Galileo, who transferred the Archimedean notion of buoyancy from liquids to gases, and used it in conceiving falling-in-vacuum as an ideal situation of falling in a medium, whose density tends to zero.
In the Whipple Museum of the History of Science in Cambridge, "The Victorian Parlour" exhibition evokes the parlour of a 19th-century family interested in science. One can sit around the family's table and read scientific books from their collection; can open the drawers; can explore scientific objects placed in different corners of the room. A printed page of an advertisement, referring to an evening science event, informs that the family was to go to Mr. W. Richardson's popular lectures, in which a variety of electric, galvanic, electro-magnetic experiments were to be performed...
The present paper will analyze that the two different exhibition approaches are linked to two different historiographical approaches. The historical part of the Deutsches Museum exhibition, described above, is linked to the common 20th-century approach, according to which the history of science is identified as the history of ideas, while the Whipple Museum exhibition evokes the "metamodern" history of science trend, according to which the history of science has to interpret the scientific past contextually and to integrate in the history of ideas, the history of places, institutions, instruments, and experimental cultures.

Jean-François Loude
The Physics Museum at UNIL/EPFL
École Polytechnique Fédérale de Lausanne, Switzerland

Regular courses of Experimental Physics at the Lausanne Academy (founded in 1537 as a school for Protestant pastors, University from 1890) were not held before 1776, when a collection of demonstration instruments ("Cabinet de physique") was brought to Lausanne by the first physics professor. In parallel to the Academy, the École Polytechnique, founded in 1853 as a private engineering college, became part of the Academy in 1869.
Called École Polytechnique de l'Université de Lausanne (EPUL) in 1946, it was transferred to the Swiss Confederation in 1969 and took the name École Polytechnique Fédérale (EPFL) it bears today. The first "Ingénieur-physicien" diplomas were given by EPUL in 1950, simultaneously with the creation of an experimental physics laboratory. In 2003 the University of Lausanne (UNIL) closed its Science Faculty, letting the EPFL absorb its Chemistry, Physics and Mathematics Departments. Just before Physics was transferred from UNIL to EPFL, my colleagues wondered what to do with the important collection of old physics instruments at UNIL, part of the cultural heritage of Canton de Vaud. I had just retired, they knew I was interested, so my colleagues proposed that I should set a permanent exhibition (in short a Museum) in our physics building. The location was given, a fairly large public hall with recesses in the walls, where it was possible to install a maximum of eleven showcases without hindering the traffic of people and equipments, in addition to a small number of free-standing or wall display cabinets. Looking for old instruments, I tried to visit every room and to open every cupboard. I contacted old friends. Only instruments made before 1960 (with a few exceptions) were taken into consideration. Those for exclusive medical, pharmaceutical or biological use were excluded. The result, after more than 6 years of work, is a collection described in a scientific inventory of 863 files, and a Museum. Each inventory file, besides one to three photographs, includes a description and bibliographic references. About 2/3 of the objects come from the Experimental Physics Laboratory of UNIL, the oldest and the only physics laboratory at UNIL until late in the 1950s. They are representative of a typical university collection, with a mixture of instruments for lecture demonstrations, for students laboratories, for research, for professional, industrial or commercial use. The best represented categories reflect the main research interests of the 19th century: Electricity & Magnetism (45%) and Optics (24%). About 160 objects (maybe 200 in a near future) are now displayed, as far as possible thematically arranged, in a way somehow reminiscent of "Cabinets de physique" of old, but accompanied with short descriptive notices. A few of these instruments are what engineers like to call "Milestones", to say that science and technology were not the same before and after these instruments were introduced.

Session IX b
RESEARCH AND EDUCATIONAL TOOLS

Marco Galloni, *Mara Fausone*
Making Old Instruments Live Again: The Video Experience of Scientific and Technologic Archives, University of Turin
ASTUT - Archivio Scientifico e Tecnologico dell'Università di Torino, Italy

The Archivio Scientifico e Tecnologico dell'Università di Torino, was founded in 1992 when some researchers realised that it was necessary to create an institution devoted to the preservation of a large heritage of instruments, testimony for the history of science.
ASTUT collects, restores, studies and tries to improve the interest in instruments and objects of science and technology that were used in the different branches of the University of Turin. Archives' stores are full of instruments (since 18th century up to

a few years ago) that are an important part of our cultural heritage and we try to make them known through exhibitions. Sometimes mere exposure of these objects appears to be of little involving factor especially for young people and for those without competences in these fields. For such reasons, in the preparation of exhibitions ASTUT pays special attention to the right setting. Besides, whenever possible, we produce audio-visual aids to improve understanding; to see in a short video an old instrument that is functioning is more effective than hundreds of words trying to explain how it was used. We will consider several examples of our experience: both in reconstruction of environments with the correct details and in preparation of audio-visual media where instruments are made to be working again.

Christine Blondel, *Bertrand Wolff*
Historical Instruments and Experiments on the Web: Videos Between History, Physics, Education and Popularisation
Centre Koyré, CNRS, Paris, France

The technical easiness to make videos with digital cameras and to put them online has opened up new resources for the display of scientific instruments and historical experiments. The web shares with science museums the challenge of dealing with broader and mixed audiences. On the site Ampère and the history of electricity, the Education Course presents up to now twenty-five videos (30s to 9min) included in a series of chapters dealing with the history of electricity and magnetism (http://www.ampere.cnrs.fr/parcourspedagogique/accesauxvideos.php).
Within these videos, historical experiments are performed on instruments belonging to 19th and beginning of 20th-centuries teaching collections. These qualitative experiments – electrostatic attractions, electrophorus, Leyden jar, Aepinus cylinder, gas discharges... or Coulomb, Galvani, Volta, Oersted, Ampère, Faraday experiments –, are intended to present historical "milestones" and less known experiments in their context, and to offer materials to teachers and students. They disclose the experimental skills of natural philosophers and some of them are quite difficult to reproduce in a classroom such as Coulomb balance or Galvani's experiments on the frog which would moreover spark off debates. Some of them just try to give the flavour of 18th-century spectacular science.
As usually in experimental life, some of these electrostatic experiments, even very simples ones, raised questions or problems which led us to deeper investigations both in history and in physics. They are reviewed in the Historical Laboratory of the site (www.ampere.cnrs.fr/labo/index.php) alongside with discussions of Coulomb experiment, or Ampère "induction" experiment which produced divergent results since the end of 19th century. In this latter case a fresh look at historical sources and the involvement of engineer students helped to clarify the question and to precise the configuration of Ampère instrument.
Through the process of production of these videos, the original educational purpose was expanded to historical and scientific questions.

Elizabeth Cavicchi
Telescopes and Telescopic Acts Bring Galileo into my Classroom
Edgerton Center, MIT, Cambridge, Massachusetts, USA

Invited to play, observe and imagine with lenses and other materials, my students constructed homemade telescopes and conducted telescopic acts where events distant in time came into their immediate view. Through a variety of instruments, and the teaching method called "critical explorations", my students met Galileo, his telescope, and its wondrous observations in an undergraduate lab 400 years later. By exploring Galileo's writings and by experimenting in like manner with telescopes and other optical devices, the students found themselves faced with perplexing interpretations, behaviours they did not expect, and surprising observations. What students did in response was as fuelled by curiosity on their part, as were Galileo's investigations.
For example, the images they saw with a convex lens were confusing: upright or not; magnified or indistinct. As they experimented to build their understanding of the lens, students wondered how Galileo worked with and improved lenses. Were their confusions like his? Would their experiments recreate what he thought and tried with lenses? Being encouraged to record their observations in a personal journal, students wrote him letters in their journals. They described their experimental struggles, asked about his optical methods, marvelled at his observing skills, and shared the excitement of their discoveries and his. In class, my students actively engaged with optical practices and instruments of the past. Emulating artists of 15th-century Florence, my students sighted through empty picture frames from disparate vantage-points, diagrammed the differing scenes, and puzzled over spatial and pictorial relationships. They documented what a master artist did in blowing a glass "reticello" vase by a Renaissance glass-blowing technique. Optical effects of magnification, inversion, reflection, distortion and chromatic aberration emerged in combinations of lenses and mirrors. On looking through the eyepiece of a historical telescope in a museum showcase display, students wanted to know what object they were seeing. They searched to identify it.
As the teacher, I explored too, seeking to understand what my students tried and wondered about, and to respond with materials, readings or activities that might extend their involvement. In developing these experiences of teacher and students, I apply critical exploration, the research pedagogy developed by Eleanor Duckworth. This pedagogy has historical origins in the clinical interviewing of Jean Piaget and Bärbel Inhelder and the Elementary Science Study of the 1960s. In critical explorations, curriculum evolves interactively as students engage with provocative materials, while the teacher opens new possibilities and sustains students' tentative ideas. In their inventing and exploring with telescopes, my students were developing telescopic acts of mind by which the science of the past came into relation with observations that will become their future.

Session X a
PHYSICAL AND CHEMICAL INSTRUMENTS

Huib Zuidervaart
Play Things or Serious Devices? The Content and Usage of Dutch Cabinets for Experimental Philosophy in the Long 18th Century
Huygens Institute, The Hague, The Netherlands

The Cabinet for Experimental Philosophy is a well known cultural phenomenon in Europe during the long 18th century. In the Netherlands doing physical experiments in a small group of enthusiasts became very popular in the 1730s. A contemporary

presents us with a nice description of this Dutch trend towards popularisation:
"[These days, in 1737] everywhere societies are founded, in which one deliberates about physics and performs experiments. […] Every one seeks to be a connoisseur of natural philosophy. The merchant leaves his desk to work with the air pump and he does not hesitate to work in sweat on the composition of some apparatus. The artisan rests from his work to set himself to these things in which he takes far more pleasure. Yes, if one would believe it, even farmers who one would held as examples of stupidity, are practising mathematics and are trying to become a Natural Philosopher."
The lecture tour, made in the early 1730s by the English Newtonian J.T. Desaguliers, was instrumental in the rise of this Dutch hype for experimental philosophy. He amazed his Dutch public with spectacular demonstrations, in which entertainment and commerce seemed to be as important as the scientific component. The popularization of experimental philosophy which followed this tour generated a firm demand for scientific instruments as well as popular literature in this field.
At the Dutch universities the use of scientific instruments for instruction purposes had started earlier. In the late 17th century professors De Volder and Senguerd had introduced the experimental method at Leyden University. In 1717 their successor 's Gravesande intertwined this method with the then rising Newtonianism. During a London visit he had witnessed Desaguliers's lessons, and back home he put this method of instruction at the heart of his pedagogy. His book *Physices Elementa Mathematica, Experimentis Confirmata. Sive Introductio Ad Philosophiam Newtonianam* (1720-1721) became the leading book on the subject for a long time. The instruments described were designed in cooperation with the instrument maker Van Musschenbroek. It is said that these devices became so popular, that they were abundantly copied for the many cabinets of experimental philosophy all over Europe.
We will investigate this claim for the Netherlands, using preserved inventories of Dutch instrument cabinets of the period. Was the content of these cabinets really that much influenced by 's Gravesande's book? Or were other writers, like Desaguliers or Nollet, followed more prominently? Was there in this respect a difference between the institutional cabinets of experimental philosophy and the private one's? Who actually were the owners of these privately owned cabinets? And which use was made of the instruments in these cabinets: were they used for entertainment, contemplation, research or to show-off? I will address questions like these and will try to provide some (preliminary) answers.

Gloria Clifton
Paris, London and St Petersburg: the Role of Scientific Instruments and Their Makers in European Scientific Networks
Royal Observatory, Greenwich, United Kingdom

Manuscripts of astronomers preserved at the Paris Observatory reveal much about the importance of European scientific networks maintained by correspondence, in comparing observations, spreading knowledge and refining practice, from the 17th to the 19th centuries.
This paper will seek to explore the evidence the collections provide for the role played by instrument makers in these networks and the contributions of their instruments to the development of ideas or practices. It will also investigate whether any notable change in their influence occurred during the period under review.

Wolfgang Engels
Size Matters? The Big Lichtenberg Electrophorus
Universität Oldenburg, Germany

In 1762 Johan Carl Wilcke invented the electrophorus which later was improved by Alessandro Volta and Georg Christoph Lichtenberg. Compared to frictional electrostatic machines the simple electrophorus turned out to be much more reasonable for doing research on high tension electricity than other machines. Sophisticated friction machines had to be manufactured by skilled instrument makers, and they required expensive material.
In contrast the necessary material for an electrophorus was available for anyone and the manufacturing could be managed by the researchers themselves. It also turned out that building gigantic machines without unsolvable peculiar or financial problems was possible. In 1777 Lichtenberg did successful experiments with a big machine which was able to generate sparks of about 30 cm. These experiments have been repeated with a replication of the instrument reconstructed on the base of historical letters.
This reconstruction has been possible thanks to the support of the Fondazione Scienza e Tecnica and of the Ente Cassa di Risparmio of Florence.

Peter Heering
Looking Again at Coulomb's Torsion Balance Experiments
Institut für Physik und Chemie und ihre Didaktik, Universität Flensburg, Germany

Coulomb's torsion balance can be taken as an instrument that became canonical through the history of physics. However, even though the experiments described by Coulomb were frequently quoted in physics textbooks, it was particularly the analysis with the replication method that resulted in a historical debate on the meaning of the experiment and the data published by Coulomb. Recently, several papers were presented, either based on experiences with independently reconstructed torsion balances, or attempting to summarize this work. Parallel to these approaches, several other experiments by Coulomb were analyzed with the replication method, among them Coulomb's experiments on the torsion of metal wires, on charge leakage, and the experiments from his collaboration with Cassini. Through these additional case studies, it was attempted to develop a more thorough understanding of Coulomb's experimental practices and his understanding of the role of experiments in the process of producing scientific knowledge.
In my presentation I am going to discuss both approaches and will suggest an interpretation that appears to be more adequate than the traditional perspective on Coulomb's work as being completely empirical.

Session X b
RESEARCH AND EDUCATIONAL TOOLS

Elena Corradini, *Silvia Rossi*, *Sara Uboldi*

Educational Programmes for the Cataloguing of Scientific/Technological Heritage: A Fundamental Tool for Preservation, Safeguard and Valorisation
Università degli Studi di Modena e Reggio Emilia, Italy

The main purpose of educational programmes for cataloguing scientific-technological heritage is the opportunity to experiment the catalogue file for different kinds of technical and scientific goods, in order to share and to make available cognitive data regarding scientific-technological heritage by accessing information in a common database. This will be possible through the use of the PST catalogue file realized by the Central Institute for Cataloguing and Documentation of the Italian Ministry for Cultural Heritage and Activities within the Masters course in Computer cataloguing for the valorisation of cultural heritage of the University of Modena and Reggio Emilia.
Cataloguing is the fundamental tool to support preservation and safeguard activities, but also for the study and scientific research, and it can be used as basic scientific tool to prepare educational and indicative material, specifically designed to spread the knowledge of cultural heritage within different publics.
Moreover, cataloguing allows museums to show data regarding the information acquisition activity and the management of recorded cultural heritage through publications, conferences and presentations of results.
In particular, cataloguing is a useful tool for valorisation and promotion of cultural heritage and territory: for example, it can support cultural heritage educational activities by allowing to design educational paths and cultural-touristic itineraries. The relationship with the territory is therefore fundamental to disclose not only the significance of the materiality of cultural goods but also the intangible dimension of knowledge, techniques and know-how that lays behind cultural heritage.

Josep Batlló (a), *Susana Custódio (b)*, *João Narciso (b)*, *Paulo Ribeiro (b)*, *Fernando C. Lopes (b)*, *Décio Martins (c)*, *Celeste R. Gomes (b)*
The Collection of Historical Instruments of the Geophysics Institute of the Coimbra University: Its Importance for Present Research and Science Education
a) Instituto D. Luis - CGUL, Universidade de Lisboa, Portugal
b) Centro de Geofísica, FCT, Universidade de Coimbra, Portugal
c) Departamento de Física, FCT, Universidade de Coimbra, Portugal

The Geophysical Institute of the University of Coimbra (IGUC) was founded in 1864 as the meteorological and geomagnetic observatory of the University. Its present name was adopted in 1925, reflecting the growth and expansion of the observatory's research fields. Its foundation is the result of the institutionalization of previous efforts in these fields developed at the University of Coimbra during the first part of the 19th century. IGUC first design was highly inspired on that of the Kew Observatory in the United Kingdom. IGUC is the origin place of a continuous and homogeneous series of meteorological and geomagnetic data. It is also the place where regular seismic recording started in mainland Portugal and early Solar-Terrestrial Physics studies took place. A large amount of the instruments used at the IGUC are still preserved and they constitute, together with their records and the preserved early architectural design of the building, an impressive collection to study the evolution of geophysical instrumentation and data recording on the last 150 years.
In this research we will present the characteristics and importance of the documental and instrumental heritage of IGUC. We start by explaining the conditions that led to the foundation of IGUC. We then proceed with a section on the earliest studies of Earth Sciences at the UC. The following sections are dedicated to the development of research on geomagnetism, meteorology and seismology at IGUC. Here we focus on the instruments and records collected and used throughout time at the observatory. We further give some examples of the use of old records, such as the ones preserved at IGUC, in modern scientific studies. Ongoing efforts aim at preserving IGUC's invaluable heritage, which owns not only museological interest but also a striking significance for modern science and science education.
Nowadays the different sections of the Geophysical Institute are visited by secondary teachers and students in a formal way of teaching and learning. The Portuguese curricula of Sciences include some geophysical contents, especially about earthquakes, its origin and hazards, in a perspective of science, technology, society and environmental education. The opportunity given to the students to observe the different instruments and records guided by didactic materials constructed according to the curricula guidelines is very important in order to promote a significant learning. The instruments, records, objects and knowledge preserved throughout time are also important for learning with historical concrete examples. The high level education and teaching education on seismology are also implemented at the IGUC.

Marcus Granato (a), *Marta C. Lourenço (b)*
Thesaurus of Scientific Instruments in Portuguese: Networking for Preservation and Access
a) Museo de Astronomia e Ciências Afins, Rio de Janeiro, Brazil
b) Museo de Ciências da Universidade de Lisboa, Portugal

The preservation of scientific heritage is a major challenge in present-day society. Dispersed through a multitude of institutions – from universities to schools and research laboratories – and unprotected by cultural heritage legislation, the preservation of scientific heritage needs to gradually change from a museum-based approach to an approach increasingly oriented towards in situ preservation, sustained by networks and partnerships at national and international scale. This shift has several implications in training and the provision of reference materials.
The Museum of Astronomy of Rio de Janeiro (MAST) and the Museum of Science of the University of Lisbon (MCUL) realised that few of these reference materials exist, both in Portuguese and in other languages. Since 2006, and inspired by similar experiences in France and Italy, they have been involved in the production of a thesaurus of scientific instruments in Portuguese. This task involved from the beginning a network of institutions. Apart from the MAST and the MCUL, the following institutions are involved: in Brazil, Pedro II Secondary School (Rio), Museum of the Polytechnic School (Rio), Museum of Science and Technique (Juiz de Fora), Museum of Pharmacy (Juiz de Fora), Museum of Science and Technology (Ouro Preto), Museum of Pharmacy (Ouro Preto); and in Portugal, Science Museum (Coimbra), Museum of Science (Porto), Museum of the Faculty of Engineering (Porto), Museum of Physics of the High Institute of Engineering (Lisbon), Museum of the High Institute of Engineering (Porto).
These institutions cover, in total, more than 60,000 scientific instruments from the 18th, 19th and 20th centuries.
The thesaurus will be an important terminology control and access tool for museums and other institutions with collections of scientific instruments. It will include an illustrated glossary and will be universally accessible in 2011 in print, DVD and online. In this paper, we will present the recent developments of this project. We will discuss the methodology and present its first results.

We will also use the experience of the Portuguese and Brazilian network to discuss the relevance of partnerships in meaningful and sustainable preservation of scientific heritage.

Session XI a
PHYSICAL AND CHEMICAL INSTRUMENTS

Michel Morizet
The "Diagomètre de Rousseau":
A Really Innovating Instrument and the First "Black Box"
Private collector, Versailles, France

The "Diagomètre de Rousseau" was designed in 1822 by a certain Mr. Rousseau of Paris to check the purity of the olive oil which, at that time, was often diluted with cheaper oils in order to increase profit.
This invention is based on the electrical conductivity of oil, which varies by type. Pure olive oil has a low conductivity but, adding one percent of beech-nut oil decreases the conductivity by two.
This method, which replaced a hard chemical analysis by a simple electrical measure, was mentioned and often praised for a hundred years by many eminent physicists such as A.C. Becquerel and Mascart.
Viewing this apparatus from our 21st century perspective, it appears to be a purely electronic device and is perhaps the ancestor of the "black box."

Roberto Mantovani
Before Ruhmkorff: Induction Coils in Italy
Gabinetto di Fisica, Museo Urbinate della Scienza e della Tecnica, Università di Urbino "Carlo Bo", Italy

It is well known that between 1850 and 1852 the Parisian maker Heinrich Daniel Ruhmkorff introduced crucial improvements into the induction coil. Ever since 1836, various scientists and instrument makers had made small models incorporating their developments and improvements into the coil. Interest in this device was strongest in America, England and France, where it was used for medical purposes.
In Italy the new instrument was introduced and described for the first time at the beginning of 1841 by professor Gianalessandro Majocchi of Milan in the first number of the Annals of Physics, Chemistry and Mathematics, of which he was editor. In this journal, Majocchi published a drawing of the Bachhoffner induction coil model, which he copied from Sturgeon's Annals printed in 1837. Shortly after the publication of this description, a new model of induction coil was proposed by Carlo Dell'Acqua, instrument maker and physics assistant at the Liceo Sant'Alessandro in Milan (the same school where Majocchi taught physics). He shaped his model by ingeniously adapting the Ritchie electro-magnet motor as rotating breaker. This design of coil spread in the northern area of Italy until about 1850, being used primarily by physicians for electrotherapy. After the Dell'Acqua model a further design of induction coil was proposed, essentially for teaching purposes, by the Italian scientist Luigi Palmieri. This apparatus, made by the Neapolitan instrument maker Giovanni Bandieri, was essentially a modification of the Rev. F. Lockey's induction coil. Palmieri added two different interrupters at the Lockey breaker of the primary circuit: a vibrating iron hammer break and, from Dell'Acqua, Ritchie's revolving voltaic-magnet.
This latter interrupter was studied in Verona by the Italian physicist and priest Vincenzo Vignola, probably at the end of 1850. Vignola invented an improved and more efficient version of Dell'Acqua's breaker, which he assembled into an improved coil. In 1851 the Vignola apparatus was awarded a gold medal by the Academy of Agriculture, Arts and Commerce of Verona "for introducing important and useful changes in the Callan's electromotor". The original award-winning coil has been identified and is preserved in the collection of the Museum of Physics "Antonio Maria Traversi" in Venice. Documents relating to the history of the coil development have been found in Verona.

Paolo Brenni
The Tamed Lightning: The Uses and the Diffusion of High Voltage and High Frequency Apparatus (1890-1950)
CNR; Fondazione Scienza e Tecnica, Florence, Italy

In the 1890s the researches of Nikola Tesla and Elihu Thomson showed the very peculiar properties of high frequency currents. Tesla's oscillators and transformers produced powerful effects such as long electric sparks and luminous effluvia. Electric tubes without connection with the generators were lighted up in an high frequency field. Furthermore, when the so called Tesla's currents passed trough the experimenter's body they did not produced the painful shock and the muscular contractions which were associated with low frequency currents. While Tesla struggled to use high frequency currents for the wireless transmission of energy, their physiological effects were investigated by the French physicist and physiologist Arsène d'Arsonval, who inaugurated the high frequency therapy soon baptized "darsonvalisation". In Europe as well as in the USA the new therapy became fashionable and aroused great hopes in the medical community. Until the 1940s electrotherapists tried to cure with the darsonvalisation many pathologies and diseases such as diabetes, obesity, tuberculosis, several types of skin cancers, paralysis, etc. Instrument makers proposed a new array of large and sophisticated electro-therapy apparatus including powerful transformers and induction coils, Leyden jars, spark gaps, auto-conduction solenoids, condensing beds, electrodes which transformed many medical practices in electrical laboratories. At the same time domestic high frequency therapy became very popular thanks to the portable "violet rays" apparatus.
But, if the surprising phenomena of high frequency currents entered as "classical" demonstrations in the physics courses and in popular science exhibitions, in the first decades of the 20th century they were also exploited in the vaudevilles and in the fairs where magicians and showmen proposed spectacular experiments using powerful Tesla's transformers. These performances were a blend of science, occult, magic and mystery. But also the movie industry, before the era of computer generated special effects, largely used Tesla's apparatus for generating artificial lightning and for equipping the laboratories of cinematic evil "mad scientists".
In my paper I will illustrate the evolution of high frequency and high voltage apparatus as well as their use and diffusion in different professions and in various fields of application.

Martin Panusch

The Development of Millikan's Oil Drop Experiment

Institut für Physik und Chemie und ihre Didaktik, University of Flensburg, Germany

In the discussion of Robert A. Millikan's oil drop experiment, the impression is created that this is one experiment and consequently one apparatus. But a closer analysis of the publications of Millikan and his assistant Harvey Fletcher reveals that the drawings and the descriptions differ in several relevant details. It is possible to identify at least four different apparatuses (or more accurately speaking four variants of one apparatus) that Millikan and Fletcher used in their researches. With an analysis of the drawings and descriptions, the development of the apparatus can be reconstructed. Every step of this development can be interpreted in terms of optimising the apparatus – in this respect, the stabilization of the measurement appears to be a crucial aspect.
Currently, there is an oil drop apparatus on display in the "Science Storms" exhibition in the Museum of Science and Industry in Chicago. It was donated to the museum in the 1930s and is considered to be one of Millikan's original set-ups. However, this is not the apparatus which is represented in numerous pictures that can be found in the internet. Before the Chicago set-up went into the showroom I had the opportunity to take measurements and pictures of the apparatus.
The comparison of the artefact with my analysis of the drawings and the descriptions gave me the opportunity to examine the correspondences and dissimilarities between the publications and the apparatus. My measurements enabled an analysis which shows how the apparatus in the exhibition corresponds to drawings and descriptions in the publications of Millikan and Fletcher. In my presentation I will summarize the development of Millikan's oil drop experiment apparatus. In doing so, I will refer to the drawings, pictures and descriptions in Millikan's and Fletcher's publications and relate these information to the apparatus kept in Chicago.

Session XI b
RESEARCH AND EDUCATIONAL TOOLS

Vincenza Ferrara (a), *Marinella Calisi (b)*

Astronomical and Copernican Museum: Online Catalog of Scientific Instruments

a) Sapienza Università di Roma, Italy
b) INAF – Osservatorio Astronomico di Roma, Italy

In recent years online communication has become an opportunity for the promotion of cultural heritage and the dissemination of scientific culture and artistic history. Through the web you can use a new communication model that contextualizes the cultural object with the ability to make accessible to all, appropriate language, knowledge within a virtual windows open on their collections.
The Copernican Astronomy Museum for years has taken up the challenge of this new model of developing a "sss" catalogue card (*strumenti scientifici storici*, historical scientific instruments) and creating a catalogue available online in HTML format. Since 2000, for technical problems, these catalogue cards haven't been longer available on the Web, and so following a new design of the website of the museum we've decided to study the possibility of recovering information already catalogued and implement an information system for their management and publication on the Internet.
There are several museums over the years have used new technologies to catalogue their collections for both internal management and for making available to scholars or to all people to meet the needs of disseminating knowledge and of their scientific patrimony. But sometimes the evolution of technology has resulted in the loss of information that, with difficulty, were collected with software obsolete. We will submit a project that has attempted to solve this problem for to retrieve automatically the information already collected and catalogued and then the publication and accessibility on the WEB. First goal of the project was to study the organization of information with the structure of a database according the "sss" catalogue cards.
We have proceeded to implement a software to retrieve information from the HTML pages produced in the past and the automatic population of the database. For this purpose, it has been used php technology installed on Apache server software and MySQL to database management.
It has been designed and implemented the information system that allows management information by the responsible scientific of the Museum and their Web publishing for content accessibility.
It's possible connect to link http://w3.uniroma1.it/labinfo/minerva/museo/index.htm for the access the website of the museum while the information system is is being tested to be made available the collection of scientific instrument.

Santiago Vallmitjana (a), *Josep Batlló (b)*, *Pedro Ruiz (c)*, *Jaume Valentines (d)*, *Gabriel Vidal (e)*, *Alfons Zarzoso (f)*

Database and Cataloguing of the Collection of Scientific Instruments Owned by the Faculty of Physics of the University of Barcelona

a) Departament de Física Aplicada i Òptica, Universitat de Barcelona, Spain
b) Instituto D. Luiz, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal
c) Instituto de Historia de la Medicina y de la Ciencia, Universitat de Valencia, Spain
d) ETSEIB - Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, Spain
e) Departament d'Enginyeria Electrònica, Universitat Autonoma de Barcelona, Spain
f) Museu d'Història de la Medicina, Barcelona, Spain

The Faculty of Physics of the University of Barcelona has an important collection of scientific instruments that has accumulated over a period of a hundred and fifty years of academic and research life. Unfortunately, no task of cataloguing, conservation or recovery was made, until the end of the eighties when preliminary work of inventory and restoration started. Since then the Faculty of Physics has promoted restoration work of the elements that are in a deficient state and to carry out serious systematic work of inventory, study and cataloguing of this patrimony.
Thanks to the concession of the project HAR2008-02580-I/HIST (through the Proyectos de Investigación del Ministerio de Ciencia y Innovación, within the framework of Plan National of I+D+I), the elaboration of a data base and the development of a first version of a catalogue of about two hundred scientific instruments of the Faculty of Physics of the University of Barcelona has been possible.

Several achievements of this work will be presented, allowing us to appreciate that in quality as well as in components, it is undoubtedly one of the most important collections of Catalan scientific instruments and which constitutes a part of the history of science in Catalonia.

Session XII a
PHYSICAL AND CHEMICAL INSTRUMENTS

George Brock-Nannestad
Human Interpretation of Scientific Data
Indipendent scholar, Patent Tactics, Gentofte, Copenhagen, Denmark

Scientific data are obtained by observation, either unaided or by the means of instruments performing measurements or recording. All data are subjected to human interpretation, with one philosophically important exception. Ever since feedback control became conscious, measurements gave rise to internal, invisible data that were used in a mechanism without human intervention, and only the range of interest was specified.
If sampling occurs, we have a series of measurements, of data points. If recording is continuous, we have an infinite number of measurements available for later interpretation. All measurements and recordings are subject to errors and uncertainties, and wise human interpretation takes these into account. Many empirical physical laws have been obtained by polynomia following "best fit" curves through the swarm of data points in a two-dimensional representation. Very frequently a visual analysis is performed, because this is a well-tried method for identifying patterns. Quoting Peter Fellgett, FRS: "In most cases, a scientific instrument is devised in the first place as a means to the end of making some physical phenomenon or quantity susceptible to observation or measurement, and once it has served this purpose nobody thinks very deeply about it again. Consequently, it is often tacitly accepted that 'in theory' an instrument should have a particular performance, but 'in practice' it does not. This however is not good science, which demands that if theory and practice differ, then one or both must be improved" (1984).
As an elaborated example of the data that we subject to human interpretation we shall use the recording of the variations in atmospheric pressure that we know as 'sound'. We shall look at the first graphic recordings of airborne sound, performed by Édouard-Léon Scott around 1857 and at the first scientific tin-foil recordings by Fleeming Jenkin and J.A. Ewing, which happened 20 years later. The field of recorded sound and its uses is very rich, but these two types of recording demonstrate a few fundamental principles.
Scott's approach was visual, interpreting the curves as representing the performance practice of utterances, whereas that of his instrument maker Rudolph Koenig was analytical, and Jenkin and Ewing used Fourier analysis of the recorded sound as their primary analysis tool. They were, however, also aware of the new development: 'reproduction of sound' and applied it judiciously.

Alexander Jonckheere, *Kristel Wautier*
Jules Duboscq and the Bioscope: A Missing Link in Early Visual Media Brought Back to Life
Universiteit Gent, Museum voor de Geschiedenis van de Wetenschappen, Ghent, Belgium

The 1830ies were a thrilling time regarding visual media. It marked the birth of two optical illusions, which still capture the imagination of people worldwide.
In 1832 the physicist Joseph Plateau (1801-1883) developed the illusion of movement for the first time. He based his invention on the aspects of stroboscopy (as first described by Faraday) and the "persistence of vision" (the subject of his own research). This resulted in the first moving image device, the world famous phenakistiscope or fantascope, commercialized by Ackerman. At the same time another physicist, Charles Wheatstone (1802-1875), made an important discovery on human vision. He pointed out that the left eye registers a different perspective of the surroundings than the right eye. After quantifying these differences he was able to reproduce the illusion of depth in drawings and photographic imagery resulting in the first stereoscopic images. David Brewster (1781-1868) continued to improve the marketability of these images by developing the lenticular stereoscope.
The Parisian instrument builder Jules Duboscq (1817-1886) played an important part in the early commercialisation of both inventions. In 1852 however, he took these principles one step further. He developed the bioscope, a device that produced "the illusion of life" by combining the features of the phenakistiscope with those of the stereoscope. The bioscope did not become a commercial success, but deserves merit for not only producing the first stereoscopic moving image, but also the first moving photographic image.
The device disappeared completely, the only proof of its existence being the patent from 1852, the catalogues by "Maison Jules Duboscq" and several articles in scientific or artistic literature. Around 1990 however a bioscope disc was rediscovered in the Joseph Plateau Collection at the Museum for the History of Sciences at Ghent University, the only known remaining disc today. The device needed to "play" the disc remained a mystery.
Until today, based on the original description by Jules Duboscq and a drawing of the bioscope in his catalogues, a working prototype of a replica of the device was produced at the Museum for the History of Sciences at Ghent University, bringing this missing link back to life and providing new insights on the features and limitations of this enigmatic piece of visual media history.

Neil Brown
A Neglected Instrument: The Significance and History of the Diffraction Grating
Formerly The Science Museum, London, United Kingdom

It has been said that no single tool has contributed more to the progress of modern physics than the diffraction grating, especially in its reflecting form. Yet there is very little about diffraction gratings in writings on the history of science and technology, and they rarely feature in instruments on display in science museum though they can often be found in reserve collections.
This paper begins by examining the significance of diffraction gratings in improving spectroscopy and thus promoting the development of astrophysics and of atomic and molecular physics. It then discusses the history of the making of diffraction gratings and the building of the ruling engines on which they were produced, through the work of the main practitioners: the

independent astronomer Lewis Rutherfurd, Henry Rowland at Johns Hopkins University, Albert Michelson in Chicago, the Mount Wilson Observatory, MIT, the Bausch and Lomb Corporation and the Richardson Grating Laboratory that grew out of it, plus a mention of less significant figures such as Lloyd Blythswood, with examples of gratings now in the collection of the Science Museum in London. The paper concludes with some tentative observations on the reasons why diffraction gratings feature so little in the published history of science and in displays in science museums.

Olympe Jouet, *Axelle Amon*, *Dominique Bernard*
Jules Violle's Actinometer: A Simple Instrument to Deduce the Temperature of the Sun from Measurements with a Thermometer
Université de Rennes 1, France

The French physicist Jules Violle (1841-1923) is known for his works related to radiometry, photometry and calorimetry. He has published numerous experimental studies about the radiation law, i.e. the relation between the energy radiated by a body and its temperature. He performed a study about the determination of the effective temperature at the surface of the Sun (1). At that time, estimations of that temperature were spreading several orders of magnitudes and the validity of the admitted laws at very high temperature was discussed (2).
J. Violle made his measurements with an actinometer, an instrument he improved to fulfil his specifications. This system is constituted of two concentric metallic spheres with several openings. A thermometer can be introduced inside the precinct. A hole in the spheres allows radiations to enlighten and warm the bulb of the mercury thermometer placed in the centre of the system. J. Violle has measured the temperature reached in a permanent regime and the temperature variation rate at the opening or closure of the aperture. The important effect of the absorption of the radiations by the atmosphere can be estimated by doing measurements at several heights and J. Violle is famous for having done several experiments at the Mont-Blanc summit (1871-1875).
His measurements lead to a value of 2,540 cal.min-1.cm-2 (1771 W.m-2) for the solar constant (present accepted value: 1368 W.m-2) and ~1500°C for the effective temperature of the surface of the Sun (2, 3) (present accepted value: 5254°C). In order to deduce those values, he used the empirical radiation law accepted at that time: the Dulong and Petit law which is no longer used since the Planck theory.
At the Université de Rennes 1, valorization of our scientific collections leads us to develop with Master students detailed studies of several instruments of the 19th century: history of the instruments but also restoration and operation. With a well-conserved Violle's actinometer built by Ducretet around 1900, we have performed measurements which lead to a value of 1218°C for the effective temperature of the surface of the Sun without taking account atmosphere effects and using the Dulong and Petit law. By taking account the atmosphere effect in a new manner and using the Stefan law, the same data leads to a value of 5786°C for the effective temperature of the Sun, showing the accuracy of the method used by J. Violle.
In a pedagogic point of view, conservation and valorization of scientific instruments is of great interest for the students formation. It gives them an insight into the evolution of theories and a better understanding of the meaning of measurements.

(1) *Annales de Chimie et de Physique*, 10, 289 (1877)
(2) *Comptes-Rendus des séances de l'Académie des Sciences*, 78, 1816 (1881)
(3) *Comptes-Rendus des séances de l'Académie des Sciences*, 78, 1425 (1881)

Session XII b
ASTRONOMICAL INSTRUMENTS

Yaakov Zik, *Giora Hon*
Science and Instruments: Levi ben Gerson's (1288-1344) Pinhole Camera
Department of Philosophy, University of Haifa, Israel

In his *Astronomy*, Levi ben Gerson discussed, inter alia, the functioning of the pinhole camera. Levi based his analysis on Euclidean geometry. Since the time of Euclid geometry had been the tool for addressing theoretical and practical problems in optics and astronomy. Levi is no exception in appealing to geometry while developing a theory of the pinhole camera. He assumed rectilinear propagation of rays in the projection of light and the casting of shadow on a screen behind pinhole. Levi went, however, beyond the longstanding tradition of measuring the diameter of the luminaries, for he developed an instrument and a method for finding the angular size of the radius of the Sun and Moon.
We follow the way Levi combined theory with instrument. Specifically, we document how he determined whether or not the Sun's sphere is eccentric to the centre of the world, using the projection of light through an aperture. Apart from pursuing an intense study of observational and theoretical astronomy, Levi consolidated the triad, method, theory, and instrument.

Sreeramula Rajeswara Sarma
Indian Astronomical Instruments in Italy
Formerly Aligarh Muslim University, Uttar Pradesh, India

Since several years, I have been cataloguing pre-modern astronomical instruments produced in India. So far I have collected information on some 450 specimens in museums and private collections in India, Europe and the USA. A descriptive catalogue of these specimens is currently under preparation. The catalogue will contain historical surveys of each instrument type and full technical descriptions all the extant specimens.
In Italy, there are eleven Indian instruments in private collections: five Indo-Persian astrolabes, one bilingual Zarqali astrolabe, three Sanskrit astrolabes, one Sanskrit celestial globe, one Indo-Persian sine quadrant and one Sanskrit universal ring dial.
In this lecture, after a quick overview of my project, I shall describe these eleven instruments briefly and then discuss in detail two unique specimens, viz. the bilingual Zarqali astrolabe with legends engraved in Persian and Gurumukhi scripts and the Sanskrit Celestial Globe on which the scales are labelled in Sanskrit alpha-numerical notation.

Michael Korey
New Light on an Old Master? Thoughts on Two Celestial Instruments by Christoph Schissler
Mathematisch-Physikalischer Salon, Dresden State Art Collections, Germany

In a series of noted studies in the 1950s and 1960s, Maximilian Bobinger compiled a great deal of information on the renowned 16th-century instrument maker Christoph Schissler of Augsburg.
A recent re-examination of some of Bobinger's sources – both material and archival – has revealed unexpected features of several of Schissler's lesser-understood celestial instruments. These new details and a number of open questions form the subject of this presentation.

Samuel Gessner
Fit for a Princely Collection: News About the Schissler Globe (1575) in Sintra
Centro Interuniversitário de História das Ciências e da Tecnologia, Lisbon, Portugal

Christoph Schissler the Elder (c. 1531-1608) is known for having produced mathematical instruments of precious material intended to correspond to the aristocratic rank of their future owners. In several instances he also produced written instructions about the use of the instruments, but he could neither impose nor foresee what their use would eventually be. Even if not explicit, no doubt, "displaying" was one of the "uses" many of his instruments were made for. This is certainly true in the case of the big celestial globe, made up of a brass structure and covered by engraved and fire gilt copper gores (Palácio Nacional de Sintra, Portugal, inv. 3457).
From the scarce hints we have about the globe's fortunes, from the 16th to the 20th century, the ways in which it has been displayed (or not) can be guessed at. On this basis, I will try to show how the manner of displaying in turn reflects the temporary status of this particular globe: as a potential calculating device, as a teaching tool, as a symbol of knowledge, or an historical treasure.

Session XIII a
PHYSICAL AND CHEMICAL INSTRUMENTS

Andrea Bernardoni
What Did Leonardo da Vinci's Chemical Laboratory Look Like? A Preliminary Survey
University of Bergamo, Italy
Museo Galileo, Florence, Italy

Leonardo is usually presented as an artist-engineer and scholars have mostly focussed their attention on his production in arts, mechanics, and on his philosophy of nature. Against this background, very few studies have been devoted to the examination of Leonardo's chemical interests and thoughts. Leonardo's notebooks contain in fact the description of many kinds of chemical processes such as the preparation painting's pigments and solvents and other substances to metallurgical uses, or his survey of the foundry system to cast artilleries which is one of the oldest references we have on this topic.
Although we do not possess direct references concerning Leonardo's laboratory, through the chemical apparatus displayed in his wide manuscript production we shall sketch a tentative reconstruction of the organisation of his workshop.

Alexey Emelyanov
On History of Chemical Glassware Production in Russia
Institute of History of Science and Technology, Russian Academy of Science, St Petersburg, Russia

The first factory to produce chemical glassware in Russia was opened in 1807 not far from St. Petersburg, by Ivan Riting, an entrepreneur of German origin. Before that glassware for laboratories and pharmacies were imported from Western Europe. For many years Riting's factory was the only one to supply all the scientific institutions in Russia. By the end of the 19th century chemical glassware from Germany, England, Austria and the USA penetrated to Russia. They proved to be better than Riting's. Riting's grandson who owned the factory then asked professor Vecheslav Tistchenko to make better technologies. Finally Tistchenko's glass (No 23 and 24) won the gold medal at the World Exhibition in Paris in 1900. The glass remained the best until Tistchenko retired from this job at the end of the 1920s.
And gradually the production of the factory (then called "Druzhnya Gorka" got worse. Since then Russian chemists have preferred to use German glassware.
Nowadays Druzhnaya Gorka's production is very rare. You can hardly find it in chemical laboratories but still there some samples. There is a small collection in the Museum of Chemical Faculty of St. Petersburg State University, several items in Mendeleev's Museum. We have taken some photos of them.
Druzhnaya Gorka still exists but it is about to close down.

Session XIII b
ASTRONOMICAL INSTRUMENTS

Giorgio Strano
Restoring Santucci's Armillary Sphere at the Museo Galileo in Florence: Part II
Museo Galileo, Florence, Italy

Over the last four years, Antonio Santucci of Pomarance's large armillary representing Aristotle's structure of the Cosmos has been the object of intense research and restoration. Between 2006 and 2008, the Institute for Valorising Wood and Arboreal Species (IVALSA) of the Research National Centre (CNR), and by the Opificio delle Pietre Dure of Florence completed a series of analysis of the instrument. These helped in the first stage of the restoration process.
During the temporary closure of the old Institute and Museum of the History of Science of Florence's permanent collections, the armillary was dismounted, revealing the reverse construction procedure devised by Santucci in 1593. The instrument was then moved to the Relart restoration laboratory in Florence. While there, the materials employed by Santucci and his collaborators

were further analysed. These studies distinguished which parts were original from the artefacts made during the instrument's two former restorations that took place in the second half of the 19th century and, again, in the first half of the 20th century. The final restoration plan of action for the armillary was jointly made by the restorer, the Museum's curator and an expert from Florence's Superintendence on Cultural Heritage.
The actual restoration work took place between 2008 and 2010. The instrument was cleaned by removing old "protective" varnishes as well as the most part of old restorations artefacts. The true colours of the armillary finally reappeared after several layers of altered shellac and dust has been removed. The structure of the instrument was consolidated. Some fragments of the wooden rings that had been discarded during former restorations were recovered and re-included in the armillary. The rotation of the armillary was also partially recovered. The method of chromatic selection was used for the pictorial integration of some missing parts of the paintings. Finally, in June 2010, the new Museo Galileo presented Santucci's 400 years old armillary in all its original splendour to the public at the centre of its new Room on Cosmography.

Peter Abrahams
John Hadley and the Construction of Early Reflecting Telescopes
Independent scholar, Portland, Oregon, USA

John Hadley of Essex constructed the first functional reflecting telescopes, circa 1720. Hadley applied a scientist's skills to a craftsman's problem, improving the earlier reflectors of Newton and Gregory to the degree that useful astronomical observations could be made. Furthermore, he instructed commercial instrument makers in his techniques, with an openness that is uncharacteristic of his era. These detailed verbal instructions were incorporated into the 12 page chapter on making telescope mirrors published in Robert Smith's *Compleat System of Opticks* of 1738. Hadley's techniques therefore survive as a fairly thorough account of this very early development of speculum metal optical systems.
A brief account of Hadley's life and his important navigator's octant will provide perspective on the abilities of this mathematician and instrument maker.

John L. McKnight
A Telescope for the 1760's Transit of Venus
College of William & Mary, Williamsburg, Virginia, USA

In 1761 and 1769 the planet Venus passed across the disk of the Sun. This afforded a way to more accurately determine the distance between Earth and the Sun, and, as a result, using Kepler's Laws, to find the scale of the Solar System. A telescope in the Colonial Williamsburg collection, by John Bennett of London and dating from the 1760s, has a novel attachment, which modern measuring techniques have revealed to be a thoroughly adequate filter to permit visual solar observation.
This paper will detail the optical nature of the telescope and the filter and discuss the techniques used in the measurement of it's transmissivity.

Santiago Vallmitjana
Three Telescopes Belonging to the Faculty of Physics of the University of Barcelona
Departament de Física Aplicada i Òptica, Universitat de Barcelona, Spain

In the heritage of scientific instruments of the Faculty of Physics of the University of Barcelona we can highlight three different telescopes acquired between 1875 and 1925. Each one has different characteristics and different chronicles of acquisition, uses and applications. Concerning their display to the public, it is also necessary to make differentiations.
In the first place a refractor telescope is presented with a massive wooden altitude-azimuth mount, endowed with inverter lenses, which makes it more suitable for terrestrial uses than astronomic ones. The acquisition was promoted by the chair of Optics and Acoustics with didactic purposes. It was constructed in Barcelona, by a local lens-maker, and is the oldest of the three elements shown in this work. The telescope is located at present in the office of the director of the department of Applied Physics and Optics.
The second is a refractor telescope with a 22 cm aperture on an equatorial mount, made by the French R. Mailhat Company, with a twin tube (both visual and photographic objectives). This telescope, including a dome of 5.3 m of diameter was acquired by the Catalan patron Rafael Patxot i Jubert (1872-1964) in 1895, and was installed in the town of San Feliu de Guixols on the Costa Brava. Some years later he donated it to the Astronomical Society of Barcelona, which finally made a donation to the Faculty of Sciences in 1923. At present a project of visits by school's students is under consideration.
The third instrument in concern is the first refractor equatorial telescope acquired by the University of Barcelona, with a five-inch aperture, from the Irish company Grubb in Dublin. It was working in the middle of 1906 for experimental teaching of the subject of Cosmography and Physics of the Earth in the Physics Section of the Faculty of Sciences, and it continued to run until 1993. At present it is on display in the hall of the Faculty of Physics, a witness with dignity and majesty to the teaching and the research developed during a century of history of the section of Physical Sciences of the University of Barcelona.
In this study some aspects of the display, origin, promotion, acquisition, technical characteristics, service and other interesting data for the history of astronomy are discussed.

Session XIV a
PHYSICAL AND CHEMICAL INSTRUMENTS

Michael T. Wright
Scientific Clockmaking: Smeaton's Measurements of the Thermal Expansion of Solids and a Dateable Early Application
Imperial College, London, United Kingdom

In 1754 John Smeaton published in Philosophical Transactions the results of his experiments on the thermal expansion of solids, made using his "new pyrometer". Of the materials tested, by far the greatest expansivity was shown by zinc "hammered ½ inch per foot", and in a postscript Smeaton drew attention to its possible use in the building of temperature-compensated pendulums for precision clocks. Smeaton's old friend and sometime mentor the clockmaker Henry Hindley built a clock with

such a pendulum which is dateable to c. 1756, the earliest known example of this use of zinc. The clock survives, but its pendulum was thought to have been garbled by someone who did not understand its design. The author, who has recently had access to it, will show that the alteration was probably made by Hindley himself; and that although the pendulum was originally designed to contain a bar of hammered zinc, it was subsequently modified to work with a longer bar of zinc left as cast, which has a lesser expansivity. The author suggests that zinc that has been subjected to such extreme cold-working as Smeaton advocated would not only be very brittle but would probably have proved unstable.

Jane Insley
James Watt's Cookbook Chemistry
The Science Museum, London, United Kingdom

The 18th-century steam engineer James Watt was a man of wide scientific interests. After moving to his newly built home at Heathfield near Birmingham in 1790 he converted an attic above the kitchens into a workshop, where he could carry out experiments away from the rest of the household. After his death in 1819, this garret workshop became something of a shrine, being initially locked up and not visited, then the focus of a very few respectful admirers by permission of the family or tenants, and finally, when plans for the area meant the house was to be demolished, removed in its entirety to the Science Museum in 1924.
The workshop contains over 3000 items, reflecting his work and interests throughout his life, and being dominated by two sculpture copying machines he was developing until he died. The workshop is to re-displayed in spring 2011, and in the course of the attendant research, some of this material is being looked at for the first time. One corner of the workshop contains 67 white ceramic pots, many with paper labels in Watt's own hand, which may or may not contain the chemicals claimed on the labels. Another piece of furniture, a 38 drawer cabinet, contains little deal boxes and packets of more samples of "drugs" and a third tranche of samples are packets of brown paper further along the shelving.
These items are considered as a (biased and incomplete) snapshot of James Watt's chemical interests obtained by looking at his ingredients, and throw a new light onto some aspects of the state of practical 18th-century chemistry.

Session XIV b
ASTRONOMICAL INSTRUMENTS

Simone Bianchi
The Historical Instruments of the Arcetri Astrophysics Observatory in Florence
INAF - Osservatorio Astrofisico di Arcetri, Florence, Italy

The Arcetri Observatory, founded in 1872, has hosted several significant astronomical instruments. However, due to the lack of space and to the astronomers' needs, the most important pieces have been either handed over to other institutions (mainly, the Museo Galileo of Florence), modified for the use which was then current, or discarded.
In this contribution I will trace the history of the main instruments, and in particular of the Amici II telescope (now hosted at the Museo Galileo) and of the recently restored personal telescope of the German astronomer Wilhelm Tempel. I will also describe the status and display of the current collection.

James Caplan
The French Programme of Stellar Radial Velocity Measurement with Objective Prisms
Observatoire astronomique de Marseille-Provence, France

In the 1940s, Charles Fehrenbach (1914-2008), then assistant director of the CNRS's Haute Provence Observatory and (from 1948) director of the Marseille Observatory (University of Aix-Marseille), developed a method of efficiently measuring large numbers of stellar radial velocities, accurate to a few tens of km/s, using slitless spectroscopy. An objective prism was used in front of an astrograph-type objective in order to record large numbers of low-resolution spectra of stars on a photographic plate.
This resembled the observations made since the 1880s at the Harvard College Observatory to determine many stellar spectral types from a single plate. But Fehrenbach used a "direct vision" prism, with zero deviation for a certain wavelength. By reversing the prism between two exposures of the same field of the sky on the same plate, each star had a pair of spectra permitting the determination of its velocity along the line of sight. This reversal method had been proposed in the 1890s but was not possible until Fehrenbach's development of a special distortion-free direct-vision prism. Special equipment was constructed for the observations as well as for the measurement of the plates. During several decades, the "vitesses radiales" programme occupied a large number of astronomers and technicians at the two observatories as well as in the southern hemisphere.

Françoise Le Guet Tully (a), *Jean Davoigneau (b)*, *Christine Etienne (a)*, *James Caplan (c)*
The Fate of Old Astronomical Instruments: A Comparative Approach Based on Case Studies
a) Observatoire de la Côte d'Azur, Nice, France
b) Direction des patrimoines, Ministère de la culture, Paris, France
c) Observatoire astronomique de Marseille-Provence, France

The inventory of astronomical instruments launched in France in the mid 1990s has allowed us to study a number of large 19th- and 20th-century astronomical instruments, some still in use and some not. The results provide useful material for exploring the fate of these instruments once they have become obsolete – at least for their original purposes – for professional astronomers.
We shall examine the cases of large meridian circles and equatorial refracting telescopes in France and a few other countries. We shall then try to analyze the variety of situations encountered in terms of historical, scientific and cultural contexts.