BOOK OF ABSTRACTS

SIC Symposium, Turin, 7-11 September 2015

The abstracts are grouped by section in order of the conference programme

8 September 2015 Session 1 9:20 -11:00

GLASS AND POWER: SOURCING SCIENTIFIC GLASS IN NORTH AMERICA, 1600-1850

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Keywords: glass, imports, North America

Glassmaking in America before the 19th century has been called a "chronicle of continuous failure." The reasons were practical and economic. Skilled labor and craft knowledge were choke points, but more important were British laws forcing the colonies to ship raw materials to the mother country and buy back the finished goods. A rare colonial manufactory like Wistar Glassworks (1739-1780) in New Jersey had to operate "under the radar," while nearly all domestic glass was imported from England. The situation was worse for scientific glass such as glass globes, bell jars, and tubes for philosophical apparatus, cover glasses for magnetic compasses, and lenses for telescopes, microscopes, and spectacles. Benjamin Franklin tried to use Wistar bottles for making Leyden jars, but the poor quality led him back to London suppliers. Adding insult to injury, the Townshend Acts in 1767 placed duties on imported glass.

Drawing upon newspaper advertisements, colonial bills of lading, correspondence, and scientific instruments used in colonial America, this paper will show American dependency on English manufacturers to supply glass for optical, philosophical, and other scientific purposes. It will trace the arc of dependency through the antebellum period, exploring to what degree the establishment of new domestic glass manufactories mitigated the situation.

This paper is the first part of a research project that will explore the problem of available glass for optical and philosophical instruments in North America from colonial times until after World War. I.

Sara J. Schechner is the David. P. Wheatland Curator of the Collection of Historical Scientific Instruments at Harvard University. Her research is on sundials and American telescopes. Latest books include Tangible Things: Making History through Objects (2015) and Time and Time Again: How Science and Culture Shape the Past, Present, and Future (2014).

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AN EARLY SPYGLASS FROM DELFT

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Keywords: telescope, optics, 17th century

In my talk I will present the findings on a recently unearthed archaeological find that proves to be a spyglass from the early decades of Dutch telescope production. The instrument was uncovered during railroad construction works in Delft, on a site that was a military defense structure during the Eighty Years' War. The find is remarkable not only because of its early date of manufacture, but also because its fashioning perfectly fits the characteristics of early Dutch telescopes as had recently been 'predicted' from archival sources. This makes the spyglass the earliest of only three Dutch telescopes from the seventeenth century that have been preserved worldwide.

I will relate the story of its discovery and subsequent research, and situate its characteristics within recent historiography on the telescope. Finally, I will discuss the instrument's optical characteristics in relation to contemporary Dutch lens grinding instructions, and show how the find can be associated with a network of optical artisans in the early seventeenth-century Netherlands.

Tiemen Cocquyt is curator of natural sciences at Museum Boerhaave in Leiden, the Netherlands. His research interests include the history of optical instruments and cabinets of experimental philosophy. He studied history and philosophy of science at Utrecht University and previously held a position at the Utrecht University Museum.

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LACQUER FOR BRASS

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Keywords: restoration, lacquer, varnish, brass

The lacquer for brass used to make scientific instruments is a transparent varnish that has a base of alcohol and natural resin. This forms a protective film against oxidation, and confers a golden tonality that enhances the instruments. This is a specific varnish for this type of manufacture, and constitutes one of the characteristic elements to be carefully safeguarded during conservation and restoration operations. In some cases, it may even be necessary to re-apply it. To handle these operations in the best possible way, we first did a historic study of lacquers for brass, looking at the formulas published from the second half of the 18th century on, selecting some, reproducing them, and then applying them to brass samples.

We analyzed the samples using a non-invasive technique—infrared spectrophotometry used in reflectance—according to a new procedure that we developed. The analytical results enabled us to develop the research in various directions, in order to perfect a method for identifying the components present in a complex mixture of this type and to evaluate by means of artificial ageing the effects of time on the conservation conditions. One development of particular interest, then, consists in the possibility of applying our technique and the results of the analyses to original lacquers present on instruments.

Anna Giatti is curator at the Fondazione Scienza e Tecnica in Florence. She is involved in the preservation, restoration, and cataloguing of scientific instruments in the Fondazione collections and collaborates with other institution regarding these themes. She is also active in popularizing the history and the use of the scientific instruments.

Paolo Brenni graduated in physics in 1981 at the University of Zürich. He specializes in the history of scientific instruments (mid-18th century to the mid-20th century). He is researcher for the Italian National Research Council and works in Florence for the Fondazione Scienza e Tecnica and for the Museo Galileo. He has studied, restored, and catalogued several collections of historical instruments. Between 2002 and 2013 he was president of the Scientific Instrument Commission of the IUHPS and is currently president of the Scientific Instrument Society.

Giancarlo Lanterna is the director of the Chemistry Laboratory at the Opificio and responsible for the diagnosis and analysis of all polychrome work of arts, restoration methodologies, and products. Co-director of "OPD restauro" magazine, he is teacher of "Chemistry in the cultural heritage" (CHIM/12) at the OPD-SAFS school for the training of conservators. He participates in several Italian and European scientific projects affiliated with the CNR and has written over 70 publications in the field of conservation science.

8 September 2015 Session 1 9:20 -11:00

OLD INSTRUMENTS IN NEW CLOTHES: BLASCHKA GLASS INVERTEBRATES AS EXAMPLES OF A NEW SCIENTIFIC MATERIAL

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Keywords: collecting, glass models, conservation

Although Leopold and Rudolph Blaschka are best known for their stunning glass models of flowers - such as those on display at the Harvard Museum of Natural History, a highlight of our 2007 SIC symposium program - these objects followed years of producing marine invertebrate glass models for collections around Europe and North America in particular. These models illustrate changing 19th-century collecting practices, and embody evolving techniques in gathering, teaching, and disseminating scientific knowledge. We will examine the origins and uses of these models, address their conservation issues, and explore how they continue to serve as valuable tools for scientific, artistic, and public audiences today.

The current proposal is part of an attempt to take up topics raised at a session on scientific glass at last year's SIC meeting in Estonia. During the question and answer period, and in conversations following that session, attendees expressed interest in exploring technical and contextual details relating to the role of glass in scientific instruments. This session addresses those questions explicitly, and moves the discussion well into the important matter of 20th-century scientific instruments.

After curating and researching the history of astronomy at Chicago's Adler Planetarium, Marvin Bolt moved to the Corning Museum of Glass. He researches the variations and evolution of glass in scientific instruments, with a special interest in 17th and 18th century telescopes. New collaborators and collaborations are always welcome!

8 September 2015 Session 2a 11:20 -1:00pm

LOOKING BEYOND THE SIGNS

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Keywords: astrology, astrolabe, European instruments, Islamic instruments

‘Scientific’ instruments, notably astrolabes, frequently face researchers with scales that may appear to be anything but scientific to the modern mind. Whilst all other parts seemingly conform to expectations of mathematically based scales for very practical use, the backs often don’t. Rather they provide the maker with otherwise blank spaces that are more often than not filled with astrological scales. The frequency with which these scales appear makes it clear that they must have been of equal importance to owners and users.

This paper will give an overview of the various data and systems that can be found on both European instruments and those originating from the Islamic World in their historical context in order to set the scene for the session on instruments and astrology.

Silke Ackermann is Director of the Museum of the History of Science, Oxford. She is a medievalist and orientalist by training with a particular interest in the transfer of knowledge between the Islamic World and Europe. She has a special interest in calendars and astrology.

8 September 2015 Session 2a 11:20 -1:00pm

USING ASTROLABES FOR ASTROLOGICAL PURPOSES: THE EARLIEST EVIDENCE REVISITED

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Keywords: astrolabe, astrology

In general, when pre-modern texts and images – and today, even motion pictures – depict a person with an astrolabe, it denotes not only that he is practising astronomy, but also his familiarity with astrology, and perhaps even magic. To what extent, however, was the astrolabe an astrological instrument? To begin to answer to this question, this talk will investigate the earliest evidence of the astrolabe, in texts as well as instruments. This will include Greek texts, notably Syriac treatises by John Philoponos (Alexandria, *c*.490–*c*.570) and Severus Sebokht (Nisibis, Kennesrin, *c*.575–666/667), and Arabic treatises by al-Khwārizmī (Baghdād, d. before 850) and □Alī b. □Isā (Baghdād, fl. *c*. 830), as well as astrolabes by Nas□ūlus (IIC #3501 made in 927-8; IIC #1130 = #4023; IIC #----) and al-Khujandī (IIC #0111 made in 984-5). This investigation will allow us to draw some conclusions about the use of the astrolabe for astrological purposes in these early times.

Petra G. Schmidl is a postdoctoral research assistant at Frankfurt University. Her research interests lie in the field of pre-modern astronomy and astrology in Islamicate societies, and astronomical instruments, mainly the astrolabe, in both the Orient and the Occident. She mainly concentrates on folk astronomical traditions and descriptive astrological methods and is interested in the inter-dependence between astronomy and astrology, and religion and power.

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BYZANTINE ASTROLABES IN THE FOURTEENTH CENTURY

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Keywords: astrology, astrolabe

Early 14th-century Constantinople was an anxious city. The gains the empire had made following the recovery of the capital from the Latin crusaders were evaporating. Hostile neighbours were seizing territory on all sides. Imperial finances were in turmoil. In this context the astronomical/astrological sciences enjoyed a revival, especially in the work of Nicephorus Gregroas. Gregoras had initially used his technical expertise in the mathematical sciences to establish his position at the imperial court. Later, when he found himself on the wrong side of a series of controversies and expelled from the court, he once again deployed his technical expertise – this time astronomical and astrological knowledge – to re-establish his position and gain the favour of the new emperor. Central to Gregoras's success was his skill in predicting eclipses, interpreting celestial phenomena and constructing astrolabes. Gregoras celebrated his superior knowledge in his text on the construction of astrolabes. He claimed that by providing geometric demonstrations of technical details such as stereographic projection, his text surpassed others, which he dismissed as mere user's manuals. Examining Gregoras's efforts to regain his position at court reveals the nature and importance of technical, astrological expertise in early 14th-century Constantinople.

Darin Hayton is Associate Professor of the History of Science at Haverford College. His work looks at how knowledge was inscribed in instruments, collected, displayed and deployed by institutions, and aligned with political and social agendas, with particular emphasis on Early Modern Europe, Central Europe and the late Byzantine Empire.

8 September 2015 Session 2a 11:20 -1:00pm

MEDICAL AND ASTROLOGICAL PLATES: THEIR ROLES IN MEDIEVAL AND RENAISSANCE KNOWLEDGE

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Keywords: astrology, medicine, astrological plates

Divination has always been based on some technique, a specific way of performing a calculation, and in a few cases also the use of some technological device, such as astrolabes, astronomical rings or different types of plates. Practitioners of divination set out how to go about forming a judgement with as much accuracy as possible and how to predict possible future events. This paper will discuss two 16th-century German astrological plates that were used in different contexts: astrology (to establish the division of the houses) and medicine (to determine the critical days of an illness). My purpose is to describe the plates in order to understand how they might have been used, and to uncover more about the practitioners (astrologers or physicians) who might have been interested in owning and using these instruments.

Arribas has substantial research experience in the history of medieval science (astronomy, astrology and astrolabes). She is especially interested in critical approaches to the definition of pre-modern science, the presence of science in non-scientific texts and contexts, and the relations of textual and material cultures in medieval science.

8 September 2015 Session 2b 11:20 -1:00pm

A MICROSCOPE FOR THE OBSERVATION OF *IN TOTO* BRAIN SECTIONS (CARLO GIACOMINI'S MICROSCOPE, 1883)

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Keywords: Carlo Giacomini, microscope, brain section, cultural heritage

The Museum of Human Anatomy of the University of Turin houses a rich collection of microscopes and instruments for the preparation of microscope slides. Some of these instruments were produced during the second half of the eighteenth century, but most of them belong to the second half of the nineteenth. One of these microscopes deserves special attention, for historical reasons as well as for its status as cultural heritage.
It was constructed by the firm Koristka in Milan in 1883, following the designs of Carlo Giacomini (1840-1898) an anatomist in Turin. It is characterized by a large stage, allowing observation of microscope slides with *in toto* sections of the human brain. Two specimens of this microscope are preserved. It represents an excellent example of a scientific instrument interacting with other categories of cultural objects. For example, almost 200 brain sections, stained with carminium, are stored in a pear wood cabinet with 300 drawers, crafted in the 1880s. A stained glass window in the Museum is decorated with drawings of these brain sections. In addition, the Museum archives contain several related documents, including purchase invoices for the microscopes, cabinet and window, a description of the microscope published by Giacomini (and a related manuscript), his publications of observations made with the microscope (including his description of the hippocampus) and related original *camera lucida* drawings. This series of cultural artefacts is enriched by the skeleton of professor Giacomini himself, which was prepared and exhibited in the Museum according to the wish expressed in his testament.

Giacomo Giacobini is professor of Human Anatomy in the Department of Neuroscience, University of Torino. He is President of the Museum System of the same university. His current research interests focus on museology and on the history of the collections of the Museum of Human Anatomy.

8 September 2015 Session 2b 11:20 -1:00pm

KIPP & ZONEN, ANOTHER 'DELFT BLUE' COMPANY

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Keywords: Moll-Gorczynski, Kipp, thermopile

A small pharmacy shop in Delft, The Netherlands, bought in 1830 by Petrus Jacobus Kipp in 1830, has grown out into a market leader in measuring solar radiation.

In 1880, the pharmacy branched into physical, chemical and medical instruments. Under the direction of J.W. Giltay, the company further evolved into instrument making, including railway signalling, phonographs, telephones and microtomes, as well as being a representative for various foreign suppliers, such as Leybold Nachfolger and Tinsley & Co.

A new impulse came with the involvement of Professor W.J.H. Moll of Utrecht University in 1913. He introduced several innovations, such as sensitive mirror galvanometers and a rapid, sensitive thermopile. Key developments, introduced in 1923, were the Moll-Gorczynski pyranometer and pyrheliometer, with routine production starting in 1927. These instruments connected meteorology with measuring global and direct solar radiation on a daily basis, recording on photographic drums. On-going company split-offs, including Salm-Kipp in 1931 and Kipp Analytica in 1975, focussed the product range to chart recorders, galvanometers and thermopile-based radiation sensors.

In 1975, the termination of thermopile production was considered, as it contributed to only 1% of the total sales. However the impact of the 1973 oil crisis, causing increased use of solar energy, and the automation of horticulture gave rise to a growing demand for reliable solar radiation sensors, yielding a ten-fold turnover.

In 2005, Museum Boerhaave obtained a number of key Kipp instruments, developed throughout its existence and documenting the ongoing importance of this Delft company. In my presentation I will sketch briefly the history of the Kipp firm. Then I will focus on the highlights of Kipp's thermopile-based instruments.

Kees Ruitenbeek worked at Shell in various positions and locations. Upon his retirement, he joined Museum Boerhaave as an associated curator. In 2014, he spoke about Dr CE Bleeker at the SIC symposium in Tartu and published this in Studium, Vol. 7, No 4 (2014), pp. 240 – 250.

8 September 2015 Session 2b 11:20 -1:00pm

BUILDING THE TRAJECTORY OF THE MAST COLLECTION'S BAMBERG ELBOW TRANSIT TELESCOPE

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Keywords: restoration, Bamberg, elbow transit telescope

The Museum of Astronomy and Related Sciences (MAST) is a science and technology museum located in the São Cristóvão district of Rio de Janeiro (Brazil). It shares a 40,000m^2 campus with the National Observatory. The observatory's buildings in this site were completed in 1927, including the astronomical pavilions, three of which shelter meridian telescopes. Part of the National Observatory's movable and non-movable heritage was transferred to MAST for its safeguarding when the museum was created in 1985. All the buildings, collections and archives have been listed by the federal and state heritage protection institutes (respectively, IPHAN, 1986, and INEPAC, 1987).

Rather few academic studies have been done that focus on one historic scientific instrument in particular. This research takes place precisely in this context, addressing the trajectory of the Bamberg elbow transit telescope, a listed object that is part of the MAST collection, with the aim of contributing to the production of knowledge and information to help in its restoration. This initiative is part of a broader restoration project of the original pavilion and an in-situ exhibition of the restored instrument. The challenge of its restoration began in the recovery of information on its history, full of historical gaps, but with many references in institutional memories and rich of information provided by the instrument itself through its parts and component materials. The information that was produced about the instrument and its history has been very important for decisions related to restoration procedures to be adopted for the object.

By training, Marco Granato is a metallurgical engineer, with a D.Sc. in materials engineering. He is head of the Museology Department at MAST and vice-director and professor at the D.Sc. Course on Museology and Heritage (Federal University of Rio de Janeiro State). His areas of interest include scientific heritage studies, conservation of science and technology heritage, metals conservation, as well as science and technology exhibitions.

8 September 2015 Session 2b 11:20 -1:00pm

A TELESCOPE IN CONFLICT: ASTRONOMY IN COLONIAL ALGERIA

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Keywords: astronomy, colonialism, Algeria, Foucault

The development and use of the half-meter Foucault telescope (1858 - 1962) in French colonial Algeria offers us a good case study of an "instrument in conflict".

The birth of the project of commissioning a large telescope in Algeria came from a conflict within French astronomy. As the newly named director of the Paris Observatory, Urbain Le Verrier was opposed to Foucault and several other astronomers committed to physical astronomy. Le Verrier himself was devoted to positional astronomy and celestial mechanics, while a group of people tried to develop in France the study of the physical appearance of the heavenly bodies using new technical tools like photography and big telescopes.

The giant reflecting telescope, established in Algiers in 1861, became an issue in the conflict between civil and military powers in the colony: on one side, the ministry of *Instruction publique*, which was in charge of French astronomy, on the other side the *Gouverneur Général* of Algeria, a high-ranking army officer, keen on astronomy, who was the French proconsul in Algeria. This instrument also came into conflict with its environment because of its size (how to protect it and how to move it?) and the special challenges it presented alongside the other instruments of the Algiers observatory acquired during the course of the 19th and 20th centuries (raising issues as to the scientific program of observations, availability of observers, and localisation in the observatory in respect with other specific instruments). Finally, from our study, we would like to suggest some museological considerations for conveying this scientific heritage in contemporary Algeria with concern for possible conflicts of meaning (national/colonial, western /Arabic astronomy).

After a MSc degree in applied physics, Frederic Soulu was in charge of the Observatory of Abbadia, heritage of the Academie des Sciences of Paris, where he led the public opening for ten years. He's now PhD student on the history of colonial astronomy in Algeria.

8 September 2015 Session 2c 11:20 -1:00pm

IT'S BIG, SO IT MUST BE GOOD . . .

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Keywords: instruments, storage, selection

Selecting objects which should be kept in a university museum is not always easy. Of course you have (i.e. should have) a collection plan, which more or less dictates what to accept and what to reject. But there is always a shady area which conflicts with the plan. It can be because of personal interest, to satisfy present or future donors (a "political" eason) or to keep an ensemble together. My talk will focus on the last issue. Sometimes you accept (or want, or already have in the collection) an object which is the main part of an ensemble with all kind of auxiliary equipment. Before you know it, you end up with stores filled with crashed computers and old furniture.

Being a lecture in Turin, one example to be presented has to be car-related. It is a full-size driving simulator. Originating from the Faculty of Psychology at Groningen, it is said to be the first simulator exclusively designed for research (instead of instruction, as for instance a flight simulator). Of course we felt we *must* have this for the museum, although the people who had built it wished to have it scrapped. Initially we moved the whole setup to our storage facility, but after some years and a lot of head scratching it was decided that it was altogether too much. So a lot had to go. In the end it was decided to keep the main component, this being both visibly attractive and enabling re-creation of the setup in future exhibitions.

Jan Waling Huisman is the collections and stores manager/curator of scientific instruments at the museum of the University of Groningen. Besides his general interest in physics he has a special interest in astronomical and crystallographic instruments. In his spare time he likes to tinker with his "bella machina".

8 September 2015 Session 2c 11:20 -1:00pm

DESIGN THEORY: A FRAMEWORK FOR INTERPRETING EMBODIED PRACTICE

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Keywords: design theory, object interpretation, object-grounded historiography

Historical scientific instruments can resist interpretation by layers of obscurity, overwhelming detail, or the need for unfamiliar technical knowledge. Many instruments offer the exhibit writer or historian little beyond a case to interpret. Many others invite decorative readings with at most symbolic connection to science. Labels often focus on classification, leaving the object to speak for itself: "Name. Materials. Maker. Year." Objects obviously need a historiography involving more than Platonist essentialism, but doing more proves tricky, even counterintuitive. But when objects are reduced to mere illustration, it is hard to justify having them at all.

The object can be foregrounded via material culture studies. Scientific instruments tax the Prownian approach, whose practitioners often struggle with scientific content, and the recent trend to use objects as intersections for multiple narratives tends to value intellectual history far less than social. As a further possibility, I propose that design theory, specifically product semantics, affordances and affordings, can support an embodied practice-oriented interpretation of instruments, hinging on the interaction between instrument and the operator's body. We can apply these theories by extending the art communicators' question, "What do you notice?" to, "Where would your body go?" and "How would that feel?" or positioning mannequins as an embodied demonstration of practice.

Embodiment does not apply universally: some instruments lack embodied use. Those require a different theoretical framework. Which frameworks we choose depends necessarily on the kinds of use that the instrument served, and indeed on what we mean by 'science'.

Alistair Kwan studies the materiality and spatiality of knowledge practices, especially the emergence of new practices when people negotiate relationships with their spaces and tools. He is collecting and examining students' textbooks, written work and instruments to develop a classroom-level history of science education in the nineteenth and twentieth centuries.

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MYSTERY PENDULUM: HOW THE SCIENTIFIC INSTRUMENT COMMUNITY SOLVED A RIDDLE

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Keywords: pendulum, gravity, Borda

A strange "pendulum" – at least initially taken for such – was discovered by one of us (F.L.) in the university collections: a long brass rod with a knife-edge at its top; at its bottom, a large horizontal disk acts as a micrometer (1 micron accuracy), so as to lengthen or shorten the rod; its position is read on a lateral scale. The disk is signed "*Secrétan à Paris, 1855*". In the same box, a 36 mm brass sphere, a second similar knife-edge and some broken copper wires were found.

A debate was launched with colleagues and on the RETE list. Particularly puzzling was the scale graduation – 735 to 795 mm – that could suggest some relationship with atmospheric pressure. Finally, the object was characterized as a Borda pendulum used for accurate *g*-measurements, as briefly described in Secrétan's catalogues. In fact, the sphere, wire and second knife-edge were the pendulum, while the adjustable rod was used to accurately measure its length.

The authors intend to account for the richness of this discussion, a living illustration of our community's behaviour when facing a mysterious object: freedom of mind and a broad spectrum of suggestions and references. Unusual or wrong ideas also can help!

Finally, subsequent improvements in gravity-measurements with pendulums through the nineteenth century will be examined: how the Borda pendulum was progressively replaced by Kater-like reversible pendulums, reaching highest accuracy in the 1880s. It will appear that some "strange" ideas put forward in the above discussion were not completely off the point.

Françoise Khantine-Langlois taught physics at the University of Lyon up to last year. She is now involved in the restoration and public presentation of historical devices belonging to the university collections.

Pierre Lauginie, former lecturer and researcher in physics, has developed an experimental approach to history of science teaching, based on adaptations of historical experiments.

8 September 2015 Session 2c 11:20 -1:00pm

FROM THE BRILLIANT INVENTION TO USELESS GADGET: INSTRUMENT MAKERS AT WORK

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Keywords: Instrument makers, milestone instrument, gadget

In the past, scientific instruments makers have not only responded to the requests of scholars and amateurs, but they were able to create both truly important objects and machines as well as utterly mundane things.

For example, Nicolas Bion, known to the SIC community as a famous maker of mathematical instruments, is known worldwide rather as the inventor of the fountain pen. Mr. Soleil, optician "rue de l'Odéon à Paris,"who invented a fine type of saccharimeter, also published and manufactured an improved model of coffee maker. Others, like Edme Régnier or Perreaux were prolix inventors with dozens of inventions in various fields.

This presentation reviews a limited number of inventions made by makers, engineers, enthusiasts, scholars or unknown geniuses. Although the focus of the analysis will be France, the context of interface between science, technology, and gadgetry is common in many countries and broader research questions will also be outlined

The author observes the neglected role of the makers in the evolution of sciences. By the way, he discovers also the funny side of the invention.

8 September 2015 Session 3a 2:00 -3:40pm

ASTROLOGICAL TABLES ON PAPER INSTRUMENTS: JOHANN STABIUS'S 'ASTROLOBIUM IMPERATORIUM' OF 1515

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Keywords: astrology, Johann Stabius, paper instruments

It is well known that in the 1510s, Johann Stabius, court astrologer, historian and poet laureate for the Emperor Maximilian I, designed four large, broadside prints for his patron, each presenting an 'instrument' composed of a complex network of curves and lines. Printed in Nuremberg with blocks cut by Hans Springinklee, a member of Dürer's workshop, these sheets have attracted considerable attention from art historians. But as far as I know, no one has examined the mathematics of Stabius's instruments or has tried to situate them within sixteenth-century dialing and astrological traditions.

Stabius labeled three of his instruments 'horoscopion', which they are not; he called the fourth an 'astrolabium', which it is not. In this paper, I shall examine the astrolabium and shall explore how Stabius managed to reduce pages of numerical tables, providing boundaries for the astrological houses on a horoscope, to graphic representation. Although Stabius's astrolabium itself would never, as far as I know, be reprinted or constructed in metal, some of its graphic elements would find use by later sixteenth-century block cutters and instrument makers.

Richard Kremer is Associate Professor of History at Dartmouth College and specializes in European science from the fifteenth to nineteenth centuries. His current research examines responses to Copernican astronomy in astrological calendars printed between 1543 and 1630.

8 September 2015 Session 3a 2:00 -3:40pm

WHAT'S ON THE BACK OF AN ASTROLABE? ASTROLABES AS SUPPORTS FOR PLANETARY CALCULATORS

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Keywords: astrology, equatorium, astrolabe

This paper will examine the appearance of planetary calculators on the backs of astrolabes from medieval Europe. These range from simple sources of mean motion data, effectively reconfigured tables, to more complex equatoria that represent the Ptolemaic models of planetary motions, while remaining simple enough to fit on a single side of a portable disc.

Planetary calculators were used to learn and demonstrate astronomical theories, but also for practical astrological purposes. Their popularity is attested not only by extant instruments, but by a number of manuscript treatises explaining their design and use. The paper will assess the astrological functions of planetary calculators, and will then use some examples of instruments and treatises to show how designers and makers were able to pursue their astrological interests using the limited space and material available on the backs of astrolabes.

Seb Falk is a PhD student in the Department of History and Philosophy of Science at the University of Cambridge. His doctoral research (supervised by Professor Liba Taub) focuses on the use of astronomical instruments in religious contexts in medieval England. His other research interests include navigation, globes, and pedagogy.

8 September 2015 Session 3a 2:00 -3:40pm

DISPLAYING ASTROLOGICAL KNOWLEDGE BY TABULATION: SOME NOTES PERTAINING TO PARTICULAR ARRANGEMENTS ON INSTRUMENTS

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Keywords: astrology, astrological indications, Early Modern period

Astrological indications and inscriptions on scientific instruments have been given attention only occasionally. Time measurement is an indispensable prerequisite for astrology, and every timepiece – be it a sundial, astrolabe or mechanical clock – can serve astrological purposes. But astrology also has special requirements for its interpretative framework (the meanings of houses, properties of the planets, their dignities, boundaries, etc.). Such information is displayed on a number of instruments, which provide important data and interpretative tools for horoscopic work; for these devices the term 'tabular instrument' may be coined. Some examples will be discussed in this paper, with special reference to three astrolabes made by Tobias Volckmer (*c*.1550–1622), preserved in Brunswick (Braunschweigisches Landesmuseum), Stift Seitenstetten (Austria) and the British Museum, as well as a unique device formerly owned by Heinrich Rantzau (1526–1598), an ardent believer in astrology. This last consists of two hinged brass tablets, which served as an *aide-mémoire* for the practising astrologer.

Günther Oestmann was trained as a clockmaker and teaches history of science in Berlin. In 2013 the 'Prix Gaïa' of the Musée international d'horlogerie in La Chaux-de-Fonds was awarded to him. His fields of research include history of scientific instruments and clocks, history of astronomy and mathematical geography, and maritime history.

8 September 2015 Session 3a 2:00 -3:40pm

ASTROLOGICAL ASPECTARIA ON EARLY MODERN INSTRUMENTS, 1480-1620

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Keywords: aspectarium, volvelle, astronomical compendium

Typically found on lunar volvelles included within diptych dials and astronomical compendia, an aspectarium is an astrological *aide-mémoire* depicting the aspects or angles between the planets. It was thought that these angles could generate positive or negative effects within a horoscope.

In this paper I will review the frequency and type of aspectaria found on instruments produced during the Early Modern period and will explore the implications of their appearance. I will assess whether certain makers favoured the inclusion of aspectaria on their instruments and consider possible sources, such as Peter Apian's *Cosmographia* (1524), which may have provided the inspiration for their designs. In addition, I will consider whether the aspectarium was a standard feature or one requested by clients for bespoke items. It is curious to note that aspectaria are not usually depicted on astrolabes, despite the inclusion of other astrological data on these instruments.

More generally, this review of aspectaria will give an opportunity to examine the relationship between astrology and scientific instruments. For example, aspectaria begin to appear on German and English instruments from around 1480, reaching their peak popularity between 1570 and 1600, before disappearing around 1620. This raises many questions, such as how does this appearance correlate with general attitudes to astrology during this period? Was the diagram included as a practical or decorative piece of information? Was there a reason for its popularity during the late 16th century? These questions and more will be discussed further in this review.

Louise Devoy is Curator of the Royal Observatory Greenwich (ROG) and has worked on a number of exhibitions and collections in relation to the history of astronomy. She is currently working on the reinterpretation of the historic narratives across the ROG site.

8 September 2015 Session 3b 2:00 -3:40pm

FROM PRACTICE TO OBJECTS – ANALYSING AND INTERPRETING SOLAR MICROSCOPES

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Keywords: solar microscope, instrument development

Solar microscopes – or more accurately, the practice of using solar microscopes – was the topic of talks I have presented at previous occasions (Krakow, Dresden). Yet, in those papers a strong emphasis was placed on the experiences made in working with the instruments, and on the comparison of the quality and technical details of some of the instruments themselves. However, when going beyond the practice with individual instruments, other issues arise. One starting point in considering the development of these instruments can be seen in the scioptric ball, a device that existed already since the mid-17th century. Solar microscopes as such were only developed in the 1740s, and by the 1780s there already existed a sort of standard device which was mainly made by workshops of the London opticians (and sometimes its design was copied on the Continent). Though the evolution from the starting point to the standard device was of course by no means a linear one, it is possible to trace some developments, e.g. how the mirror adjustment or the focusing was technically realized. This presentation draws on an analysis of instruments in several collections to re-construct aspects of this history. Some of these developments appear to be crucial and were adopted by future makers. Others can be seen in options added on to the solar microscope – for example, a way to show images of opaque objects, or the possibility to project images as with a magic lantern.

Peter Heering has been professor of physics and the didactics of physics at the Europa-Universität Flensburg since 2009. His current research interests in history of science focus on the development of experimental practices, which he analyses with the replication method. Moreover, he is also interested in the history of physics education.

8 September 2015 Session 3b 2:00 -3:40pm

THE EMERGENCE OF MACEDONIO MELLONI'S OPTICAL BENCH

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Keywords: Macedonio Melloni, banco ottico, calore radiante

We present a reconstruction of the emergence of Melloni's optical bench, one of the most common apparatus of historic collections of scientific instruments in schools and universities both in Italy and abroad. While originally developed as an instrument for experimental research, Melloni's bench was soon used also as a teaching and demonstration tool.

The bench was first introduced to the scientific community on 12 January 1835, when Italian physicist Macedonio Melloni presented a memorandum to the *Academie des Sciences* in Paris summarizing all his previous experimental work. Melloni claimed that by properly choosing the components of the apparatus it was indeed possible to reproduce the most significant experiments he had performed to prove the identity between "calorific rays" and visible light.

In this study we will analyse the development of the different components and accessories of Melloni's bench: sources, screens, lenses and the mobile arm built to overcome the problems of secondary emission. Particular attention will be paid to the "thermomultiplier", the combination of a thermopile and galvanometer, also through Melloni's original documents preserved in the archives of the *Academie des Sciences*. Though originally devised by the Italian physicist Leopoldo Nobili, the thermomultiplier was eventually improved by Melloni to become a powerful tool in the study of what later was known as infrared radiation.

Emanuela Colombi studied physics at the University of Parma where she received her PhD in 2015 with a thesis on "Macedonio Melloni: a scientific biography".

Matteo Leone is Associate Professor of Didactics and History of Physics in the Department of Philosophy and Educational Sciences of the University of Turin; his main fields of research are the history of physics and physics education.

Nadia Robotti is Full Professor of History of Physics in the Department of Physics of the University of Genova; her main fields of research are the history of atomic and nuclear physics, as well as the history of scientific instruments.

8 September 2015 Session 3b 2:00 -3:40pm

LIGHT AND SHADOW: CONTRIBUTIONS TO INTERFEROMETRY BY MACH, FATHER AND SON

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Keywords: optics, interference, photography

The history of physics in the 19th and 20th knows of several prominent examples of transmission of research interests or passion for science between two generations of family members. One might think of Manne (1886-1978) and Kai Siegbahn (1918-2007), William Henry (1862-1942) and Lawrence Bragg (1890-1971), Marie Curie (1856-1934) and Irène Joliot-Curie (1897-1956) – to name but a few from the exclusive group of Nobel laureates. Active scientific collaboration on the *same* research subject between members of one family is, however, less frequently encountered. A notable case is the joint work on interferometry of the Austrian physicist, philosopher Ernst Mach (1838-1916), and his eldest son Ludwig (1868-1951) at the Charles University in Prague around 1890. The 4-plate interferometer, whose design was independently developed by the Swiss physicist Ludwig Zehnder (1854-1949), is one of the few surviving original instruments designed and used by Mach, father and son, out of a formerly extensive university collection of physical instruments which appears to have been lost or destroyed. In this contribution, we will retrace the history of the Machs' joint work on interferometry, noting how the boundaries between individual contributions to research are blurred. It is argued that the cooperation between father and son can be a source of conflict; in the case of the Machs, Ludwig despaired that in spite of his own achievements he could not step out of the shadow of his eminent father.

Johannes-Geert Hagmann studied physics at the University of Karlsruhe and the Ecole Normale Supérieure de Lyon before joining the Deutsches Museum in Munich in 2009 as curator for the departments of physics, geophysics, and geodesy. His research focuses on the history of physics ca. 1850-1918 and on methodologies for collecting recent scientific heritage.

8 September 2015 Session 3b 2:00 -3:40pm

SCIENTIFIC INSTRUMENTS FOR TECHNICAL SCHOOLS IN TURIN (1847-1906): THE ROLE OF Q. SELLA

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Keywords: collections, mechanics, crystallography

The establishment of engineering schools in 1859 in Turin and Milan was a result of a 10-year debate on technical-scientific education and its role in the development of the country. Mathematicians, like G. Bidone and C.I. Giulio, contributed to the new practical orientation of the Turin Faculty of Science by renewing programs, by sending their best graduates to foreign institutions of applied sciences and by establishing new technical schools.

In particular, Q. Sella, Giulio's pupil, was sent to study at the *École des mines* in Paris (1847-52) and to visit foreign factories and institutions in Belgium, Germany and Great Britain. His correspondence and his travel diaries shed new light on the European collections of mechanics and crystallography instruments, machines and models he visited and the ones he chose for Turin's royal *Istituto tecnico* (1852-1859) and royal *Scuola di Applicazione per ingegneri* (1860-1906). Sella visited and commented on more than a hundred instruments he saw at the Great Exhibition of London (1851) and at the Mineralogy Section of the Exhibition of Paris (1855).

I intend to illustrate some precision instruments and geometric models of this collection, discuss the reasons why some of them were preferred to others (e.g. the reflecting goniometer and the theodolite), document the relationships Turin institutions had with scientific instruments makers, like Meyerstein, Troughton and Simms, etc. and underline the use of these instruments both for research and for teaching (lessons on construction, hydraulics and crystallography). I'll show how Turin artisans and makers, working for the *Istituto*, succeeded in exporting scientific instruments to other Italian and foreign schools.

Chiara Pizzarelli, a mathematics graduate at the University of Turin (2012), is a PhD student in mathematics. Her main field of interest is the history of mathematics and the sciences in the 19th-20th century. Her PhD thesis regards the technical-scientific education in the Savoyard Kingdom from 1848 until the establishment of the R. Politecnico di Torino (1906). She has published four papers and one cd-rom.

8 September 2015 Session 3c 2:00 -3:40pm

FRENCH SCIENTISTS AND SCIENTIFIC INSTRUMENTS IN THE WORLD WAR I

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Keywords: French scientists, instruments, World War I

Many events, research projects and commemorative ceremonies are being organised during the four years 2014-2018 in commemoration of the First World War. In this context, it appears interesting to present the situation one hundred years ago of French science, some scientists and their instruments. We will focus on:

*The creation in 1887 of the *Commission d'examen des inventions intéressant l'armée* and especially the contribution of the mathematician Paul Painlevé (1863-1933). Between 1915 and 1917, Painlevé was French Minister for Public Instruction and Inventions.

*The activities of some scientists contributing to the "war effort" in spite of their pacifist and internationalist convictions, including Aimé Cotton, Pierre Weiss, Paul Langevin, Jean Perrin, Marie and Irene Curie.

*The development of new research on scientific instruments in several scientific disciplines: communications and radiotelegraphy (General Ferrié), optics, medicine and their applications in the war activities.

*The consequences of WWI on the new organisation of the French research with the death of numerous young scientists and the creation of several public research organisations (among them the "first" CNRS).

Dominique Bernard, physicist at the University of Rennes 1 (France), plays a central role in the constitution of the instruments collection there (see http://cst.univ-rennes1.fr/themes/lieuxCulture/) and participates at the National Mission for Preservation of Contemporary and Technical Heritage (PATSTEC) with CNAM.

Denis Beaudouin is the author of «Charles Beaudouin: une histoire d'instruments scientifiques» (EDP edition) and «l'expérience retrouvée» (BELIN edition). He realized several inventories of ancient instruments in scientific institutions and is a contributor to the future "Dictionnaire des Constructeurs français d'instruments scientifiques" with Anthony Turner and Paolo Brenni.

8 September 2015 Session 3c 2:00 -3:40pm

PROTECTION FROM POISON GAS IN WWI: EXPERIMENTS AT THE UNIVERSITY OF TURIN

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Keywords: WWI, gas mask, poison gas

Italy went to war in May 1915. Immediately afterwards in Turin, the problem of protecting Italian soldiers from gas warfare was faced. Two different institutions, the Reale Accademia di Medicina and the Associazione Chimica Industriale, were involved in looking for answers. Two professors of the University of Turin studied new devices and new compounds in order to neutralize poison gas. Icilio Guareschi (1847-1918), professor of pharmaceutical chemistry and toxicology, and Amedeo Herlitzka (1872-1949), professor of human physiology, made two different models of gas masks. They tested their inventions on animals, men, and even themselves. Recently, within the holdings of ASTUT, we found the prototype of the Herlitzka's celluloid gas mask, which was described in a paper in the journal of the Reale Accademia di Medicina di Torino. This paper will focus on these inventors and the solutions they adopted to solve the problem of protection from poison gas.

Mara Fausone is curator of ASTUT, Archivio Scientifico e Tecnologico dell'Università di Torino. The mission of this institution is to collect, store, and study instruments used in the past in different branches of the University of Turin.

8 September 2015 Session 3c 2:00 -3:40pm

GERMAN INSTRUMENTS IN FRENCH OBSERVATORIES AFTER WWI AND WWII

Jean Davoigneau[a], Françoise Le Guet Tully[b]

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Keywords: war reparations, astronomical instruments

After WWI Nice Observatory was given an astrographic telescope and a comet seeker built by Zeiss in Jena as war reparations. After WWII, three of the Würzburg air search radars deployed on the coast of France by the German Luftwaffe became the first French radio telescopes – one was installed in Meudon (and later transferred to Bordeaux), and two equipped the newly founded Nançay observatory. We shall examine these two case studies and try to understand for each one the political and scientific contexts within which the decisions were taken and the implementation of the instruments was achieved.

Jean Davoigneau, a historian with a scientific background, works for the Mission Inventaire général du patrimoine culturel at the French Ministry of Culture, where he is the specialist in scientific and technical heritage. He is also involved in several international collaborations within the Convention France-UNESCO.

Françoise Le Guet Tully is an honorary astronomer. Her research projects concern the history of astronomical instruments and of institutional observatories. She also works on the history of interferometry and collaborates on the Hypertelescope project, a joint R&D venture of Collège de France and Observatoire de la Côte d'Azur.

8 September 2015 Session 3c 2:00 -3:40pm

THE FIRST WORLD WAR, THE SECOND WORLD WAR AND THE COLD WAR: GERMAN TIDE-PREDICTING MACHINES OF THE TWENTIETH CENTURY

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Keywords: analogue computers, Cold War, World Wars, Germany

In seafaring, understanding the tides is of vital importance. But they constitute a highly complex geophysical phenomenon, and are accordingly difficult to predict. Over the course of the twentieth century, three tide-predicting machines were constructed in Germany. Essentially, they were intricate analogue computers capable of Fourier synthesis.

All three were constructed in order to gain an advantage in war. The first machine was completed in 1916, in a secret operation coordinated by the German navy following the outbreak of World War I. Knowledge of tides was of strategic importance to submarines in the Channel and British data was no longer easily available. The second machine was completed in 1939, not coincidentally just before the outbreak of World War II. This machine continued to be used in Hamburg until 1968, when it was replaced by a digital computer. This was more than a decade after East Germany had, in turn, constructed the third analogue machine, in order to ensure independence from its bête noire in the Cold War, West Germany.

The machines have been preserved, the first and last in the German Maritime Museum in Bremerhaven, the second at the Deutsches Museum in Munich. This paper will focus on the machines in Bremerhaven, primarily exploring the context in which they were first constructed, but also explaining how they work, summarising how they were re-assembled in the late 1990s, and finally addressing the issue of how they should be incorporated into the new permanent exhibition of the German Maritime Museum.

Martin Weiss is a postdoctoral researcher at the German Maritime Museum in Bremerhaven. He wrote his PhD at Leiden University on the changing public role of Teylers Museum in the nineteenth century and subsequently worked for the European Commission in Brussels and at the Deutsches Museum in Munich.

8 September 2015 Session 4a 4:00 -5:40pm

IMAGINING THE ASTROLOGER

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Keywords: astrology, iconography

In the *Monas Hieroglyphica* of 1564, John Dee offered up an evocative image. The symbolic language his text described would, he claimed, reform observational practice. The 'astronomus' (astrologer/astronomer), Dee wrote, would 'regret all the sleepless vigils and cold labors he has suffered under the open sky, when here, without any discomfort from the air, under his own roof, with windows and doors shut on all sides, at any given time, he is able to observe the movements of the heavenly bodies? And, indeed, without any mechanical instruments made from wood or brass?'

Taking Dee's image as inspiration, this paper will explore visual and literary iconography as evidence of instrumental practice in astrology. Focusing on European representations in the period 1550–1800, it will examine the extent to which such images might allow the historian to think about the practices of astrology and the relationship of astrologers to their instruments.

Richard Dunn is Senior Curator and Head of Science and Technology at Royal Museums Greenwich. He is currently working towards a proposed exhibition on the history of astrology, tentatively scheduled to open in 2018.

8 September 2015 Session 4a 4:00 -5:40pm

ITALIAN ASTRONOMICAL CLOCKS AS PUBLIC ASTROLOGICAL MACHINES

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Keywords: astronomical clocks, astrology, horology

Jacopo Dondi dall'Orologio made the first astronomical turret clock in Italy, in 1343, for the Padua lords, the Carraresi family. His design included a zodiac circle, a hand indicating the positions of the Sun and Moon, and a central disc, intended to supply information about the so-called astrological aspects: trine, square and sextile. The Moon's phases and day of the lunar month were easily understood by those who normally saw the clock and related to agricultural activities. The astrological aspects offered more complex information, mainly intended for horoscopes, as well as for medical and judicial astrology. This sort of dial, quite different in design from the astrolabic dials so common in Germanic countries, became almost standard for astronomical clocks in Italy for three centuries. It probably also inspired French makers, including the Huguenot Nicholas Oursian, maker of the Hampton Court clock for Henry VIII. Horological literature on these clocks often notes the astrological aspects, but their proper reading, which was well understood in the age in which they were made, is now practically unknown. Furthermore, some dials were covered in black varnish in the 20th century, a reaction against supposed superstition. Thanks to an Italian text describing the design and calculations of one of these dials, and other late medieval and Renaissance sources, it has been possible to reconstruct how they were read and interpreted.

Marisa Addomine is an independent researcher on the history of mechanical horology. Mainly interested in public clocks and early clockmaking, she discovered in 2004 a clock in Chioggia which she could date to 1386. She currently works in coopertaion with Italian and foreign universities and museums. She has been an invited speaker at the British Horological Institute and at the International Medieval Congress in Leeds.

8 September 2015 Session 4a 4:00 -5:40pm

THE ROLE OF THE COSMOS AT THE MEDICI COURT: THE NON-ASTRONOMICAL CONTENTS OF ANTONIO SANTUCCI'S LARGE PLANETARY MODEL

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Keywords: astronomy, astrology, Antonio Santucci

In 1582, Cardinal Ferdinand de' Medici commissioned Antonio Santucci of Pomarance to make a cosmological model. Once completed, the model was sent as a gift to Philip II of Spain. Making the instrument stimulated Santucci to write a *Trattato sopra la nuova inventione della sfera armillare*, explaining the astronomical and astrological content of an even larger and more sophisticated cosmological model. Work on this larger model began after Ferdinand stepped down from his position as Cardinal and became Grand Duke of Tuscany in 1587. The new model (now preserved at the Museo Galileo in Florence) was made between 1588 and 1593. Santucci coordinated a group of skilled craftsmen and artists to build an armillary about 3.7m high, designed to adorn the centre of the Mathematics Room of the Uffizi Gallery. It was originally placed between two large globes by Cosimo I de' Medici's cosmographer, Egnazio Danti. The new cosmological model synthesized Santucci's astronomical, astrological and geographical knowledge, as described in part in the *Trattato*. It also emphasized the power of the Medici dynasty and its recent union, blessed by God, with the Lorraine family: in 1586, Ferdinand I had married Cristina of Lorraine.

The two-year restoration of Santucci's large armillary, completed in 2010, has brought to light a considerable amount of information previously concealed beneath layers of blackened varnish. Brought together with Santucci's *Trattato* and other works, this information reveals the multifaceted – not just astronomical – purposes of the armillary.

Giorgio Strano, curator of the collections at the Museo Galileo in Florence, has particular interests in the history of astronomy. He has published articles in international journals and collaborated in making exhibitions on the history of science. He is general editor of the series Scientific Instruments and Collections.

8 September 2015 Session 4a 4:00 -5:40pm

WERE GLOBES USED IN THE PRACTICE OF EARLY-MODERN ASTROLOGY?

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Keywords: globes, astrology, Moxon

In the sixteenth and seventeenth centuries astrologers were often depicted with celestial globes; the aim of the paper is to consider whether this represents working practice or artistic convention. We recognise that astrology existed within the practice of astronomy but there are images where we can be sure that astrological work was intended. A small number of globes have design features that were specifically for astrology, but we might doubt the usefulness of the regular celestial globe to an astrologer. Certain astrological calculations could be carried out but the value of a globe for casting horoscopes, for example, would surely be seriously limited by the absence of planets.

In this paper we consider what evidence might be found for or against the real use of globes in astrological work. In particular we have tried to investigate the possible survival of material evidence for the techniques recommended by the English globe-maker Joseph Moxon.

Sylvia Sumira is an independent conservator specialising in globes.
Jim Bennett is a retired museum curator of scientific instruments.

8 September 2015 Session 4b 4:00 -5:40pm

CITY SCHOLARS, STATE SCIENCE AND AN ELECTRICAL FRICTION MACHINE

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Keywords: Lavoisier, science and social context, frictional electrical machine

The collection of the Museum Boerhaave in Leiden contains a glass disc electrical machine, made by John Cuthbertson, to which an important place in the history of chemistry has traditionally been attributed. In 1789 a small group Dutch chemists, who called themselves the Society of Dutch Chemists, managed to give elegant experimental evidence for Lavoisier's 'new' chemistry in a time when this theory was still heavily disputed. Recent historiography, however, has taken the edge off the significance of this 'evidence' for the dissemination of Lavoisier's work.

In my presentation I will emphasize that Lavoisier and the Dutch chemists worked in completely different social contexts, giving rise to two different kinds of scientific value systems. The organisation, material culture and epistemic values of the scientific practices differed markedly in both situations. From this perspective, I will argue that the most important significance of the Dutch chemists' experiments may have been that it served to 'translate' Lavoisier's chemistry into a scientific context – one governed by deviating, and even conflicting, values and practices.

Ad Maas is curator at the Museum Boerhaave. His interests are nineteenth-century scientific culture, the history of Dutch physics, the practical work of Albert Einstein, and the life and work of Willem Jacob 's Gravesande.

8 September 2015 Session 4b 4:00 -5:40pm

POINTS OF CONFLICT: HISTORIC SURVEY MARKERS, INSTRUMENTS AND THEIR COLLECTORS

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Keywords: surveying, exploration, instruments, collectors

The Canada Science and Technology Museum has a collection of 138 historic survey markers from across Canada, including related instruments once used in the field. The markers are made of wood, iron, and stone, and span dates 1762 to 1940. They come from every region of Canada, from the Yukon to Halifax. The original instruments used by the surveyors greatly enrich this collection, as well as links to the surveyors' original field books and plans in the Canada Lands Survey Records. In this paper, I describe three periods of history and conflict related to these historic markers and instruments – when they were first used, when they were collected, and their present use by university students in a collection-based digital history seminar. In the first context, the markers and instruments cover a range of tensions including technical issues surrounding practice, colonial and national expansion, and conflicting interests (and cultural perspectives) between government, surveyors, private enterprises, individual property owners, and First Nations communities. In the second context from 1952 to 1973, Dominion land surveyors collected these objects amidst great technical and institutional change in their profession. The history of the collectors and their heritage activities reveals much about their own time, values and preoccupations. Preservation in this context was an active expression of embracing and resisting generational change within the profession. In the third context, I will describe the present use of this collection in a history seminar, and the tensions that arise from digitizing and sharing this information with the public.

David Pantalony is curator of the Physical Sciences and Medicine at the Canada Science and Technology Museum. The present paper is based on an annual collection-based seminar he teaches at the University of Ottawa.

8 September 2015 Session 4b 4:00 -5:40pm

BRAWLING IN THE STREETS AND BROADSHEETS: INSTRUMENT TRADE WARS IN EARLY MODERN LONDON

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Keywords: early modern, London, trade

The London instrument trade grew prodigiously in scale over the long eighteenth century, flooding the British provinces and much of Europe and its colonies with wares. Most of the men (and occasionally women) involved had to be consummate tradesmen as well capable craftsmen in order to establish and maintain a thriving business.

As a result a number – encompassing names both well-known and largely unknown today – participated in commercial conflicts and posturing. Some sniped at each other *mano a mano* in response to personal aspersions, succession claims, or narrowly-targeted competition. In other instances, trade members banded together *en masse* to attack presumptuous instrument makers over claims to technological advancement, superior skill, or monopolies.

Individuals engaged in these battles in arenas from the public street to publications. Disagreements which originated in real space, as when a young trade member impinged too closely on the location and shop sign of an elder statesman, could also spill over into column inches. Alternatively, clashes which seem to have first played out in newsprint could manifest themselves in the real world. For example, some opponents staged public comparisons of their wares after increasingly-heated printed exchanges, and others sent spies into competitors' shops to compare published claims with ready stock.

These exchanges could reference common debates about practice and authority, both artisanal and commercial. Some accusations were made in earnest, while others were relatively disingenuous but strategic commercial manoeuvres – intended to position or to protect the members of a thriving but crowded trade.

Baker completed a Ph.D. at Oxford in 2010 on the early modern London instrument trade. In 2010-2013, she was a post-doc on the Cambridge / National Maritime Museum project 'Board of Longitude 1714–1828: Science, Innovation and Empire in the Georgian World'. In 2013-2015, she was a Cambridge Mellon/Newton Fellow.

8 September 2015 Session 4b 4:00 -5:40pm

INSTRUMENT MAKERS IN CONFLICT IN 19TH CENTURY ENGLAND

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Keywords: instrument makers, trade disputes, nineteenth-century England

By the nineteenth century England had a well-developed scientific instrument-making community characterized by extensive sub-contracting and buying-in of complete objects from other manufacturers, as well as rivalries between competitors. In some cases these complex networks of relationships resulted in disputes, a few of which ended up in the law courts, or in competing claims in the press and in advertising. The examination of a sample of such disputes will help to illuminate the connections between different branches of the instrument trades and how some of the larger businesses provided a supply of goods for their shops.

Gloria Clifton is curator emeritus at the Royal Museums Greenwich, which includes the National Maritime Museum and Royal Observatory. Before retirement she was Head Curator of the Royal Observatory and continues to work there as a volunteer. Her main research interests are in the history of British scientific instrument-making.

8 September 2015 Session 4c 4:00 -5:40pm

AUGUSTE DE LA RIVE'S APPARATUS TO REPRODUCE POLAR AURORAS

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Keywords: Polar auroras, terrestrial magnetism, atmospheric electricity

Based on a partially erroneus theory, the Geneva physicist Auguste de la Rive (1801-1873) built in the mid 19th century an experimental model reproducing polar auroras. He wanted to prove that this phenomen, then regarded as "electric meteors", could be easily explained by the interaction between electricity and terrestrial magnetism. According to him, auroras are due to discharges occurring in the polar regions between the positive electricity of the atmosphere and the negative electricity of the Earth. These discharges are then subjected to the influence of the earth's magnetic field.

The aurora machine is inspired by a previous experimental device designed by De la Rive, called the "electric egg" , to demonstrate the rotation of electrical discharge due to the action of an electromagnet.

For nearly half a century, the theory of De la Rive was considered one of the most plausible to explain the formation of the aurora. It was not until the early 20th century that the Norwegian physicist Kristian Birkeland showed that auroras have an "extraterrestrial" origin and that their colorful appearance results from collisions between an electron flow coming from the Sun and molecules in the Earth's upper atmosphere.

Based on the writings of De la Rive, The Musée d'histoire des sciences de Genève undertook a reconstruction of the original machine preserved in its collections.

Biologist and scientific writer, Stéphane Fischer is assistant-curator at the Musée d'histoire des sciences de Genève, which houses a collection of scientific instruments coming from the cabinets of some of Geneva's principal scholars of the past: Horace-Bénedict de Saussure, Auguste de la Rive, Marc-Auguste Pictet and Jean-Daniel Colladon. He is in charge of the collection of the Museum and its promotion to the public through publications, demonstrations and reconstitutions.

8 September 2015 Session 4c 4:00 -5:40pm

UNDERSTANDING PRACTICES: REFLECTIONS ON THE EXPERIENCES WITH MILLIKAN'S OIL DROP APPARATUS

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Keywords: Millikan, electron, 20th-century physics, oil drop apparatus, replication method

In my ongoing project I analyse material and procedural aspects of Robert A. Millikan's famous experiment with the oil drop apparatus. In doing so, I am using the replication method. In two previous talks (Florence 2010 and Manchester 2013) I discussed the historical apparatus as well as the experiences made in reconstructing the device. The last presentation ended by giving first impressions of the experiments that were carried out with the apparatus. In this year's presentation, I am going to discuss these experiments in detail and will present some of my findings – both in terms of experimental data as well as in reflections on the meaning of my experiences with respect to developing an understanding of Millikan's apparatus and work. For the final stage of this project I revisited Millikan's lab books and publications, and by considering my practical experiences, I developed a perception of it different than before. With this comprehension I can now offer answers to some questions in the controversy about Millikan's measurement of the elementary charge.

Martin Panusch has a background in physics and mathematics. He completed his studies with a thesis on Coulomb's torsion balance experiments on charge leakage. Currently, he is completing his PhD in which he analyses Millikan's experiments on the elementary charge by means of the replication method.

8 September 2015 Session 4c 4:00 -5:40pm

HOW STRONG IS A SPARK?
MAKING THE EPHEMERAL MEASURABLE

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Keywords: spark, energy, air-thermometer

In 1787, Alessandro Volta invented the straw electrometer that allowed measuring the electrical voltage for the first time by reading a scale. However, it remained impossible to get any information about energy, i.e. about current, voltage, and time at the same moment. Given that the power of the largest static generators or Leyden jars only resulted in one single, extremely short-term spark, this was impossible to measure.

In the absence of such measurement of energy, efficiency could only be communicated by the determinable length of the spark and by perception. So researchers described the colour, the brightness, the sound or even the intensity of the ozone smell generated by their instrument. The length of wire that could be evaporated also provided an estimate for the performance. Finally, the intensity of pain generated by an electric shock or the ability of killing animals was also a unit for measuring the energy.

In a letter to Benjamin Franklin in 1761, Ebenezer Kinnersley (1711-1778) described an electrical air-thermometer that was able to solve these difficulties. By means of a spark gap inside a sealed glass tube the spark communicates its energy completely to the surrounding air so that the subsequent thermal expansion (being proportional to the energy) could be measured by reading a scale. Many instruments derivative of Kinnersley's can be found in collections, but the one Franklin obviously held in his own hands could not be found. In order to make a comparative analysis between the performance of this first instrument and the most advanced ones available in the early 20th century, Kinnersley's instrument has been replicated based on the original paper from 1762. Experiments have been executed in Purmerend (NL), Florence (I) and Oldenburg (D). In this paper, a summary of those experiments will be presented and discussed and the results examined in the historical context described.

Wolfgang Engels , who holds a "Diplom" in physics (University of Oldenburg), specializes in the replication of historic apparatus and experiments, including Wilson's cloud chamber experiments, the Einstein-de Haas Experiment and the replication of Einstein's vaporization refrigerator. Several history of science museum exhibitions feature reconstructed instruments built under his direction; he frequently collaborates with documentary filmmakers concerning previous experimental practice, and his firm HistEx has produced working instrumental replicas for museums (including Dresden, Florence, Frankfurt, Kassel, and Berlin)

8 September 2015 Session 4c 4:00 -5:40pm

1672 DIVINI MICROSCOPE REPLICA – MODERN TECHNOLOGIES AT THE SERVICE OF TRADITIONAL KNOW-HOW

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Keywords: Divini, microscope, replica

The Museum of the History of Physics of the University of Padua holds a microscope dated 1672 and bearing the signature of Eustachio Divini. A replica of the microscope was commissioned from the ArtesMechanicae group in November 2014, and its realization was carried out over a period of four months. A proper philological reproduction was particularly complex, due to some specific features of the instrument.
In this paper we will present the problems encountered in making the replica, and we will discuss the implemented solutions and workarounds.
More specifically, we will present the results of the investigations on the structure, the materials and the manufacturing techniques of the original microscope, highlighting some features that represented problems designing and building the replica.
At the same time we will discuss the solutions which were implemented, solutions that all had to respond to three different needs. The first is the intention to build a replica as philologically correct as possible and - at the same time - to avoid producing a fake. The second is the necessity to use materials other than those used at the time, which are no longer available. The third is to produce a replica that is easy to display and durable over time (under certain conditions).
The entire process has been a significant testing ground for the use of modern technologies such as 3D printing, as well as a unique occasion for investigating traditional craftsmanship and techniques.

Andrea Bernardoni is a researcher and conservator at Institute and Museum of History of Science (Museo Galileo) in Florence and member of the research group Artes Mechanicae, which coordinates numerical simulations and physical reconstructions of historical technological processes. His last publication is «Construire à la Renaissance», PUFR, Tours, 2014.

9 September 2015 Session 5a 9:00 – 10:40

INSTRUMENTS, TOOLS AND MATERIALS: THE INVENTORIES OF J.DUBOSCQ'S AND D.H.RUHMKORFF'S WORKSHOPS

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Keywords: instrument maker, inventory, workshop**,** production, tools

During my recent research in the French National Archives, I discovered some interesting and unknown documents concerning the activities and the production of two leading 19th-century Parisian instrument makers: Jules Duboscq (1817-1886) and Heinrich Ruhmkorff (1803-1877). These documents are preserved in the huge "*Minutier central des notaires de Paris*", a collection of several million pages with all the notarized and official acts made in Paris between the end of the 15th and the beginning of the 20th century.

J. Duboscq (successor and son-in-law of the optician Soleil) was specialized in the production of sophisticated optical instruments. Duboscq and his wife Rosalie Jeanne Soleil were married on the basis of joint ownership of property and when she died in 1859, it was necessary to compile a detailed inventory of their common assets. In it, there is also a description of Duboscq's workshop with a list with all his instruments (ready to be sold or not yet completed) as well as the tools and materials used to make them.

H. Ruhmkorff, whose name is indissolubly bound to a well-known and improved type of induction coil, invented, improved and manufactured many electrical laboratory instruments which were used for research and teaching. After Ruhmkorff's death in 1878, his daughters decided to sell the lease of the workshop as well as all the furniture, the tools, the materials, and the instruments that were left in it. Also on this occasion a detailed inventory was compiled.

The two inventories mentioned are valuable sources of information concerning the activities of the two instruments makers. They allow us to cast a new light on the instruments they produced (for example Ruhmkorff never published a trade catalogue). Furthermore, by examining the list of hand and machine tools in their workshops, we can better understand how instruments were made.

In this paper I will present and comment on these inventories.

Paolo Brenni graduated in physics in 1981 at the University of Zürich. He specializes in the history of scientific instruments (mid-18th century to the mid-20th century). He is researcher for the Italian National Research Council and works in Florence for the Fondazione Scienza e Tecnica and for the Museo Galileo. He has studied, restored, and catalogued several collections of historical instruments. Between 2002 and 2013 he was president of the Scientific Instrument Commission of the IUHPS and is currently president of the Scientific Instrument Society.

9 September 2015 Session 5a 9:00 – 10:40

ANTONY VAN LEEUWENHOEK'S SCIENTIFIC INSTRUMENTS: NEW INFORMATION FROM THE DELFT ARCHIVES

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Keywords: Leeuwenhoek, scientific instruments, microscopy

This paper discusses the scientific instruments made and used by the microscopist Anthony van Leeuwenhoek (1632-1723). The immediate cause of our study was the discovery of an overlooked document from the Delft archives: an inventory of the possessions left in 1745 after the death of Leeuwenhoek's daughter Maria. This list sums up which tools and scientific instruments Leeuwenhoek possessed at the end of his life, including his famous microscopes. This information, combined with the results of earlier historical research, provides us new insights about the way Leeuwenhoek began his lens grinding and how eventually he made his best lenses. It also teaches us more about Leeuwenhoek's work as a surveyor and a wine gauger.

A further investigation of the 1747 sale of Leeuwenhoek's 531 single-lens microscopes has not only led us to the identification of nearly all buyers, but also has provided us with some explanation as to why only a dozen of this large number of microscopes has survived.

Huib Zuidervaart is a Dutch historian of science. He is the editor in chief of Studium, the Belgian-Dutch journal for the history of science, medicine and universities. His principal research topic is the history of scientific instruments and institutions in the Low Countries from the 17th-19th centuries.

9 September 2015 Session 5a 9:00 – 10:40

WHO INVENTED THE TELESCOPE? NEW LIGHT ON THE CONTROVERSY AROUND THE INVENTION OF THE TELESCOPE

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Keywords: telescope, 1608

In 1609 Galileo Galilei pointed his telescope to the heavens. What he saw and published changed the view of the world forever. The instrument used by Galilei came into his hands after the launch of the telescope in the Netherlands. In the fall of 1608, a year before Galilei's remarkable observations, there was an intense argument in the Dutch Republic about the question who invented the telescope. Three men disputed this invention, two of them are known by name: Lipperhey & Metius. The name of the third person was never revealed at the time. The - very successful - claim for the third person, Jansen, was made only years later: in 1654 when Borel investigated the invention, at the request of the Dutch ambassador in Paris. Recent research has shown that this claim (made by Jansen's son) was based on false information.
In my paper I will sketch the situation of the Netherlands in 1608. After the introduction of the main characters of the dispute, I show the way in which their rights on the invention were defended, and which strategy in the end appeared to be most successful.

Hans Hooijmaijers is Head of Collections and Vice Director at Museum Boerhaave in Leiden, The Netherlands. He started as curator of physics and astronomy and curated exhibitions on science in sports, the weather, light, food, Christiaan Huygens, clocks and telescopes. His latest writing projects were on a Dutch instrument maker of orreries, the Leiden Observatory and the history of Dutch navigation.

9 September 2015 Session 5a 9:00 – 10:40

SAVING ST PAUL'S –"REPARATIONS" AT ST PAUL'S CATHEDRAL, 1925 to 1930

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Keywords: surveying instruments, St Paul's cathedral, architectural history

The architect's office at St Paul's Cathedral, London, housed some 1920s surveying instruments about which no details were remembered. My research has uncovered that they had been used to measure the cathedral – in particular, the shape of the Dome, and the pillars on which it rests. As the combined weight was about 67,000 tonnes, the problem was to decide what the best way would be to consolidate the fabric, without destroying London's most famous building. These ordinary instruments represent a fascinating story, which is now brought back into the public domain.

Having retired from the Science Museum, London, in September 2012, Jane Insley became a volunteer on the collections at St Paul's Cathedral. This work in turn became part of a doctoral study in the history of 3D model making, using museum dioramas, architectural models, and mineralogical crystal models as case studies.

9 September 2015 Session 5b 9:00 – 10:40

SECTORS AND *TOISES* ASSAULT THE *FIGURE DE LA TERRE*

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Keywords: sector, *toise*, meridian

At the end of the 17th century a controversy arose concerning the shape of the Earth. Is its shape like a mandarin orange or like a lemon? In essence, that was the question. The first opinion was advocated by Newton's *Principia*, published in 1687. The second came from Cassini I's measurements made in 1683, running from Picard's southern point along a meridian arc up to Bourges, in the center of France, and (1700/1701) with his son Cassini II, up to the Pyrenees; the data obtained were compared with Picard's measurements from 1669/1670. Both measurements were made by the geodetic method of triangulation, employing sectors and, for the length reference, the *toise*. But which sectors and which *toise* were used? That is a second question. Later, mostly by La Hire, the northern part of Picard's arc was extended to the frontier by 1718. The results were published in 1720 and 1723 by Cassini II. Voltaire and others supported Newton's shape and the *Académie Royale des Sciences* decided to send two expeditions, in 1735 (close to the equator) and in 1736 (as close as possible to the North Pole). After the return of the second one, in 1737, credit for the correct shape was given to Newton and new measurements were performed, mostly by Lacaille in 1739/1740. In turn, these were published by Cassini III in 1744. So, which were the instruments and the *toise*? That is the last question and the end of the controversy.

Astronomer Suzanne Débarbat began to work - at first part-time - in history of astronomy in 1975. Since her retirement she has pursued work on the history of the Observatoire de Paris, its astronomers, their instruments, works, and discoveries. She has been an active participant in the SIC since 1981.

9 September 2015 Session 5b 9:00 – 10:40

WHAT WERE THE 'PROPER' INSTRUMENTS FOR EXPLORERS?: TENSIONS WITHIN THE ROYAL GEOGRAPHICAL SOCIETY, LONDON 1830-1900.

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Keywords: Exploration, Humboldtian science, 19th century

In 1830 the Royal Geographical Society (RGS) was founded with the expressed aim of providing a collection of instruments for the perusal of potential explorers. It did not actually attempt to fulfil this role until the 1850s, and did not succeed until the 1870s when it could be said instruments were properly managed and documented. One constant issue was the tension between the 'Humboldtian' desire to provide a great deal of data with a great number of expensive instruments, and the realities of their mobilisation and the restrictions imposed by finance and circumstances. It was not simply an issue of physical possibilities. The RGS had to position itself as distinct from professional surveying, but their explorers were not simply tourists. Therefore the promotion, development and recommendation of particular instruments both reflected and defined the rather precarious position of the RGS.

The tension within the RGS has been noted by Felix Driver. This paper will investigate it further by looking at controversies which impinged on instruments, finding instances where the advice to potential explorers was conflicting, and explaining how issues were resolved in the design and inclusion of certain items.

Jane Wess worked at the Science Museum in London for many years. Her research interests are in 18th-century philosophical instruments, and mathematical instruments from the 17th to the 19th centuries. She is undertaking a PhD on the Role of Instruments in Exploration with Edinburgh University and the RGS-IBG.

9 September 2015 Session 5b 9:00 – 10:40

ADOLF ERIK NORDENSKIÖLD: GEOMAGNETISM AND GEODESY IN THE ARCTIC REGIONS

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Keywords: A.E. Nordenskiöld, geomagnetism, geodesy

The present paper discusses Adolf Erik Nordenskiöld's contribution to research in geomagnetism and geodesy during his ten expeditions to the Arctic waters. It also reports on the apparatus used and the accuracy of the results.

During the second half of the 19th century the Swedish mineralogist Adolf Erik Nordenskiöld (1832-1901) undertook ten expeditions into the Arctic. Five of these expeditions went to Spitsbergen (Svalbard). The teams of scientists taking part in the expeditions also included physicists, performing meteorological and geomagnetic observations, and Nordenskiöld himself made astronomical observations. Having the exact positions of several landmarks made it possible to draw accurate maps. Nordenskiöld presented new maps of Spitsbergen and Björnøya and made corrections to old maps. During the *Vega*-cruise around Asia and Europe (1878-1880) the coastline of the Taimyr peninsula was shifted to the west. According to old maps *Vega* would have sailed on terra firma.

During the expeditions to Spitsbergen Nordenskiöld also put up a triangulation network for an arc-measurement at this northern latitude. The arc measured 4^{o} 10' (475 km) and it gave a valuable contribution to the calculations of the shape and dimensions of the Earth.

Peter Holmberg is Emeritus Professor of Physics at the Faculty of Medicine in Helsinki. He started as a nuclear physicist studying the structure of atomic nuclei, then followed research in biophysics. Today his main interest is in the history of physics. He has written several textbooks and reviews.

9 September 2015 Session 5b 9:00 – 10:40

ALL AT SEA: INSTRUMENTS IN EDWARD WRIGHT'S NAVIGATIONAL PRACTICE

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Keywords: Edward Wright, navigation, instruments

The English mathematician Edward Wright (1561-1615) is best known for *Certaine Errors in Navigation* (1599). This work was a major contribution to navigational theory, and provided not only the first published account of the construction of the Mercator projection but a detailed analysis and remedy of contemporary instrumental problems at sea. Wright was not simply an armchair theorist: he had been granted leave of absence from his Cambridge college fellowship to sail with the privateering Earl of Cumberland on a voyage to the Azores in 1589. The resulting narrative and Mercator chart of this voyage was subsequently published in *Certaine Errors*. This paper presents evidence for Wright's participation in another voyage with Cumberland, in 1593. From previously unpublished manuscript evidence, it examines Wright's navigational practice and shows that he travelled with at least three different observing instruments. Because Wright carefully recorded the specific astronomical observations for which they were used, this material provides extremely rare evidence for the circumstances in which different instruments were used at sea. It also illuminates innovations in practice at just the moment when Wright and others were establishing English mastery in mathematical navigation.

Stephen Johnston has been Assistant Keeper at the Museum of the History of Science in Oxford since 1995. He has published on a range of mathematical arts and sciences from the Renaissance to the 19th century, with a special focus on early-modern England.

9 September 2015 Session 5c 9:00 – 10:40

TECHNICAL COLLECTIONS AT THE STATE HERMITAGE MUSEUM: CHAPTERS OF HISTORY

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Keywords: Peter the Great, Hermitage, scientific instruments, technical collection

The larger-than-life personality and deeds of Peter the Great have generated heated arguments among historians, cultural specialists and philosophers up to this day. I would like to address one particular area of his inheritance, his collection of scientific tools and instruments, now kept and exhibited at the Hermitage Museum. Peter the Great collected, used and studied scientific instruments during his entire life. Unlike most politicians, however, Peter practiced what he preached; legend tells that he worked at 14 trades. This was an absolute breakthrough for Russian society, conflicting with older traditions.

The Hermitage in St. Petersburg owns approximately 1500 instruments which belonged to Peter the Great: among them artilleristic, astronomical, geodetic, medical, nautical and drawing instruments as well as time-measuring devices. The most striking among these are exhibited in the re-created "Turning Room of Peter the Great".

The Hermitage is an encyclopaedic museum, covering all fields of human activity, including science and technology. Peter's collection of instruments and tools has become the foundation of the Hermitage Museum technical collection, now encompassing approximately 3000 objects. Several of these items reflect the troubled life of their makers. Other exhibits were directly involved in social, financial, military and political conflicts of Russian life during the last three centuries. The collections' long history reflects wars, reforms and revolutions, which influenced its formation, development, present state and value. Several of these stories of conflict will be highlighted in my presentation.

Grigoriy Yastrebinsky is the the curator of the collection of scientific instruments and tools of the History of Russian Culture Department at the State Hermitage Museum in St. Petersburg, Russia. His main research field is scientific instruments of the 17th-20th centuries and, in particular, Peter the Great's instruments.

9 September 2015 Session 5c 9:00 – 10:40

SCIENTIFIC INSTRUMENTS FROM THE UNIVERSITY OF PADUA TO SECONDARY SCHOOLS: STORIES OF PEACE AND WAR IN NINETEENTH-CENTURY NORTH-EAST ITALY

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Keywords: university, schools, cabinet of physics, historicization

In two schools of the Veneto region, one in Padua and one in Verona, we found eighteenth- and nineteenth-century scientific instruments closely related to the University of Padua. The present paper will show how the study of these instruments has brought to light two very different stories: a fruitful scientific collaboration on the one hand, and a stormy quarrel about the University Cabinet of Physics on the other hand. Both these stories have shed new light on the history of the University of Padua and on the process of historicization of its Cabinet of Physics. In fact, the latter is an open issue which we are currently trying to clarify.

Sofia Talas is curator of the Museum of the History of Physics at the University of Padua. Her main research interests are in the history of scientific instruments and the history of physics from the 18th to the 20th century.

9 September 2015 Session 5c 9:00 – 10:40

HEIRS TO THE GLORIOUS PAST: TARTU OBSERVATORY BETWEEN THE TWO WORLD WARS

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Keywords: astronomy, interwar period, Tartu

In 1839, when F.G.W. Struve went to Pulkovo, he left the small observatory in Tartu very well equipped. There were instruments from the best makers in England (Herschel, Dollond, Troughton), as wellas the best makers in Germany (Fraunhofer, Reichenbach, Ertel). The observatory and its instruments attracted famous astronomers to apply for the post left by Struve.

In 1919, 80 years later, the situation was very different. The Dollond, the Reichenbach and the Fraunhofer telescopes were old and unreliable; the new Zeiss telescope with its astrograph had been taken to inner Russia to protect it from the war. There was a new Republic of Estonia and a new university that used Estonian language in teaching, together with a new generation of astronomers with a lot of talent but little financial resources.

In this paper I will analyse how the observatory coped with its new position and how the economic and political situation influenced the research programme and equipment acquirement choices at the observatory. In this I am concentrating on the instruments that were made locally rather than ordered from abroad.

Janet Laidla is the Head of the Old Observatory at the University of Tartu Museum. She had studied history with interest in early modern historiography before turning to the history of astronomy. She had curated exhibitions on space exploration and solar eclipses.

9 September 2015 Session 5c 9:00 – 10:40

DENIS PAPINS'S (?) STEAM CYLINDER

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Keywords: steam engine, Papin, Kassel

The Astronomisch-Physikalisches Kabinett in Kassel holds a number of instruments ascribed to Denis Papin: of those, a large cast-iron cylinder (height ca. 1.20m, diameter ca. 1.25m) stands out. The cylinder came into the Kassel Collection in 1869. It arrived with an extraordinary endorsement based on the 1847 assessment by industrialist Carl Anton Henschel that the cylinder once was part of an early steam engine built by Papin, predating Savery and Newcomen. For Henschel, the existence of the cylinder was proof that the steam engine was a German invention. When the cylinder was sent to the Special Loans Exhibition in 1876 it was there for a specific purpose: to demonstrate conclusively the ancestry of Papin's device.

Not everybody agreed. Indeed, even the men who strongly underlined its historical importance differed in their opinions as to which of the Hessian steam experiments of Papin the cylinder had actually belonged. The cylinder's appearance in London did not settle any of these questions. For example, Frederick Bramwell dismissed the notion that the cylinder could have been used by Papin. Such criticism does not seem to have deterred local pride: in the first-ever printed catalogue of the Kassel Collection, published in 1878, the cylinder was given a special in-depth treatment, and it was regarded as equal in historical importance to the 16th century astronomical instruments of Wilhelm IV.

My talk aims to shed light on the 19th-century discussions concerning this cylinder and to follow-up that debate to the present.

Peter Schimkat was trained as a physicist and astronomer, but evolved into an historian of science (PhD, University of Munich, 2005). He is still enjoying that fact. Primarily, he is interested in the histories of geology and astronomy, in globes, and in scientific instruments, He works as a freelance writer.

9 September 2015 Session 6a 2:30 -3:45

WORKING WITH FAKES: XRF ANALYSIS OF WHIPPLE MUSEUM OBJECTS

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Keywords: Fake instruments, XRF analysis, Robert Stewart Whipple

Derek Price's 1956 identification of fake scientific instruments in major European collections relied upon a combination of provenance, analytical, and visual evidence. A major source for this work were the five fakes Price identified in the collection of his own department in Cambridge, in the Whipple Museum of the History of Science. Important for his case had been the chance to subject two of these objects to spectroscopic spark tests, exposing serious abnormalities in the composition of their metal parts. This paper will return to these same concerns, discussing the role of a modern non-invasive spectroscopic technique – XRF analysis – in the ongoing investigation of potentially fake or "restored" objects in the Whipple Museum's collection. By widening the scope beyond the Strozzi and Mensing fakes, the paper will address recent attempts to better understand several significant objects purchased by Robert Stewart Whipple in the interwar period, during the peak years of his private collecting activities. New XRF results will be shared that shed new light on the authenticity of a major acquisition by Whipple, and the implications of such tests for the curation and interpretation of instrument collections will be discussed.

Joshua Nall is Assistant Curator of the Whipple Museum of the History of Science, in the Department of the History and Philosophy of Science at the University of Cambridge. His research focuses on mass media and material culture of the physical sciences after 1800.

9 September 2015 Session 6a 2:30 -3:45

SCIENTIFIC INSTRUMENTS AND THE CULT OF AUTHENTICITY

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Keywords: Fake Instruments, Collecting, Robert Stewart Whipple

When in 1956 Derek Price dramatically unmasked the so-called 'Mensing fakes' he drew primarily on his experience of working with scientific instruments from the Whipple Museum of the History of Science in Cambridge. More recently, the Anton Mensing Scientific Instrument Project has dealt in great detail with almost all aspects of the story, from its beginnings around the time of the sale of the Strozzi collection in 1911 to ongoing research into the authenticity of objects in a large number of collections. Yet the acquisition by Robert Stewart Whipple of Mensing fakes has not itself been the subject of historical analysis. In part this is because documentary evidence – as Price made clear in the 1950s – is hard to come by. But it is also because interest in forgeries has tended to be motivated by what we might call the forensic urge: Why were fakes made? How can we identify them? And so on.

In this paper I approach the problem from a very different angle. Objects that we know to be inauthentic are, I argue, particularly revealing elements in a collection, betraying the deepest desires of collectors and shedding light on an age less burdened with our obsession with authenticity. I will present a summary of what we know about the Whipple Mensing fakes, in addition to an account of Whipple's collecting that begins with, rather than excludes, these seductive instruments.

Boris Jardine is the Munby Research Fellow in Bibliography at Cambridge University Library. He works on the history of scientific instruments, in particular in relation to the book trade

9 September 2015 Session 6a 2:30 -3:45

SPOTTING FAKES: NOTES FROM THE TRADE

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Keywords: Fake Instruments, Collecting, Trade

"There are, unfortunately, very few collectors of fine mathematical instruments, very few persons who know anything whatever about them." (G.C. Williamson, *The Art Journal*, 1911)

With these words Williamson set about introducing the instruments of Erasmus Habermel to the early-twentieth century art market. But the combination of the interest Williamson sought to promote, along with the ignorance that he diagnosed, was a recipe for disaster. Williamson, then Anton Mensing, the Feeterse brothers, Antique Art Galleries of Grafton Street, and ultimately the collector Robert Stewart Whipple all played their subsequent parts in this story, in which a large number of fake instruments entered the market.

Amazingly these early 20th-century fakes still continue to deceive and fool to this day. This paper will present some examples recently seen in the art market, and explore how they have been presented by the trade and received by collectors. Some of these (honest) mistakes may shed light as to how Whipple, between the 1920s and 1950s, unknowingly amassed fake scientific instruments as part of his fine collection.

James Hyslop is Head of Department for Travel, Science and Natural History at Christie's. He catalogues scientific instruments and globes for all the international auction salerooms.

9 September 2015 Session 6b 2:30 -4:10

MOVIES THROUGH THE MICROSCOPE: INSTRUMENTS AND TECHNIQUES

Marco Galloni

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Keywords: movie camera, microscope, cinematography

Cinematography had its birth with Auguste and Louis Lumière on December 28, 1895, and soon it had scientific uses in order to record subjects and events in motion. The microcosmos was also investigated with wooden and hand-cranked movie cameras linked to microscopes: in a similar way, in 1892 Jules Marey had obtained image sequences with his chronophotographic camera. The problems that cine-microscopists had to overcome in the first years concerned focusing, illumination and vibrations, the first two such drawbacks being increased by low luminosity of the optics and very low sensibility of the film. Strong illumination was achieved with heliostats or electric arc lamps, taking care not to damage the subjects, particularly living microorganisms. Focusing problems were solved by observing the images directly projected by the microscope on the film, because the black-and-white films of the silent movie age could be used as a translucent focusing screen if observed from the back through a light-tight magnifying telescope. Vibrations were controlled with heavy supports. The subsequent evolution of micro-cinematography involved the progresses of microscopy, such as dark-field microscopy, phase contrast, electron microscopy etc. On the other hand, cinematographic techniques evolved with motor-driven, time-lapse and high-speed filming, variable shutters, reflex view-finders, high-sensitivity films etc. In biology, in-vitro cell cultures and protistology were the areas which took greater advantage of micro-cinematography, with scientists such as Julius von Ries, Jean Comandon, Osvaldo Polimanti, Warren Lewis, Giuseppe Levi and Roberto Omegna. The instrument makers most involved were Pathé, Debrie, Ernemann, Zeiss, Siemens, Askania, Vinten and Bolex.

Marco Galloni is a biologist and teaches anatomy in the Department of Veterinary Sciences, University of Torino. He is also the scientific director of ASTUT and is primarily interested in research about microscopy, scientific photography and cinematography, physiological and medical technology as well as museology.

9 September 2015 Session 6b 2:30 -4:10

PENICILLIN – A 3D RECONSTRUCTION OF THE HISTORICAL PRODUCTION PROCESS

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Keywords: penicillin, antibiotics, 3d-visualization

This presentation will explain the early production of penicillin and the usefulness of 3D tools for the illustration of such historical processes. “3D visualization” is a brilliant tool to bring old and often forgotten things back to life, offering the opportunity to demonstrate every step in the production process in rich detail.
The purpose of this presentation is thus, on the one hand, to explain the production of penicillin in 1940s Oxford and, on the other, to underscore the significance of the use of 3D visualization tools to demonstrate complex mechanisms. We want to draw attention to recent developments in the field and to the power of this visualization tool for museum exhibitions.
The present project is a key part of the planned “Antibiotics Exhibition 2016” at the Museum of the History of Science in Oxford and is produced in collaboration with the Hochschule für Technik und Wirtschaft in Dresden.

Carl Schwedes is a computer science student from Dresden, Germany. He has worked for more than seven years with software for 3D visualization and his interest about 3D reconstructions started quite early, at the age of 17. His spectrum of interest is very broad, and he aims for every project to offer a new challenge.

9 September 2015 Session 6b 2:30 -4:10

LECTURE DEMONSTRATIONS IN HISTORY OF SCIENCE MUSEUMS

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Keywords: Lecture demonstrations, history of science museums, historical experiments, science stories, Greek scientific heritage, preservation versus use

During the last decade, there has been increased interest in reviving the culture of lecture demonstrations as a means of shedding light on historical scientific instrument collections. Museums hosting such collections are confronted with one basic problem: While these scientific instruments were constructed to be used and to produce phenomena, they cannot be used by museum visitors themselves. Lecture demonstrations in these museums therefore constitute one means of engaging the public with scientific topics.

In the present paper, I will describe the experience of developing two lecture demonstrations, prepared as a means of exploring the 19th- and early 20th-century scientific instrument collection of the Athens University History Museum. The weaving of their content, the engagement of my school-students in their preparation and presentation, as well as the audience reaction will be reported. Besides, I will argue for the fact that our lecture demonstrations are a relevant means for the exploration of the above historical collection for two basic reasons. First, as they include the performance of experiments conducted with the help of modern scientific instruments used in the same way as the old ones, they constitute a way to resolve the conflict between preservation and use of the historical instruments. Second, as I will show, the culture of lecture demonstrations was an integral part of science teaching in Greece during both the 19th and early 20th centuries. Therefore, by using this way of science communication, I think that we gave back to the old instruments glimpses of their past lives.

Flora Paparou holds a Ph.D. in science education. Her research focuses on the utilization of the history of science in science teaching. She currently works in Secondary Education and collaborates with the Athens University Museum on the identification of scientific instruments and the organization of science popularization activities.

9 September 2015 Session 6b 2:30 -4:10

CONFLICT AND BALANCE: FEYNMAN INSPIRES EXPLORATIONS OF THE CLASSROOM, ASTROLABE, FLUID MECHANICS AND ARCHIMEDES

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Keywords: exploration, active learning, historical replication

Instruction is often distant from, yet conflicting with, students' personal experience. Where students let instruction keep that distance from their lives, they may not become aware of ways it conflicts with their thinking or world. As a student, Richard Feynman did not tolerate any distancing which hid the workings of what he sought to learn. When his philosophy professor ended a course of unintelligible lectures by assigning a final paper, Feynman researched his own mind, uncovering its profound make-up: "I wonder why I wonder why." Not content to accept geometry and physics from textbooks, Feynman recreated derivations, uncovered conflicts, and generated questions. My students aspire to Feynman's spirit of readiness to question, delve into the heart of a matter, unearth conflicts, and reconstruct past work through original investigations. Meeting together with me, learning and teaching evolves organically. Historical instruments and readings precipitate activities including: recreating ancient proofs, adapting ancient practices into class inquiry, viewing historical instruments, observing with analogue instruments, developing experiments and machines. The making of collaborative activities brings to light conflicts embedded in history, relating to our experiences. In their poster presentations linked to this oral presentation, Liuni questions the conflict arising from exhibiting the astrolabe as an art object; Heisser notices conflicts and principles of balance in historical fluid mechanics instrumentation, including a lab under continuous development since 1947; and Liuni and Heissler together observe conflicts in ancient geometry, and respond with exploratory constructions. As their teacher, I experience conflicts which transform into relationships of mutual exchange and balance.

Elizabeth Cavicchi teaches at MIT's Edgerton Center. Together with learners, her classroom research explores: historical science, instruments, and everyday natural phenomena. Research in nineteenth century electromagnetism followed Cavicchi's Harvard Ed.D.; masters' at Harvard, Boston University and MIT; MIT undergraduate degrees. Publications include Perspectives on Science (2006) and New Educator (2009).

9 September 2015 Session 6c 2:30 -4:10

A LETTER (1817) BY MANUEL PEDRO DE MELO (1765-1833) ABOUT SOME ASTRONOMICAL INSTRUMENTS FOR THE ROYAL ASTRONOMICAL OBSERVATORY OF THE UNIVERSITY OF COIMBRA

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Keywords: Coimbra Astronomical Observatory, scientific voyages**,** instruments

In 1801 Manuel Pedro de Melo (1765-1833), a former student of the Coimbra University (1790-95) and PhD in mathematics, at the time professor of the Royal Navy Academy, was named professor of hydraulics of the Coimbra's Faculty of Mathematics. In order to train for his new discipline he was sent to Europe. The voyage instructions were written by Monteiro da Rocha (1734-1819), at the time Director of the Coimbra Astronomical Observatory (OAUC). Besides hydraulic questions (machines and hydraulic constructions), those instructions specified other scientific tasks, such as visiting scientific institutions and astronomical observatories and studying their instruments. Due to the Peninsular Wars (1807-14) Pedro de Melo was away until 1815, living in different countries such as France, England, Holland and Denmark. In France, in the 1800s, he worked with Delambre (1749-1822) at the Paris Observatory. Due to this connection with Pedro de Melo, Delambre was able to acquire deep knowledge of Coimbra's astronomical ephemerides. The first volume was published in 1803, receiving some very favorable book reviews in the *Connaissance des Temps* (1806, 1807 and 1808).

In the late 1810s the OAUC was planning some instrumental acquisitions. In 1817 Joaquim Miranda (1782-66), the OAUC's technician, wrote a letter to Pedro de Melo, at the request of Monteiro da Rocha, the OAUC's director, asking for information about instruments that he could have seen during his stay abroad and information useful for the intended updating of the OAUC's instruments.

The present communication draws on this source material to present the OAUC's primary astronomical collection (a transit instrument, a portable quadrant, a sector, several telescopes, etc.) and its evolution during the observatory's first 25 years (comparing inventories from 1810 and 1824). We also intend to present some details of Pedro de Melo's scientific voyage and how it fits into the OAUC's scientific program at the time.

F.B. Figueiredo is post-doc at Coimbra University. His research interests are history of mathematics and astronomy (18th century). He is currently researching the history of astronomy and mathematics in Portugal (1772-1820), trying to understand the extent to which the major advances in celestial mechanics were assimilated and incorporated into Coimbra's astronomical ephemeris.

9 September 2015 Session 6c 2:30 -4:10

THE "GRADUS TAURINENSIS" AFFAIR AND THE INSTRUMENTS OF THE PLANA-CARLINI REVISION

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Keywords: History of Turin Observatory, old geodetic instruments

The publication of "Gradus Taurinensis", reporting the results of the measurement of a meridian arc passing along the Turin Astronomical Observatory spanning about 126 kilometers between the northern station of Andrate and the southern station at Mondovi, originated a decades-long dispute running from 1774 until the publication of a third revision of the original measurement by the duo Giovanni Plana and Francesco Carlini in 1827. The measurement of this meridian arc and the related astronomical observations are customarily associated with the foundation of the Turin Observatory. The original instruments for the "Gradus" operations have all been lost; however, our collection of astronomical and geodetic instruments still contains, among many others, the ones used for the 19th-century revision; these have been recently restored thanks to special support from the Italian Educational Ministry. Most of them are from renowned foreign makers, but some have been built within the observatory shop, testifying to the good skill level of local artists.
After a brief review of the opposing terms of the original dispute, the contribution of the astronomers and instruments of the Turin Observatory to the geodetic operations that led to its resolution will be discussed.

The author started his activity in the field of classical astronomy (proper motion determination, reference systems) but switched to technology about fifteen years ago. He is now in charge of the scientific instrumentation (new and historic) and the optical laboratory at the Turin Observatory.

9 September 2015 Session 6c 2:30 -3:45

TYCHO'S OCCULTING ALIDADES

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Keywords: Tycho Brahe, Johannes Hevelius, alidade

Tycho Brahe's celestial position measurements in the late sixteenth century, which made it possible for Kepler to formulate his laws of planetary motion, were much more accurate than previous observations. The principal reason was that Tycho had abandoned the ancient use of two pinnules on his alidades for aiming towards a star or planet, and substituted an occulting system, which I shall describe. Tycho himself did not really understand the optics that made his alidade so precise, which is understandable because Kepler had not yet elucidated the optics of the human eye. But by the mid-seventeenth century the Keplerian telescope equipped with cross-hairs had shown even greater promise for pointing, and only Johannes Hevelius – widely criticized, notably by Robert Hooke – continued to use such *instruments in conflict*. Although Hevelius could achieve accuracy comparable to that of early telescopic observers like Flamsteed and Picard, he was limited to rather bright stars, and was the last astronomer to use Tychonic sights.

I shall explain the simple geometrical optics of this unrecognised device, which played such an important role in astronomy. The failure of Hooke and others over the centuries to understand it is a mystery to me. Today it is obvious that the precision of an occulting alidade is limited by diffraction, resulting in a significant apparent angular size of stars and planets. I believe this may explain the stellar diameters claimed by Tycho, which were cited in support of a geocentric universe.

James Caplan, born in Chicago, studied physics at the University of Chicago and obtained a PhD in astronomy from Northwestern University, before moving to the Marseille Observatory for research on the interstellar medium using Fabry-Perot interferometers, and now astronomical history. He is an astronome émérite *at the Université d'Aix-Marseille.*

9 September 2015 Session 7 4:30 -6:00

INSTRUMENTS ONLINE - DIGITALISATION OF THE FOUNDATION COLLECTION OF THE DEUTSCHES MUSEUM

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Keywords: digitalisation, collection, mathematical and physical instruments

The poster portrays contents and purposes of the research project for the creation of a digital catalogue of the foundation collection of the Deutsches Museum. This collection contains the mathematical and physical instruments of the Bavarian Academy of Sciences and Humanities. It numbers among the most substantial groups of scientific apparatus in the German territories of the 18th and 19th centuries and represents the diversity of disciplines and the close connections between science and practical application. Beside the emphasis on optical and meteorological devices, the collection includes, for example, astronomical, electrical and mechanical exhibits. They bear witness to two large-scale scientific projects: the first international meteorological observation network (Societas Meteorological Palatina) as well as the systematic Bavarian geodetic survey. Five hundred selected objects have been indexed and digitised since January 2013 within the scope of a project focusing on functional principles and historical importance. Being purposely a pilot scheme, one of the main aims is the development of an analytic method (work flow, creation of check lists) for the digital editing of further parts of the inventory of the Deutsches Museum (e.g. instruments in the exhibition). Research results will be accessible in the online portal not only for a specialist scientific community but also for the interested public. To achieve this, search functions are available such as full-text search or searches via person, epoch or instrument category as well as extensive glossaries or indexes. Beside photographs and basic information, the resulting pages offer relevant processes of manufacturing and use. A laptop next to the poster presents a first beta-version of the collection portal with its functions and data sets.

Julia Bloemer studied particle physics at the University of Bonn and the Technical University in Munich and has now begun her PhD thesis about the foundation of the Bavarian Academy of Sciences and Humanities and the relation between science and religion. She has worked in the digitalization project as a research assistant since March 2014.

THE HIDDEN TREASURE. SCIENTIFIC INSTRUMENTS AND THEIR BOXES IN 18TH-20TH C. GREECE

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Keywords: Greece,19th century, scientific isntruments' boxes

The independent Greek State suffered from a lack of interest for the advancement of sciences mainly due to ideological reasons. This drawback was visible in the University of Athens where the chairs of Physics and Chemistry remained under the Faculty of Philosophy until the turn of the 19th century. Nevertheless and despite numerous financial and bureaucratic difficulties the Professors of Physics and Chemistry tried to acquire as many instruments as possible to be used in their laboratories. Most instruments were bought from French and German instrument makers and a large number of instruments gradually enriched the relevant catalogue of the University's holdings.

In the present paper we aim to study the fate of these instruments. Many of them were never used or have been on display, as adequately trained personnel to use them safely and properly was lacking. So there was no other option than to keep them closed in their boxes, which were stored together in the basements of the University of Athens buildings dedicated to the teaching of Physics and Chemistry according to German standards. So these boxes sheltered their contents for over a century like precious treasures.

Though usually our interest is directed at the instruments themselves we claim here that it was the structure and the quality of the boxes which made possible the preservation of the instruments.

In this sense we may conclude that these boxes were at least as precious as their contents.

George Vlahakis is Assistant Professor of History and Philosophy of science in the Hellenic Open University and Fellow Researcher in the National Hellenic Research Foundation. He is acting president of the Commission on Science and Literature/DHST/IUHPST and Secretary of the History of Physics Group of the European Physical Society. The history of scientific instruments is among his main scientific interests.

9 September 2015 Session 7 4:30 -6:00

THE FIRST POLISH CYCLOTRONS

Małgorzata Taborska

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Keywords: cyclotron, nuclear physics, Institute of Nuclear Physics

The C-48 and the U-120 (produced in the USSR) were the first two cyclotrons operating in Poland. Since the beginning of the 1950s a team led by Prof. Henryk Niewodniczański in Krakow begun work on constructing the C-48. The work of the team was accelerated after the conference *Atoms for Peace* (Geneva, 1955) as the Soviet Union decided to sell their U-120 model to all socialist countries. They wanted the first functional instrument to be made in Poland. Moreover, the experience of the use of the C-48 was a crucial argument when was taken the decision where to build the laboratory for the U-120 (and why it should not be Warsaw).
The first beam of protons with the C-48 was obtained on 28 December 1956. The U-120 was purchased in 1956, but started operating in 1958, delivering its first deuterium beam in November. Both instruments functioned at the Institute of Nuclear Physics in Krakow.
The C-48 in 1992 was given to the Institute of Physics of the Lublin University. Now it is not operating, but is used for educational purposes. There was a proposal to store it in the Museum, but the size and weight of the object made it difficult. The U-120 was dismantled in 1995.

A biologist and surveyor, Taborska has been curator at the Museum of the Jagiellonian University since 2006. She is a supervisor of the collection of globes, clocks, sundials, watches as well as surveying, cartographical and meteorological instruments and biological laboratory equipment. She is interested in the history of science – especially of the natural sciences and geodesy. Her research topics include Polish language globes, history of meteorology at the Jagiellonian University, history of surveying in Poland.

9 September 2015 Session 7 4:30 -6:00

TWO SIDES OF A SINGLE ASTROLABE

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Keywords: Planispheric astrolabe, Moscow State Museum of Oriental Art, Lahore

The earliest known dated astrolabe from the Indian city of Lahore was made in 1567 by Allahdad; they are more than a hundred astrolabes extant which were made subsequently by his successors. The State Museum of Oriental Art (Moscow) displays an astrolabe (IC 3674) made in Lahore in 1587/88. Until now, there was only one description of the astrolabe made 45 years ago in Russian. New research of the instrument in 2014 revealed several problems. First, there were some inaccuracies in the previous description, i.e., the diameter of the instrument was incorrectly indicated as 160 mm. The actual diameter of the astrolabe is 151 mm. Secondly, the specific details of the astrolabe are found to demonstrate two different quality levels of the workmanship. Thus, the rete with 33 stars and one tympan (Mecca and a special plate showing only the horizon for a number of latitudes) were made by a skilled master. Four other tympans and the scales on the back and geographical gazetteer on the mater do not meet even the minimum requirements of workmanship quality. Plates for eight latitudes were made "by eye". Both they and the scales of sines and cotangents are completely non-functional. The shadow square is torn and arbitrarily located. Most of the astrological information at the back, including the planetary rulers of triplicities, decans, and terms, is, nevertheless, correct. There are some common elements with astrolabes manufactured by known masters of Lahore school (e.g., boot-shaped star-pointers) but the comparison gives no positive indication as to the name of the astrolabist. One possible source of the high-quality components is an astrolabe of Mirza Baysunghur, the Turkmen ruler of the Aq Qoyunlu dynasty. Thus, an astrolabe by Mirza Baysunghar (late 15th century) brings a new element into the history of astrolabe production in India!
The present investigation will be continued.

Sergei Maslikov is an applicant for the Candidate Degree at the Institute of History of Science and Technology (Moscow, Russia). His thesis is devoted to astrolabes. Currently Maslikov holds the position of the Director of the Large Novosibirsk Planetarium. The sphere of his research instruments is history of astronomy.

9 September 2015 Session 7 4:30 -6:00

THE ALBION OF ROME

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Keywords: history of astronomy, medieval Instruments, equatoria

Equatoria represent the most advanced category of medieval instruments designed to provide the coordinates of the planets and the stars and the time of eclipses in a simplified way. Among these, the Albion invented by the English monk Richard of Wallingford in the fourteenth century had a good success, as testified by several surviving manuscripts with the instructions for the construction and the usage of the instrument and subsequent revisions by Johannes Gmunden and Johannes Regiomontanus in the fifteenth century. Only one Albion is extant, preserved in the Museo Astronomico e Copernicano of the Astronomical Observatory of Rome. It is incomplete, unsigned and undated, and presents some differences from the manuscript tradition. An analysis of its features and a comparison with the manuscripts and some other extant instrument is ongoing. First conclusions will be presented in this paper.

The author completed his studies in physics at the University of Pavia (Italy). He is affiliated with the History of Science Society as well as the Commission for the History of Ancient and Medieval Astronomy. His research interests include astronomy in the Middle Ages, the Renaissance, and the Scientific Revolution; history and iconography of ancient astronomical instruments; star catalogues and celestial maps.

9 September 2015 Session 7 4:30 -6:00

THE VIENNA RADIUM INSTITUTE AND THE ODYSSEY OF ITS COLLECTION OF HISTORICAL INSTRUMENTS

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Keywords: Institute for Radium Research, Victor F. Hess, Echophysics

The Institute for Radium Research of the Imperial Austrian Academy of Sciences in Vienna was established and inaugurated in 1910 as the first of its kind worldwide. Under Stefan Meyer, the new institute dedicated extensive research to the physical properties of the radioactive element radium. The collection of scientific instruments from the Radium Institute does not include demonstration equipment but consists of measuring apparatus only.

The present contribution reports on the research findings of utmost significance at the Vienna Radium Institute through conducting the precise measurements which resulted into two Nobel awards. The odyssey of its rich collection of "classical measuring apparatus"—373 objects had been discarded as useless since nuclear electronics evolved—began in 1987, when the Radium Institute was split into two new institutes making the University of Vienna the new owner of the instruments. The historical value of the collection continued being underrated when, in 2004, the institute, to which the responsibility for the heritage was assigned, relocated from the historic building to a new site and cleared away the encumbering bulk into a storage room. In 2009, the claim for its removal turned imminent and, in this situation of urgency, the author undertook to adopt the "collection" as a whole, to preserve its integrity at its dual value from the historical instruments put in their original setting of furniture: the historical remains of the Vienna Radium Institute got their new home at *Echophysics,* the *European Centre for the History of Physics*, at Poellau Castle in Styria, Austria.

Born in Vienna, Austria, in 1939, the author studied history, Japanese, then mathematics and physics at the University of Vienna. In 1967 he received his Dr. phil. in physics; in 1969 he became head of marketing at Carl Zeiss, Oberkochen. Further stations: 1976 AOL-Dr. Schuster, Analytik, Optik, Lasertechnik, in Vienna; 1987 cancer of the larynx. From 1988, his research interests have been the Austrian forerunners in modern physics; optics; spectroscopy; physics and literature.

9 September 2015 Session 7 4:30 -6:00

BALANCING THE ASTROLABE BETWEEN ART AND SCIENCE

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Keywords: astrolabe, art and science

What happens when we exhibit an Islamic astrolabe? Recognizing its aesthetic value as a masterpiece, how can we highlight its function in making astronomical observations? The astrolabes whose metalworking is most refined were often the most scientifically advanced. Do exhibitions that emphasize only the artistic and historical features of astrolabes undermine the instruments' scientific importance? Is it the imperative of a museum to exhibit objects as important documents of the past that inform the future and educate society visually? When we deliberately overlook a scientific instrument's technical aspects, are we somehow damaging its essential historical value? What are possible ways of bringing about balance from this conflict, which is inherent to the astrolabe as well as other historical instruments of science?

Rather than resolving this conflict, this paper asks questions, investigates and examines all possible variables that could contribute to a spectrum of evolving approaches. In Elizabeth Cavicchi's class of Spring 2015 at MIT, *Recreate Experiments from History: Inform the Future from the Past*, we analyze the history of science, observe astronomical events, and experience on our own what physicist Richard Feynman called the "pleasure of finding things out". These explorations strengthen our awareness of the fascination of science. This paper applies that spirit to question the historical astrolabe and consider its potential for inspiring and fostering balance in communicating science and art to the public of our time.

Francesca Liuni is currently a graduate student at the Massachusetts Institute of Technology and is conducting interdisciplinary research on medieval Islamic astronomy at the juncture of astronomy, architecture and art; this work focuses on theories, instruments and buildings. The goal of her research is to create an interactive exhibition on historical Islamic astronomy. She graduated in architecture from the Politecnico di Bari and started her professional career working on the archaeological reconstruction of Kos (Greece) and collaborating with Ministero per i Beni Culturali on landscape and architectural preservation.

9 September 2015 Session 7 4:30 -6:00

CONFLICT AND BALANCE: ARCHIMEDEAN CONFLICTS

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Keywords: Archimedes, mechanics, geometry

This research expresses a collaborative and maieutic work led during Elisabeth Cavicchi's MIT class in Spring 2015. We investigated ancient geometry starting from Euclidean axioms and theorems and Archimedes' mathematical and physical principles; we tried to prove their theorems on our own by reconstructing figures on paper and seeking their principles in physical experiences; we observed the geometry of snowflakes through a microscope; we applied geometry in making perspective drawings; we analyzed Islamic geometry, and the way craftsman and mathematicians collaborated in applying geometrical principles to architecture. Our research is informed by readings from contemporary historians, such as Heilbron's *Geometry Civilized* (1998) or Baird's *Thing Knowledge* (2004).

Across our experiences of analyzing Archimedes' texts, we began to notice what we would like to define as conflicts. Although Archimedes commences his works by saying that he deduced everything by mechanics, his theorems are not always followed by a mathematical, geometrical or physical proof .

We feel that when he doesn't provide the full proof, it is because the abstraction that the geometry brings in creates a conflict with reality. Archimedes engages with what will become a long and continuing tension between mechanics and abstraction, engineers and mathematicians (compare De Groot's *Aristotele's Empiricism* (2014), Bryant and Sangwin's *How round is your circle* (2008), Assis and Magnaghi's *The Illustrated method of Archimedes* (2012)).

The aim of our project is try to solve these Archimedean conflicts by trying to reconnect the abstraction of geometry to the measured reality of mechanics. We aspire to design a machine which performs a visual mathematical proof that can talk with the observer using the language of mathematical mechanics in the tradition of the geometrical machines developed by Walter Balcke in the 1950s, now held at Harvard.

Francesca Liuni is currently a graduate student of architecture at the Massachusetts Institute of Technology Ronald Heisser is an undergraduate student of mechanical engineering and philosophy at M.I.T.. They are currently collaborating on projects of investigation and analysis of ancient geometry for a class/seminar of the professor Elisabeth Cavicchi at M.I.T.

9 September 2015 Session 7 4:30 -6:00

CONFLICT AND BALANCE: TRACING THE EVOLUTION OF MATHEMATICAL AND PHYSICAL INSTRUMENTATION OF FLUID DYNAMICS

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Keywords: Fluid Mechanics, Research Methods, Physics

This spring semester, I participated in a class called Recreating Experiments of History: Inform the Future from the Past. The class features a broad survey of original texts, instrumentation, and people from different scientific epochs. Through in-class dialogue and individual assignments, our class uncovereved multiple underlying themes which have driven scientific progress. One theme motivates this work: How has instrumentation influenced the course of scientific research?

I have taken two courses in fluid mechanics as part of my mechanical engineering (MechE) curriculum. Other courses in MechE like control theory and mechanics inspire little interest in theoretical investigation. I expected the same for fluid mechanics. Yet, in such topics as turbulent flow and boundary layers, no analytical solutions exist for most cases of fluid flow. This conflict in physical understanding warrants further investigation into the methods of fluid meachnics reserach across the field's history.

This investigation is completed through a survey of physical and mathematical instrumentation, as well as a survey of original early and modern texts on the subject. Some resources aiding in research are of the Harvard Collection of Historical Instruments, MIT Museum, and from observations of the physical structure of the MIT Gas Turbine Laboratory, a site of significant fluid mechanics progress in the last century, soon to be renovated from the inside; a milestone in its own history.

Ronald Heisser is an undergraduate student majoring in Mechanical Engineering and Philosophy at the Massachusetts Institute of Technology. He is currently a research assistant at the Computer-Aided Design Laboratory working on a web platform for product design education. His interests are ever-growing; this will be the first international conference he attends.

10 September 2015 Session 8a 9:00 – 10:40

MATHEMATICAL INSTRUMENTS AND MILITARY CONFLICT, AN AMERICAN PERSPECTIVE

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Keywords: mathematical instruments, warfare

Historians have long acknowledged the importance of armed conflict - and the fear of armed conflict - in the development and use of mathematical instruments. Galileo did refer to his sector as a military compass. Nineteenth-century military schools like the École polytechnique in Paris and the United States Military Academy at West Point purchased geometric models specifically to improve the training of military engineers. A wide range of drawing instruments was used in the design of fortifications and other military construction. Both general-purpose slide rules and those designed to solve problems relating to gunnery, aerial navigation, and nuclear weapons found their place. The development of relay and electronic computers relied heavily on military patronage, as did early electronic messaging. Conflict also led individuals to travel to new places, leaving a mark behind not only with instruments created and used in conflict but those saved as mementos of wartime activities. Both the needs of the battlefield and individual experiences are reflected in surviving instruments.

Peggy Kidwell is curator of mathematics at the Smithsonian's National Museum of American History. Her doctorate in history of science is from Yale University. She has published on instruments ranging from eighteenth-century star maps to twentieth-century computers. Her particular research interests include mathematics teaching apparatus and mathematical recreations.

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FORTIFICATION OF RESEARCH: PHYSICS INSTRUMENTS FOR MILITARY PURPOSES IN BAVARIA, CIRCA 1750 – 1870

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Keywords: science and the military, physicists and war, collection, mathematical and physical instruments

The Bavarian and Austrian armies lost the battle of Hohenlinden in the year 1800. One reason was that on several occasions their troops were unexpectedly confronted with difficult terrain. In contrast to this, the French army was equipped with detailed maps, which offered them a tactical advantage. Experiences such as these induced the founding in 1801 of a topographical bureau in Bavaria, in which physicists were involved.

Until now, hardly any historical research has been performed on other inventions by physicists to the benefit of the army in the early 1800s. The former collection of the Bavarian Academy of Science (preserved in the Deutsches Museum) represents the standard set of physics instruments from that period. Therefore, a study of this collection can help to comprehend the contribution of physicists and artisans to the development of weaponry. Amongst the preserved instruments are not only gunner's quadrants and rangefinders. The scholars in Munich also used "electric cannons" and tinkered around with fortification models. The optician Carl August Steinheil engineered a device resembling a machine gun, which he called "centrifugal machine".

What intention and motivation led the scientists and craftsmen to develop these manifold kinds of military instruments? How important was the contact to army circles to get funding? And how closely did the Bavarian Academy and the Bavarian army cooperate? I will try to answer these questions by scrutinising the role of the scholars in the relationship between the army and the society in the early 19th century.

Benjamin Mirwald studied physics at the University of Regensburg, where he afterwards also obtained his PhD thesis in history of science, for which he analysed the founding of popular astronomical observatories around 1900 in Germany. From 2013 on he has worked as a research assistant in the Deutsches Museum's project for digitising the former mathematical and physical collection of the Bavarian Academy of Science. Specialising in popular astronomy, he has taken over management of the public observatory in Munich in July 201

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FROM A MILITARY DEVICE TO A CIVILIAN ONE: THE INVENTION OF THE CATAPHOTE BY FRENCH ASTRONOMER HENRI CHRÉTIEN (1879-1956)

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Keywords: war invention, secret signalling, night reflector

A gifted mathematician and optician, the Nice astronomer Henri Chrétien enlisted in 1915 as a volunteer and joined the *Section technique de l'Aéronautique* of the Ministry of Defence where he contributed to ballistics. During that period he invented a precision device for military secret night signalling, but was unable to patent it before the end of the conflict. After the war he transformed his device into a civilian invention that he called *Catadioptre* – later to become the well-known night reflector named *Cataphote*. I shall try to track the thought process of the inventor, who ingeniously diverted an optical experiment by Fizeau to produce a multiple auto-collimating device for military optical signalling, and, after World War I, decided to downgrade the optical convergence of this device to transform it into a civilian invention for nighttime advertising, extra-luminous screens, etc. I shall also tell why it was not Chrétien who filed the trademark for the *Cataphote*.

Françoise Le Guet Tully is honorary astronomer at the Observatoire de la Côte d'Azur. Her research projects concern the history of astronomical instruments and of institutional observatories. She owns by bequest the archives of Henri Chrétien, astronomer at Nice before WWI, inventor of the aplanetic Ritchey-Chrétien telescope and of CinemaScope.

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INSTRUMENTAL INSIGHTS: A COMPARATIVE STUDY OF ARTISTIC DEPICTIONS OF SPACE RACE INSTRUMENTS IN THE US AND USSR, 1962-1975

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Keywords: space, fine art, Cold War

In 1962 the National Aeronautics and Space Administration (NASA) founded the Artists' Cooperation Program to create "a record for the future of some of the greatest moments of the present through a medium that is as old as our recorded past- the intimate, human medium of the artist's eye and hand." Through this program, NASA commissioned prominent American artists to tour its facilities, attend launches, interact with astronauts and technicians, and interpret their experiences and observations in the medium of their choosing. The resulting artwork was exhibited across the United States and the world, and represented not only American technical and artistic prowess, but also American democratic ideals. The Soviet Union similarly maintained a fine arts program that highlighted its achievements in space, the products of which toured the United States in 1975. This Soviet artwork was also embedded with nationalistic themes.

In this paper I will compare the depictions of space race instruments, such as tracking systems and wind tunnels, in the traveling exhibitions of American and Soviet space artwork. I contend that the artistic renderings of these instruments provide insight into the technological and ideological conflicts between the two nations during the Cold War. I also hope to make a broader argument about the value of the fine arts as a primary source in the history of science and technology in the twentieth century.

Emily Margolis is a graduate student in the Department of History of Science and Technology at Johns Hopkins University. Her interests include the history of the US Space program, women and gender studies, material culture, and urban history. She will pursue a curatorial career upon the completion of her degree.

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ATTRIBUTING A RENAISSANCE UNIVERSAL ASTROLABE

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Keywords: Astrolabe, Adriaan Zeelst, Attribution

At a recent auction in London, a single-sheet European universal astrolabe came up for sale. It was described in the Bonhams catalogue as "not signed or dated, engraved by two hands, the first working in the mid- to late 15th century, the second in the third quarter (or slightly later) of the 16th century". This paper will develop an argument to attribute this important instrument to Adrian Zeelst, who probably made it in Cologne around 1600 where he was working at the court of the Prince-Bishop Ernest of Bavaria. The paper will show various instruments of Zeelst, most of which were made in Louvain, where he active as a mathematician and instrument maker. The author will explain how this instrument presents a final stage in the development of the astrolabe, as it tries to replace the elaborate rete by a different system. The author will also elaborate on the current hypothesis that this astrolabe was engraved by two hands.

Koenraad Van Cleempoel completed a PhD at the Warburg Institute on scientific instruments from the Renaissance period. He catalogued the astrolabes at the National Maritime Museum in Greenwich (Oxford University Press). He has a particular interest in the Flemish school and its relationship with the Spanish court.

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ON THE SECOND LIVES OF INSTRUMENTS

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Keywords: astrolabes, 15th century, re-use

Recycling, and the second-hand trade in early instruments, although historically important, has hitherto attracted rather little scholarly attention. In the context of a presentation of examples of this practice from different periods, the paper will offer a detailed examination of two recently recovered 15th-century astrolabes, one of which was drastically transformed, the other 'enhanced', in the 16th century, and explore what these changes can tell us about the uses of instruments in periods other than their own, and how at such times they were understood.

An Oxford-trained, independent historian, Anthony Turner works on the social history of ideas during the Ancien Régime, and on the history of scientific instruments, clocks, watches and sun-dials and of precision technology in general. Current work includes a bio-bibliography of French Scientific Instrument-makers, and a catalogue of instruments in the Bibliothèque Nationale de France.

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A DESCRIPTIVE CATALOGUE OF INDIAN ASTRONOMICAL INSTRUMENTS

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Keywords: Astronomical instruments, Descriptive catalogue, Sanskrit texts

The construction and use of diverse kinds of astronomical and time-measuring instruments are described in a number of Sanskrit texts. While a few such texts have been published, no attempt has been made so far to see if any of instruments described in these texts are extant. Therefore, I decided to explore museums and identify pre-modern astronomical instruments. Such a survey, I hoped, would be useful because the actual specimens might help in understanding the terse descriptions in the Sanskrit texts. Conversely, textual knowledge would help in identifying an instrument and in dating its original design.

During the past two decades, whenever time and money was available, I explored more than a hundred museums and private collections in India, Europe and the US, and identified some 450 specimens of pre-modern Indian astronomical instruments, belonging to two broad categories: Indo-Persian instruments with inscriptions in Arabic/Persian and Sanskrit instruments with inscriptions in Sanskrit.

A descriptive catalogue of these instruments is now in the final stages of completion. It contains full technical description of each extant specimen and reproduces all the inscriptions engraved on it. The catalogue of each instrument type is preceded by a historical survey of the instrument-type, including major centres of manufacture and notable makers. In the case of Sanskrit instruments, extracts from Sanskrit texts on their construction and use are added in translation.

The paper will give an overview of the Catalogue, describe the different instrument-types which are extant and draw attention to some unusual specimens.

Formerly Professor of Sanskrit, Aligarh Muslim University, India; now retired and lives in Düsseldorf, Germany. Research interests: Sanskrit and related texts on mathematics, astronomy and astronomical instruments; extant specimens of pre-modern Indian astronomical instruments.

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AN ASTRONOMICAL COMPENDIUM FROM THE MUNICH KUNSTKAMMER

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Keywords: astronomical compendium, Kunstkammer, measurement

In 2014 an astronomical compendium dated to 1568 could be acquired for the collections of the Bayerisches Nationalmuseum. It is dedicated to the mathematician Nicolaus Rensberger, who was active in South Germany, but hitherto remains as an obscure figure, despite having published books on astronomy and geometry. In 1598 the compendium is listed in the Kunstkammer of the Dukes of Bavaria in Munich. The instrument includes a sundial, a compass, and a geometric square as well as a rotatable calendar disc showing the months, the days, the zodiac and the phases of the moon. Some of these features display oddities, partly even contradicting Rensberger's own writings. On the lid of the instrument is an engraving depicting a scene of field measurement, apparently derived from similar images in the works of Peter Apian and others. The presentation and the ensuing discussion will hopefully clarify the functions of this instrument and shed light on the figure of Nicolaus Rensberger and his environment.

Raphael Beuing is curator for arms and armour, timepieces, scientific instruments and base metal at the Bayerisches Nationalmuseum. Prior to taking up his post in 2012 he worked on silver and other examples of the decorative arts as well as on collecting art during the early modern period.

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HEAVENLY AUTOMATA IN NEED OF EARTHLY FIRST AID

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Keywords: planetary automata, mathematics at princely courts, equation of time

The two planetary automata constructed at the behest of Landgrave Wilhelm of Hessen-Kassel – his own (1559-62) and that for his brother-in-law, Elector August of Saxony (1563-68) – number among the most complex machines of the sixteenth century. Traditional historiography has to a large extent viewed these automata as idealized mechanisms: effectively removed from history upon completion. The research project *Deus ex machina* aims to re-insert these machines into the cosmos where they emerged and functioned (or didn't) within the princely courts at Kassel and Dresden. For even upon completion the clocks only survived with the help of regularly administered first aid – that is, expert mathematical and mechanical intervention. Acknowledging this leads to a number of new research questions explored in the present paper.

After working as a university mathematician in the field of harmonic analysis, Korey became curator of mathematical and philosophical instruments in Dresden in 2002. His current research addresses early-modern optics (esp. the material history of the telescope), 18th-century collections of Judaica, and the project 'Deus ex machina' on 16th-century planetary automata

UNDER THE EYE OF SATURN: CONFLICT AND COMPROMISE IN THE DESIGN AND CONSTRUCTION OF PLANETARY AUTOMATA

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Keywords: planetary clocks, Ptolemaic theory, mathematical cultures

Four planetary automata constructed in the mid-sixteenth century survive with their mechanisms intact. These are the clocks built under the direction of Eberhard Baldwein (now housed in Kassel and Dresden, finished in 1562 and 1568, respectively), Philipp Imser (Vienna, ca. 1557), and an anonymous clockmaker (the so-called 'Oronce Fine' clock held in Paris, ca. 1500/1556). All four aim to show the true, rather than mean, positions of the classical planets in accordance with Ptolematic theory. That there is more than one way to do so is revealed by a detailed analysis of their dials and gearing – in conjunction with surviving manuscripts and archival records. This paper describes the different solutions pursued in these mechanical masterpieces. It examines to what extent each approach manifests the conflicts and compromises among the various specialist communities who collaborated on its construction, focusing in particular on the various realizations of the motion of Saturn.

After a degree in physics Gessner received his PhD (Paris) in history of science. "Instruments in texts and in the practitioners' hands" was his first post-doc project at CIUHCT (Lisbon) – in line with his focus on diverse mathematical cultures in early modern Europe. Since 2014, he has been working on early planetaria.

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A HIDDEN CONFLICT IN RENAISSANCE PLANETARY HOROLOGY? NEW PERSPECTIVES ON JANELLO TORRIANI'S *DAMNATIO MEMORIAE* IN CARDANO'S WORKS

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Keywords: planetary clocks, Renaissance, patronage

Janello Torriani (Cremona, Italy ca. 1500 – Toledo, Spain 1585), a clockmaker who achieved fame as inventor, was employed at the courts of Emperor Charles V and of King Philip II of Spain. There Janello Torriani created a number of technological devices that were hailed as mechanical marvels by his contemporaries. These included the *Microcosm*, the most complex and compact planetary clock of his age; and the first gigantic machine ever seen, the *Toledo Device*. Torriani also participated in the Gregorian reform of the calendar, contributing a tract and mathematical instruments for calculation. Further mathematical and mechanical endeavours included a waterworks survey, celestial observations, automata and other curious clockworks. Unfortunately, all of Torriani's greatest inventions are lost. Nevertheless, because of his employment at court, their memory has been bestowed upon us by a large number of documents, among them, Cardano's works *De Libris Propriis* (first edition 1544), and the bestseller *De Subtilitate* (first edition 1550). However, browsing through the editions that cover the period 1544-1560, one can note how, in the second half of the 1550s Janello suddenly disappears from the books of the Milanese physician. The great number of reprints of Cardano's books has created some confusion, hiding the chronology and the reasons of this process of exclusion. In this paper, I will try to shed some light on this problem, suggesting how this shift can be read in terms of Cardano's political agenda, in relation to the category of patronage.

Cristiano Zanetti (born in Cremona, 1975) received his doctoral degree from the European University Institute in 2012. He held postdoctoral positions at the EUI, at The Medici Archive Project, and at the MPIWG in Berlin. His research focuses on medieval and Renaissance engineering and clockmaking between the princely court and urban space.

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THE COLLECTION OF SCIENTIFIC INTRUMENTS IN MARASLEIOS PEDAGOGICAL SCHOOL: A CONFLICT BETWEEN PAST AND PRESENT

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Keywords: Scientific instruments, teachers' education, Marasleios Pedagogical School

The independent Greek state was established in 1829. The newly established state totally lacked any infrastructure. Schools were no exception. The country was not only short of school buildings but of teachers, too. Teacher training has been a high priority taking place first at the Royal Teaching School (1834-1864), then at teaching centres and since 1910 at the Marasleios Pedagogical School.

At every teaching phase, physics had been part of the school curriculum and it was (supposedly) taught with experimental methods to a large extent. However, most of the teaching centres didn't have the required equipment. Only the Athens Teaching Centre had a rich collection of more than 200 instruments dating from the early 1890s. This instrument collection was enriched when teaching at the Athens Teaching Centre was upgraded from a three-year to a four-year course. The Centre was then renamed the Marasleios Pedagogical School. During the decade 1910-1920, this instrument collection became even larger than the contemporary instrument collection of the Physics Department of University of Athens.

Today, almost 140 years after the first instruments arrived, the instruments of the collection are not in good condition. Long-term disuse, ignorance and lack of interest on behalf of the staff have led to a drastic reduction in the number of instruments. There are about 75 instruments left, and these are in poor condition.

The current proposal addresses two issues. The first issue is to present the current state of the collection, giving special notice to the most interesting instruments. The second concerns the reasons that allowed this sound and enviable instrument collection to fall into its appalling current state and to describe the efforts of a mixed group of students of the 26th Athens Senior High School and Athens University postgraduate students to document and maintain the collection.

Panagiotis Lazos works as physics teacher in secondary education. He has also a BSc in photography and an MSc in history and philosophy of science. This paper is a part of his current PhD research. His main research interest is the recording of collections of scientific instruments of the 19th century in Greek schools and how they were used in the educational process.

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HISTORICAL SCIENTIFIC INSTRUMENTS AT THE ROYAL COLLEGE "CARLO ALBERTO" OF MONCALIERI

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Keywords: Francesco Denza, scientific instruments, Moncalieri, Royal College "Carlo Alberto"

The "Carlo Alberto" Royal College of Moncalieri is home to an important collection of scientific instruments, largely unknown even in Italy. The majority of the instruments is connected to Barnabite scientist Francesco Denza (1834-1894), one of the 'fathers' of Italian meteorology. Father Denza taught mathematics and physics uninterruptedly at the College, from 1857 to 1890. Most of the instruments in the collection date back to this period, even though there are a few older pieces. The collection has been entirely catalogued and it contains more than 300 instruments, some of high historical and scientific importance. Many of these instruments were manufactured by makers from Turin. The collection is particularly remarkable for having the largest number of instruments, in Italy, made by "Jest", a nineteenth century Turin family of makers who produced several excellent scientific instruments. The collection includes apparatus of physics, astronomy, meteorology, seismology and geomagnetism. Many are directly connected to the scientific research conducted by Father Denza. Among the latter, one instrument deserves special notice: the "Anemojetografo" Denza-system, a device designed by Denza himself, which is still preserved in the College's meteorological and geodynamic Observatory. It was a self-recording system that allowed recording rainfall on paper, as well as the wind speed and direction, over one week. This device was built, under Denza's direction, by the Turin-based manufacturer Franceso Cravero and first commissioned for the College's observatory in 1878. Only a few examples of this important meteorological apparatus are known worldwide. In this paper, I will describe the history, composition and use of this collection, focusing on Turin makers such as the Jest family and their instruments.

Since 1994 has been Curator of the Collection of Historical Scientific Instruments at the University of Urbino 'Carlo Bo' (Italy). His research activity is mainly devoted to the history of physics with a special focus on the history of scientific instruments. Currently he teaches "History of scientific instruments" at Urbino University.