XXV SCIENTIFIC INSTRUMENT SYMPOSIUM

"East and West the Common European Heritage"

Jagiellonian University Museum
Krakow, Poland

10 -14 September 2006

ISBN 83-921397-7-1

Druk: Poligrafia Inspektoratu Towarzystwa Salezjańskiego
ul. Konfederacka 6, 30-306 Kraków

XXV Scientific Instrument Symposium organised by:

Scientific Instrument Commission
International Union of the History and Philosophy of Science
Division of History of Science
http://www.sic.iuhps.org/

Jagiellonian University Museum
Department of the History of Science and Scientific Instruments
http://www3.uj.edu.pl/Muzeum/index.en.html

Local Organising Committee:

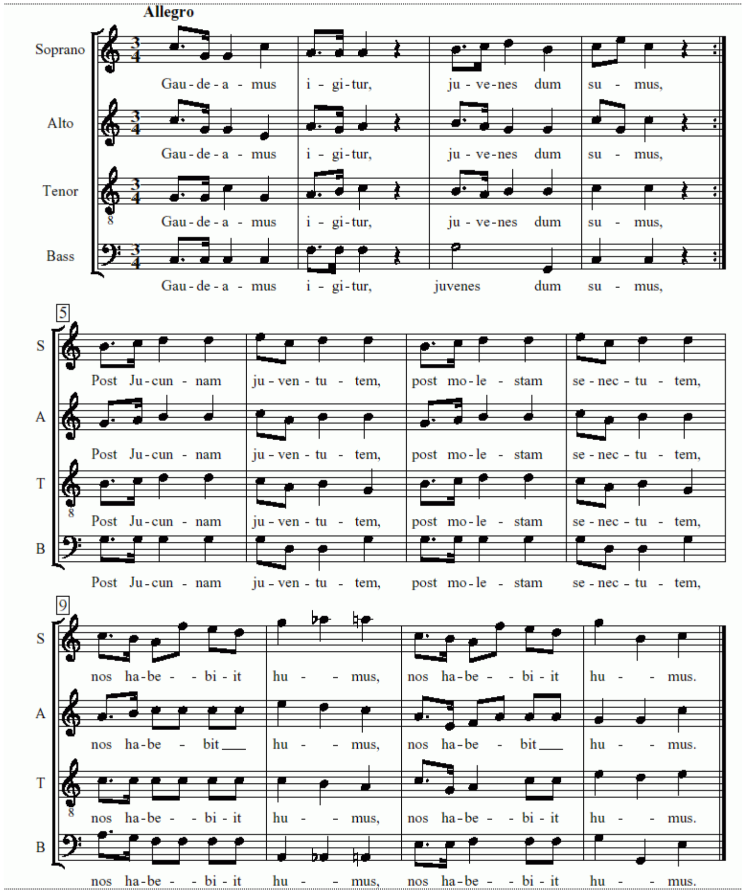
Prof. Stanisław Waltoś - Director of the Jagiellonian University Museum
Ewa Wyka
Małgorzata Taborska
Maciej Kluza
Anna Karolina Zawada

Funding for the XXV Scientific Instrument Symposium was provided in part by:

- Rector of the Jagiellonian University

- International Union of the History and Philosophy of Science Division of History of Science - Scientific Instrument Commission

Gaudeamus igitur



Gaudeamus igitur
Juvenes dum sumus
Post jucundum juventutem
Post molestam senectutem
Nos habebit humus.

Vivat academia
Vivant professores
Vivat membrum quodlibet
Vivat membra quaelibet
Semper sint in flore.

vers. C. W. Kindeleben, 1781

While we're young, let us rejoice,
Singing out in gleeful tones,
After youth's delightful frolic,
And old age (so melancholic!),
Earth will cover our bones.

Long live our academy,
Teachers whom we cherish,
Long live all the graduates,
And the undergraduates;
Ever may they flourish.

Tr. J. Mark Sugars, 1997

TABLE OF CONTENTS

List of Participants of the XXV Scientific Instrument Symposium Krakow, 10-14 September 2006

Australia

Julian Holland
P.O. Box 732,1800 Ashfield NSW
jph8524@optusnet.com.au

Belgium

Danny Segers
Museum for the History of Sciences
Ghent University
Krijgslaan 281 (S-30), B-9000 Ghent
danny.segers@ugent.be

Jos Uyttenhove
Museum for the History of Sciences
Ghent University
Krijgslaan 281 (S-30), B-9000 Ghent
jos.uyttenhove@Ugent.be

Canada

Allan Olley
Institute for History and Philosophy of Science and Technology
University of Toronto
Victoria College, 91 Charles Street West
Toronto, Ontario M5S 1K7
allan.olley@utoronto.ca

Czech Republic

Šimon Krýsl
Medical Museum, National Medical Library
Sokolská 54, 12000 Praha 2
krysl@nlk.cz

Denmark

Jørgen From Andersen
Hauchs Physiske Cabinet
Søgade 17, 4180 Sorø
jfa@awhauch.dk

France

James Caplan
Observatoire astronomique de Marseille-Provence
2 place Le Verrier, 13248 Marseille cedex 4
james.caplan@oamp.fr

Jean Davoigneau
Direction de l'Architecture et du Patrimoine
Ministère de la Culture et de la Communication
182 rue Saint-Honoré, 75001 Paris
jean.davoigneau@culture.gouv.fr

Suzanne Débarbat
Observatoire de Paris
61 avenue de l'Observatorie, 75014 Paris
Suzanne.Debarbat@obspm.fr

Françoise Le Guet Tully
Observatoire de la Côte d'Azur
BP 4229, 06304 Nice cédex 04
leguet@obs-nice.fr

Michel Jean Morizet
34 bis Avenue de Paris, 78000 Versailles
morizetb@club-internet.fr

Germany

Wolfram Dolz
Mathematisch-Physikalischer Salon
Staatliche Kunstsammlungen
Zwinger, D-01067 Dresden
wolfram.dolz@skd.smwk.sachsen.de

Sven Hauschke
Germanisches Nationalmuseum Nürnberg
Lange Str. 41, 90762 Fürth
sven.hauschke@t-online.de

Peter Heering
University Augsburg
Universitätsstr. 1, 86159 Augsburg
peter.heering@uni-oldenburg.de

Inge Keil
Reisingerstr. 6, D96159 Augsburg
inge.k@lycos.de

Peter Plaßmeyer
Mathematisch-Physikalischer Salon
Staatliche Kunstsammlungen
Zwinger, D-01067 Dresden
Peter.Plassmeyer@skd.smwk.sachsen.de

Roland Schewe
Institut für Kunsttechnik und Konservierung
Germanisches Nationalmuseum Nürnberg
Kornmarkt 1, D-90402 Nürnberg
r.schewe@gnm.de

Klaus Staubermann
Dunckerstr. 29a, 10439 Berlin
kstaubermann@yahoo.co.uk

Mathias Ullmann
Saxon Art Collections
Staatliche Kunstsammlungen
Erna-Berger-Str. 6, 01097 Dresden
mathias.ullmann@gmx.net

Gudrun Wolfschmidt
Institute for History of Science
Hamburg University
Bundesstrasse 55 - Geomatikum, D-20146 Hamburg
wolfschmidt@math.uni-hamburg.de

Greece

Yanis Bitsakis
Physics Department
University of Athens
K. Palaiologou 6, 16232 Byron
ibitsak@phs.uoa.gr

Theodore Lekkas
Department of History and Philosophy of Science
University of Athens
210 Kosti Palama, 18452 Nikaia
tlekkas@phs.uoa.gr

Efthymios Nicolaidis
National Hellenic Research Foundation
Vassileos Constantinou 48, 11635 Athens
efnicol@eie.gr

Hungary

József Vidra
Hungarian Museum for Science and Technology
Kaposvár u. 13-15, H-1117 Budapest
vidrajo@nadir.hmst.hu

Ireland

R. Charles Mollan
17 Pine Lawn, Newtownpark Avenue, Blackrock, Co. Dublin
cmollan@iol.ie

Israel

Yaakov Zik
University of Haifa
51 Hovevey Zion St., 63346 Tel Aviv
zikya@013.net

Italy

Paolo Brenni
Fondazione Scienza e Tecnica, CNR
Via Giusti 29, 50100 Florence
pbrenni@galileo.imss.firenze.it

Ileana Chinnici
INAF- Osservatorio Astronomico di Palermo
Piazza del Parlamento 1, 90134 Palermo
chinnici@astropa.unipa.it

Leonardo Gariboldi
Istituto di Fisica Generale Applicata
Sezione di Storia della Fisica
Università degli Studi di Milano
Via Brera 28, 20121 Milano
leonardo.gariboldi@unimi.it

Alberto Meschiari
Scuola Normale Superiore di Pisa
Piazza dei Cavalieri 7, 56126 Pisa
alberto.meschiari@aliceposta.it

Giorgio Strano
Instituto e Museo di Storia della Scienza
Piazza dei Giudici 1, 50122 Firenze
extraneus@imss.fi.it

Sofia Talas
Museum of the History of Physics
University of Padua
Via Marzolo 8, 35131 Padova
sofia.talas@unipd.it

Japan

Eiji Nagata
Miyagi University of Education
Akobaku Kunimi 2-2-24, 980-0943 Sendai
e-naga@staff.miyako-u.ac.jp

The Netherlands

Marian Fournier
Museum Boerhaave
P.O. BOX 11280, 2301 EG Leiden
wetenschap@museumboerhaave.nl

Hans Hooijmaijers
Museum Boerhaave
P.O. BOX 11280, 2301 EG Leiden
wetenschap@museumboerhaave.nl

Jan Waling Huisman
University Museum
Groningen State University
Oude Kijk In't Jatstraat 7a, 9712EA Groningen
j.w.huisman@rug.nl

Ad Maas
Museum Boerhaave
P.O. Box 11280, 2301 EG Leiden
wetenschap@museumboerhaave.nl

Diederick Wildeman
Netherlands Maritime Museum
Kattenburgerplein 1, 1018 KK Amsterdam
dwildeman@scheepvaartmuseum.nl

Norway

Ola Nordal
Norwegian University of Science and Technology
Bakkegata 11, 7014 Trondheim
ola.nordal@hf.ntnu.no

Roland Wittje
Department of Physics
Norwegian University of Science and Technology
Realfagbygget, 7491 Trondheim
rolandw@phys.ntnu.no

Poland

Pavel Bandakov
Institute of Philosophy and Sociology
Polish Academy of Sciences
Nowy Świat 72, 00-330 Warsaw
paultoff@yahoo.com

Zbigniew Bela
Museum of Pharmacy
Jagiellonian University
Florianska 25, 31-019 Krakow
mf@mp.pl

Maciej Kluza
Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow
maciek@maius.in.uj.edu.pl

Piotr Łopalewski
Polish Aviation Museum
Al. Jana Pawła II 39, 30-969 Krakow
piotr.lopalewski@mlp.krakow.pl

Krzysztof Mroczkowski
Polish Aviation Museum
Al. Jana Pawła II 39, 30-969 Krakow
krzysztof.mroczkowski@mlp.krakow.pl

Magdalena Pilska-Piotrowska
Copernicus Museum
Katedralna 8, 14-530 Frombork
frombork@frombork.art.pl

Małgorzata Taborska
Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow
gosia@maius.in.uj.edu.pl

Stanisław Waltoś
Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow
waltos@maius.in.uj.edu.pl

Ewa Wyka
Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow
ewa@maius.in.uj.edu.pl

Anna Karolina Zawada
Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow
karolina@maius.in.uj.edu.pl

Romania

Elena Helerea
Transilvania University of Brasov
29 Eroilor Str., Brasov 500036
helerea@unitbv.ro

Russia

Vasily Borisov
Institute of the History of Science and Technology
Russian Academy of Sciences
1/5 Staropansky per., 103012 Moscow
vborisov@ihst.ru

Larisa Brylevskaya
St. Petersburg Branch of the Institute for the History of Science and Technology of Russian Academy of Sciences
5 Universitetskaya Nab., 199034 St. Petersburg
Brylevl@mail.ru

Alexey Emelyanov
St. Petersburg Scientific Centre
Russian Academy of Sciences
5 Universitetskaya Nab., 199034 St. Petersburg
alexey64ru@yahoo.co.uk

Tatiana Moiseeva
Department of Peter the Great Museum of Antropology & Ethnograpy (Kunstkamera)
M.V. Lomonosov Museum
3 Universitetskaya Nab., 199034 St. Petersburg
msv@kunstkamera.ru, msv@home.ru

Vladimir Schurov
Museum of Science
Nizhny Novgorod State University
7 Universitetsky Lane, 603000 Nizhny Novgorod
schurov@gmail.com

Spain

Josep Batlló
Observatori de l'Ebre
Horta Alta 38, E-43520 Roquetes
jbatllo@obsebre.es

Ignacio de la Lastra
Museo Nacional de Ciencia y Tecnologia
Paseo de las Delicias 61, 28045 Madrid
ignacio.lastra@mcc.es

Joan Muñoz
Museu de la Ciència i de la Tècnica de Catalunya
Rambla d'Ègara 270, E-08221 Terrassa
joanmunoz@gencat.net

Pedro Ruiz-Castell
Departamento de Documentacion e Investigacion
Museo Nacional de Ciencia y Tecnologia
Paseo de las Delicias 61, 28045 Madrid
pedro.ruiz@mec.es

Santiago Vallmitjana
Departament de Física Aplicada i Òptica
Universitat de Barcelona
Av. Diagonal 647, 08028 Barcelona
santi.vallmitjana@ub.edu

Sweden

Staffan Andersson
Depatrament of Physics
Ångström Laboratoriet
Lägerhyddsvägen 1, 75121 Uppsala
staffan.andersson@fysik.uu.se

Peter Branden
Kungl Vetenskapsakademien/Observatoriemuseet
Drottninggatan 120, 11360 Stockholm
inga@kva.se

Inga Elmqvist Söderlund
Kungl Vetenskapsakademien/Observatoriemuseet
Drottninggatan 120, 11360 Stockholm
inga@kva.se

Karl Grandin
Center for History of Science
Royal Swedish Academy of Sciences
Box 50005, SE-104 05 Stockholm
karl.grandin@kva.se

Urban Josefsson
Museum Gustavianum, Uppsala University Museum
Akademigatan 3, 75310 Uppsala
urban.josefsson@gustavianum.uu.se

Ing-Marie Munktell
Museum Gustavianum, Uppsala University Museum
Akademigatan 3, 75310 Uppsala
ing-marie.munktell@gustavianum.uu.se

Cecilia Ödman
Museum Gustavianum, Uppsala University Museum
Akademigatan, 75310 Uppsala
cecilia.odman@gustavianum.uu.se

Switzerland

Klaus Hentschel
University of Berne
Flurstr. 1a, CH-3014 Postfach 38, Berne 22
khentsch@bluewin.ch

United Kingdom

Silke Ackermann
The British Museum
Great Russell Street, WC1B 3DG London
sackermann@thebritishmuseum.ac.uk

Jim Bennett
Museum of the History of Science
Broad Street, OX1 3AZ Oxford
jim.bennett@mhs.ox.ac.uk

Gloria Clifton
Royal Observatory
National Maritime Museum
Greenwich, SE10 9NF London
GClifton@nmm.ac.uk

Richard Dunn
National Maritime Museum
Greenwich, SE10 9NF London
rdunn@nmm.ac.uk

Kevin Johnson
Science Museum, National Museum of Science & Industry
Exhibition Road, SW7 2DD London
k.johnson@nmsi.ac.uk

Stephen Johnston
Museum of the History of Science
University of Oxford
Broad Street, OX1 3AZ Oxford
stephen.johnston@mhs.ox.ac.uk

Anita McConnell
Department of History & Philosophy of Science
University of Cambridge
Free School Lane, CB2 3RH Cambridge
am638@cam.ac.uk

Alison D. Morrison-Low
National Museums of Scotland
Chambers Street, EH1 1JF Edinburgh
a.morrison-low@nms.ac.uk

Willem Mörzer Bruyns
Sackler Research Fellow, National Maritime Museum
Greenwich, SE10 9NF London
WMorzerbruyns@nmm.ac.uk

Tacye Phillipson
National Museums of Scotland
Chambers Street, EH1 1JF Edinburgh
t.phillipson@nms.ac.uk

Sylvia Sumira
158 Old South Lambeth Road, SW8 1XX London
sylvia.sumira@btinternet.com

Michael T. Wright
Imperial College, London
61 Cambridge Grove, W6 0LB London
mtw.mechanic@virgin.net

USA

Peter Abrahams
1948 Mapleleaf Rd., 97034 Lake Oswego, Oregon
telscope@europa.com

Marvin Bolt
Adler Planetarium & Astronomy Museum
1300 S Lake Shore Drive, 60605 Chicago
mbolt@adlerplanetarium.org

David Coffeen
Tesseract
Box 151, 10706 Hastings-on-Hudson, NY
david@etesseract.com

Yola Coffeen
Tesseract
Box 151, 10706 Hastings-on-Hudson, NY
yola@etesseract.com

Robert D. Hicks
Chemical Heritage Foundation
315 Chestnut Street, 19106 Philadelphia
robertdh@chemheritage.org

Shaw Kinsley
26 Avenida de Otero, 85646-1943 Tupac, Arizona
sdk878@earthlink.net

Richard Kremer
Dartmouth College
6107 Carson Hall, 03755 Hanover, NH
richard.kremer@dartmouth.edu

David Pantalony
The Bakken Library and Museum
3537 Zenith Ave S., MN 55416-4623 Minneapolis
pantalony@thebakken.org

Gail Paselk
Robert A. Paselk Scientific Instrument Museum
Humboldt State University
1 Harpst Street, 95521 Arcata, California
rap1@humboldt.edu

Richard Paselk
Robert A. Paselk Scientific Instrument Museum
Humboldt State University
1 Harpst Street, 95521 Arcata, California
rap1@humboldt.edu

Sara Schechner
Collection of Historical Scientific Instruments
Harvard University, Science Center 251C
1 Oxford Street, 02138 Cambridge. Massachusetts
schechn@fas.harvard.edu

Ronald Smeltzer
162 Cedar Lane, 08540 Princeton, New Jersey
rksmeltzer@worldnet.att.net

Shae Trewin
Historical Scientific Instruments Collection
Peabody Museum of Natural History
170 Whitney Ave, 06511 New Haven
shae.trewin@yale.edu

Steven Turner
Smithsonian Institution
2410 Rockwood Road, 20607 Accokeek, MD
turners@si.edu

Session I

East and West - Cooperation, Competition and Trade

Chairmen: Jim Bennet, Julian Holland

Gloria Clifton	British Scientific Instrument Makers and the Transmission of Knowledge in Europe
Anita McConnell	Ramsden's Workshop: Recruiting Craftsmen from East and West
Alison D. Morrison-Low	From West to East: Nineteenth-Century Scottish Lighthouse Technology in the Pacific Rim
Sara J. Schechner	The Adventures of Captain John Smith, Pocahontas, and a Sundial
Robert D. Hicks	Instruments of Science and Technology in Early Virginia, USA, and New Historical Perspectives
Michel Jean Morizet	Fahlmer and Diebolt: Two Instrument Dealers of Strasbourg at the End of the 18th century
Mathias Ullmann	Scientific Instruments from Saxony in the Petersburg Art Collections
Ewa Wyka	Liquefaction of Gases: Its History and the Problems Surrounding the Discovery
Pedro Ruiz-Castell, Ignacio de la Lastra	A Communist Instrument in Franco's Spain
David Pantalony	Propaganda or Education? The Controversy over the Importation of Soviet Scientific Instruments to America in 1959.

BRITISH SCIENTIFIC INSTRUMENT MAKERS AND THE TRANSMISSION OF KNOWLEDGE IN EUROPE

Gloria Clifton

Royal Observatory, Greenwich, National Maritime Museum
Greenwich, London SE10 9NF, UK

Keywords: scientific instrument makers

In the sixteenth and seventeenth centuries the techniques of making precision instruments were brought to England from other parts of Europe, principally by Flemish and Dutch immigrants. Later, in the eighteenth and nineteenth centuries, the activities of British scientific instrument makers, especially those based in London, helped to spread techniques and new instruments into a number of different areas of the European Continent. A few, such as those who went to Russia under Peter the Great, at the very beginning of the eighteenth century, were deliberately invited to pass on their knowledge. Some chose to move of their own accord, or to set up satellite businesses or agencies for their London workshops, perhaps hoping to exploit new or growing markets. Others employed apprentices and workmen from various parts of Europe, who then returned home and helped to spread knowledge and techniques. This paper will review these developments, with examples drawn from individual businesses.

RAMSDEN'S WORKSHOP: RECRUITING CRAFTSMEN FROM EAST AND WEST

Anita McConnell

University of Cambridge, Department of History & Philosophy of Science
Free School Lane, Cambridge CB2 3RH, UK

Keywords: eighteenth-century workshop, apprentices, journeymen

Many visitors to the workshop of Jesse Ramsden (1735-1800) in Piccadilly, London, commented on the unusually large labour force – some forty or fifty men and boys, who worked under his roof. Investigations have revealed the names and origins of 36 of the workmen, journeymen and apprentices who were there for longer or shorter periods of time. It is shown that at least eight of these men came directly from Europe: Portugal, Sweden, Germany and France. On return to their homelands, most advertised their years with Ramsden and made instruments to his patterns. This willingness to accept foreigners suggests that Ramsden's refusal in 1788 to accept workmen from Paris to speed production of instruments for the Paris Observatory, lest they made his workmen jealous, was a deliberate untruth.

FROM WEST TO EAST: NINETEENTH-CENTURY SCOTTISH LIGHTHOUSE TECHNOLOGY IN THE PACIFIC RIM

Alison D. Morrison-Low

National Museums of Scotland
Chambers Street, EH1 1JF Edinburgh, UK

Keywords: optics, lighthouse, technology transfer

The Stevenson family of engineers is particularly famous for their lighthouses, which to this day can be found around the dangerous Scottish coasts. The second generation – especially the long-standing partnership of the brothers David and Thomas – was extremely successful. David has been judged the better engineer, while the more scientifically-minded Thomas pursued his elder brother Alan's work on lighthouse illumination, producing improved optical systems which concentrated virtually all the light from a lamp into the beam. Between them, David and Thomas Stevenson designed and built twenty-nine lighthouses for the Northern Lighthouse Board. From the 1860s, in response to requests from foreign governments, they designed lighthouses (and trained the appropriate supervisors) for India, Japan, Newfoundland, China and New Zealand: this paper will look at the applied science of lighthouses in the Pacific Rim.

THE ADVENTURES OF CAPTAIN JOHN SMITH, POCAHONTAS, AND A SUNDIAL

Sara J. Schechner

Collection of Historical Scientific Instruments, Harvard University
Science Center 251c, 1 Oxford Street, Cambridge, MA 02138, USA

Keywords: sundials, mathematics, cosmology, Jamestown

It is one of the most romantic stories in the establishment of the English colonies in North America. While exploring Virginia by canoe in December 1607, Captain John Smith was ambushed by Indians, held captive for six weeks, and repeatedly threatened with death. His life was spared first by the intervention of his magnetic compass, whose spinning needle fascinated his captors, and then by Pocahontas, the chief's compassionate and sexy daughter. At least, that's how recent movies and popular writing tell the story. But, in fact, the most famous compass in American history was more than a compass—it was a pocket sundial–and the Indian princess was no seductress, but a mere child of nine or ten years, playing her part in a shaming ritual.

This paper will examine the accounts John Smith published of his ordeal in order to learn more about his ivory compass sundial and how he could use it as the basis for lectures to the Indians on astronomy, geography, politics, and ethnography. It will be shown that Smith's compass dial represents the clash of two cosmologies–that of the Indians and European settlers. It embodies the belief that the smallest things mirrored the large, that number was the key to God's creation, and that by means of mathematical instruments, men could dominate that world. We will view Smith not only as a swashbuckling soldier-adventurer, and leader of the Jamestown colony, but also as an explorer and mathematical practitioner, a cartographer of North America, and the author of seamen's manuals.

INSTRUMENTS OF SCIENCE AND TECHNOLOGY IN EARLY VIRGINIA, USA, AND NEW HISTORICAL PERSPECTIVES

Robert D. Hicks

Chemical Heritage Foundation
315 Chestnut Street, Philadelphia, 19106 Pennsylvania, USA

In 2007, the United States will observe the anniversary of the founding of English-speaking America, at Jamestown, Virginia, in 1607. The conventional historical portrait of early Jamestown is one of incompetence, unrealistic expectations, and high mortality due to a lack of preparedness. Twenty years before Jamestown, Sir Walter Raleigh sponsored colonizing expeditions to another part of early modern Virginia at Roanoke, in modern North Carolina. Excavations at Roanoke during the 1990s revealed the original "science center," an assay workshop used by Thomas Hariot. Since 1994, archaeological work at Jamestown has recovered not only over a million artifacts, but has located the earliest triangle-shaped fort built by colonists, presumed by historians to have been eroded by the James River. The Roanoke and Jamestown artifacts taken together, present a different story of early English settlement, one of industry, a dynamic economic and cultural exchange with Native Americans, and the establishment of nascent chemical industries. In particular, archaeological excavation has yielded tools employed by a range of intellectual pursuits and artisanal trades, from pocket sundials for Jamestown's elite, to instruments and products of glassmaking, perfumery, apothecary, and metallurgy. For instance, remains of an alembic, a cucurbit, crucibles (including copper residue), and cupels have been found, attesting to colonists' interests in establishing a trade in copper, a high-value commodity among Native American elite. This paper outlines the types and nature of the instruments and tools recovered against an assessment of early English trading companies' interests and ambitions in equipping colonists to pursue early modern scientific and technological goals. Archaeology supports a view that colonial leaders understood and promoted natural philosophical inquiry in exploring North America and employed the most current tools available to identify and exploit local resources.

FAHLMER AND DIEBOLT: TWO INSTRUMENT DEALERS OF STRASBOURG AT THE END OF THE 18TH CENTURY

Michel Morizet

34 bis Avenue de Paris. 78000 Versailles, France

Keywords*: i*nstruments trade, France, Russia, 1780

In the absence of written documents, but thanks to a limited number of signed scientific instruments, it is possible to understand the management of a small but international business of instruments at the end of the 18th century in the city of Strasbourg. The style of an instrument often reveals its origin. We conclude that Fahlmer and Diebolt's signed instruments were made in Germany (workshop of Brander?), in Paris and in London. For two of these instruments, we know who ordered them. So an alidade of German origin was delivered to the "Dépot de la Direction de La Rochelle." An exceptional drawing set, containing French and English instruments but also tools, was ordered by "Monsieur Viollier." Due to the nature of the contents and to the presence of Russian units, it is possible to assert that this "Monsieur Viollier" was indeed the French miniature painter Gabriel Viollier, Secretary and designer to Grand Duchess Maria Fiodorovna.

SCIENTIFIC INSTRUMENTS FROM SAXONY IN THE PETERSBURG ART COLLECTIONS

Mathias Ullmann

Staaliche Kunstsammlungen Dresden
Erna-Berger-Str. 6, 01097 Dresden, Germany

Keywords: Peter the Great, scientific instruments, Andreas Gaertner, anemometer

Although nearly forgotten, there were large Saxon influences on the life and policy of the Russian Czar Peter I. ("the Great"), especially concerning the foundation of St. Petersburg, the establishment of the Petersburg Art Collections and the first steps towards a Russian Academy of Sciences.
The topic of my paper deals with one aspect of these Saxon-Russian relationships during the reign of Peter the Great. This is the question about what scientific instruments were bought in Saxony directly by Peter the Great or on his behalf, which are still part of the different Petersburg collections. For every item there will be a description and some information about the producer of the instrument and about his ties to the Russian court. Today one can find three of those instruments: a huge burning glass made by Ehrenfried Walther von Tschirnhaus; a hanging level made by Jacob Leupold; and, the item the spoken paper will concentrate on, a huge combination of a clock and two windmeters (to measure the direction as well as the strength of the wind) made by Andreas Gaertner, Johann Melchior Dinglinger and Moritz Bodenehr.
The paper is part of a larger project on the cultural transfer between Saxony and Russia between the 17th and 20th centuries, sponsored by The Getty Foundation.

LIQUEFACTION OF GASES: ITS HISTORY AND THE PROBLEMS SURROUNDING THE DISCOVERY

Ewa Wyka

Jagiellonian University Museum
Jagiellonska 15, 31-010 Krakow, Poland

Research on the liquefaction of gases should be analysed from two points of views.

Firstly, from the development of scientific theories' viewpoint, the obtaining of liquid gases proved that all substances could exist in three states of aggregation. Even in the first half of the 19th century scientists remained convinced that it was not possible that air could exist in a liquid state.
Then, from the development of scientific instrumentation's point of view, research on the liquefaction of gases opened new perspectives for using low temperatures in technology. What was important was that new kinds of instruments were designed as liquefiers, cryostats and so on. Also, instruments for high pressures and the measuring of low temperatures were developed.

How did this lead to the obtaining of liquid oxygen?

The scientific study of low temperatures, born in the second half of the 19th century, became very fashionable throughout this period. Many scientists and engineers were interested in it, including M. Faraday, R.P. Pictet, L.P. Cailettet, J. Dewar, W. Ramsay, H. Kammerling-Ones. Equally importantly, two scientists from Krakow – Zygmunt Wróblewski and Karol Olszewski - made had their own contributions.

In December 1877, Raul Pictet from Geneva and Louis Cailettet from Paris liquefied oxygen in a *dynamic state,* meaning that they observed drops of liquid oxygen. Both of them then sent their reports to the French Academy of Science virtually at the same time. Because of this, it became unclear who of them should be recognised as the first, despite the fact that, really, Cailettet was.
It took a further five years, until 1883, before the meniscus of liquid oxygen was finally observed, meaning that the static *liquefaction of* oxygen was achieved. This was conducted by Karol Olszewski and Zygmunt Wróblewski in Krakow, using Cailettet's apparatus that they had modified themselves.
In turn, this led to a debate between the French and Polish scientists concerning who should be recognised as the actual discoverer of this achievement, even dividing opinion amongst the French scientists.
In my paper, the development of apparatus for the liquefaction of gases will be presented, besides the contributions by researches from Krakow.

A COMMUNIST INSTRUMENT IN FRANCO'S SPAIN

Pedro Ruiz-Castell, Ignacio de la Lastra

Departamento de Documentación e Investigación, Museo Nacional de Ciencia y Tecnología
Paseo de las Delicias, 61. 28045 Madrid, Spain

Franco’s Spain became isolated in the international context after Second World War. But the beginnings of Cold War in the late 1940s changed the situation. Americans saw Spain as a strategic territory against the Soviet danger. And Truman’s doctrine fit perfectly well with Franco’s anticommunism. This meant the beginning of a military and economic collaboration between the United States of America and Spain. Therefore, the fact that two Spanish relevant institutions acquired in the 1960s two TESLA electron microscopes made in Brno (Czechoslovakia) deserves some attention. One of them, devoted to medical research, is currently at the Spanish *Museo Nacional de Ciencia y Tecnología*. This text studies not only the scientific importance of such an instrument and its use, but also explores several areas to which Spanish historiography has not paid much attention, such as the existence of commercial and economic links between Franco’s Spain and some European Communist countries.

PROPAGANDA OR EDUCATION? THE CONTROVERSY OVER THE IMPORTATION OF SOVIET SCIENTIFIC INSTRUMENTS TO AMERICA IN 1959.

David Pantalony

The Bakken Library and Museum
3537 Zenith Ave. South, Minneapolis, MN 55416-4623, USA

Keywords: Soviet scientific instruments, education, importation

Soviet educational scientific instruments were sold in the United States for a very brief period in 1959. An American instrument dealer bought them from the Ministry of Education in Moscow with the intention of selling them to American colleges. Before he could sell only a handful, however, they were impounded by U.S. Customs. There was a lively exchange in the Senate about the dangers of Soviet propaganda, and the importer was called before a hearing on Capital Hill. A bill was passed preventing schools from buying communist instruments and the remaining supply was destroyed. The instruments that came to America were part of impressive post-war changes in Soviet science education and the mass production of Soviet scientific equipment. Following the launch of Sputnik, science education suddenly became one of the heated battle grounds of the Cold War. Lobbyists for a protectionist American instrument trade used this moment to strengthen their grip on American science education. This talk is based on artifacts found at Dartmouth College and the Bakken Museum.

SESSION II

Shot at Noon - Aspects of Artillery Instruments from Early Modern Europe

Chairman: Silke Ackermann

Wolfram Dolz	Early Artillery Instruments - a Typology
Roland Schewe	Artillery Instruments from the German National Museum - Art Technology and Material Sources
Silke Ackermann	Insular views? Artillery Instruments from England.
Peter Plaßmeyer	Strategic Games? Remarks on the Function of artillery instruments in Princely Collections.

EARLY ARTILLERY INSTRUMENTS - A TYPOLOGY

Wolfram Dolz

Mathematisch-Physikalischer Salon, Staatliche Kunstsammlungen Zwinger, 01309 Dresden, Germany

Keywords: artillery instruments, typology of instruments, instrument makers, gunnery instruments, Germany

The origins of artillery as we know it can be found in early 14th century Italy; the first scientific examination of the trajectory was published by Niccolo Tartaglia in 1537. Both for the production and the adjustment of the guns, measuring instruments were necessary: the diameter of the barrel and the diameter of the shot needed to be established, the barrel needed to be raised to the appropriate elevation and adjusted to the correct direction. A new group of instruments was developed as the result of these needs: the artillery instruments, often also called 'gunnery instruments.'

The paper will examine the typology of these instruments based mainly on the collections in the Mathematisch-Physikalische Salon in Dresden and the Germanische Nationalmuseum in Nuremberg.

ARTILLERY INSTRUMENTS FROM THE GERMAN NATIONAL MUSEUM – ART TECHNOLOGY AND MATERIAL SOURCES

Roland Schewe

Institut für Kunsttechnik und Konservierung, Germanisches Nationalmuseum
Kornmarkt 1, 90402 Nürnberg, Germany

Keywords: artillery instruments, instrument makers, art technology, material sources, Rotschmiede

The Germanisches Nationalmuseum possesses some twenty-seven artillery instruments, in the narrowest sense, six of which originate in Nürnberg. There are a further thirty-five pieces that were used in the field of artillery. The earliest Nürnberg instrument dates from 1506. Most of the pieces are 17^{th} century.

The first mathematical and scientific instruments in Nürnberg date conclusively from the first half of the fifteenth century. In the beginning, astronomers and mathematicians constructed their instruments themselves. The essential components of the instruments were produced for them by metalsmiths, especially by the so-called “Rotschmiede” (Nuremburg metalsmiths specialising in the working of brass). In general the “Rotschmiede” would deliver only partially-worked pieces to the compass-makers and other producers of mechanical instruments, who then finely adjusted the elements and joined them together.

Close examination has confirmed that the essential component pieces of many instruments are in no way produced only by means of single mould processes, as is suggested in many catalogue entries. The enormous variety of joining techniques is evidence of the metal-manipulation “Know How” of the instrument-makers and their sub-contractors.

The technical and cultural aspects of the production of artillery pieces merit further discussion. This will be supported by art-technological evaluation, for example the assessment of historical materials, art- or work-techniques, and a first detailed appraisal of guidelines for the craftsmen, trade relationships, and technical writings.

INSULAR VIEWS? ARTILLERY INSTRUMENTS FROM ENGLAND.

Silke Ackermann

The British Museum
Great Russell Street, London WC1B 3DG, UK

Keywords: artillery instruments, gunnery instruments, instrument makers, England, Humfrey Cole

Some of the earliest surviving artillery instruments made in England, in particular those by the renowned maker Humfrey Cole, appear to look and function rather differently from the instruments that we know from continental Europe. Is this perception correct? And if so, why might this be the case? Who makes and who owns the instruments and how do they relate to contemporary treatises and prints? Were there links between artillery practices and practitioners across Europe or does England play a different role due to its geographical position? And how does the accuracy of the instruments compare with that of the available artillery?

The paper will examine all these questions and attempt to establish whether England had, indeed, an insular view.

STRATEGIC GAMES? REMARKS ON THE FUNCTION OF ARTILLERY INSTRUMENTS IN PRINCELY COLLECTIONS.

Peter Plaßmeyer

Mathematisch-Physikalischer Salon, Staatliche Kunstsammlungen Zwinger, 01309 Dresden, Germany

Keywords: artillery instruments, instrument maker, collections, treatise, Germany

In the 16th and 17th centuries the presence of artillery instruments in *Kunstkammers* and in printed treatises on artillery became a matter of course. Finely engraved and gilt, these instruments were precise as well as representative, often more precise in fact than the canons themselves.

Which function(s) did these mathematical instruments have in a princely collection? Very few show signs of actual use, so were they really the artillerist's tools or just models? Were they decorative pieces in a princely collection, useful to illustrate the arguments of a strategic thinking sovereign? Do they represent a further variation of the mathematical sciences or were they three-dimensional illustrations for a scientific discussion? Were they another variation of triangular instruments in the 'popular' market with scientific instruments?

This paper will analyse the function of artillery instruments, especially so called 'gunner's levels', in princely collections with a focus on the *Kunstkammers* in Dresden and Munich.

SESSION III

From Kepler's Astronomy to the 20th Century

Chairmen: Sara J. Schechner, Françoise Le Guet Tully

Inga Elmqvist Söderlund	The Identity of the Astronomer in 17th Century Imagery - Instruments Used as Attributes
Yaakov Zik, Giora Hon	Science and Instruments: Kepler's Optical Part of Astronomy
Suzanne Débarbat	Is Lacaille (1713-1762) the First in Attempting to Uniformize Instruments in View of a European Cooperation in Astronomy?
Peter Abrahams	The Telescopes of William Lassell (1799-1880)
Kevin Johnson	The 1876 Special Loan Exhibition; a Global Snapshot of Astronomy?
Klaus Staubermann	Instrument and Image: the Nineteenth Century Astronomical Lantern Slide
Anna K. Zawada	Tadeusz Banachiewicz (1882 – 1954) Director of the Krakow Observatory and Inventor of Chronocinematograph

THE IDENTITY OF THE ASTRONOMER IN 17TH CENTURY IMAGERY – INSTRUMENTS USED AS ATTRIBUTES

Inga Elmqvist Söderlund

Observatoriemuseet
Drottninggatan 120, 11360 Stockholm, Sweden

Keywords: 17th century, astronomer, illustration, identity, attributes

Pictorial representations of astronomers of the 17th century are discussed. In individual portraits where personal (or other group-) identity is stressed, it is often difficult to discern general similarities. However there are typical traits of the professional identity of astronomers that are shared in many representations. Local differences and common European aspects are discussed. Besides clothes, posture, mimic, gestures, architectural details, and hierarchical relations, scientific instruments are in many cases used as attributes to explain aspects of the pictured person's identity or professional interest.

SCIENCE AND INSTRUMENTS: KEPLER'S OPTICAL PART OF ASTRONOMY

Yaakov Zik and **Giora Hon**

University of Haifa
51 Hovevey Zion St., 63346 Tel Aviv, Israel

In Kepler's *Astronomiae pars optica* of 1604 we read,
"Considerable difficulties stand between us and the prediction of eclipses and to an exact reconstruction of the moon's motion. It is my hope in these pages to remove these difficulties by a straightforward demonstration of the theorem, and by laying bare the sources of the errors [*et apertis errorum fontibus*], which displayed themselves to me through a careful observation of the solar eclipse that occurred in 1600 (Chapter 2: 48)."
Kepler argues that inherent to the medium between the eye and the stars are certain effects that disturb the results of astronomical observations. One of Kepler's chief purposes in this study was to examine astronomical instruments at the theoretical level and then to realize his ideas in reliable instruments which take account of the disturbing effects. He knew further that flaws in design and manufacturing techniques as well as improper usage made instruments subject to more errors. It was therefore important to understand the extent to which astronomical instruments introduce deception into the study of motion of the heavenly bodies, and the degree to which the sense of sight itself is beset by errors.
Kepler acknowledged the role of instruments not only as generating data or measuring natural phenomena, but as a vehicle for conceptualizing and testing scientific theories. Laying bare the sources of error was one of the pillars of Kepler's novel epistemology. He aimed at a better understanding of how science and instruments are related. The paper we present brings together historical and philosophical perspectives on these aspects of experimental science.

IS LACAILLE (1713-1762) THE FIRST IN ATTEMPTING TO UNIFORMIZE INSTRUMENTS IN VIEW OF A EUROPEAN COOPERATION IN ASTRONOMY?

Suzanne Débarbat

Observatoire de Paris – SYRTE/UMR 8630
61 avenue de l'Observatoire 75014 Paris, France

Keywords: Lacaille, Lalande, Moon, Peiresc, sextant

National and/or international cooperation, in the field of astronomy, began, in modern times, during the 17th century under the leadership of Peiresc, Gassendi and Gaultier de La Valette. Several stations were set up around the Mediterranean on the occasion of a lunar eclipse. As a result, the length of the sea, in longitude, was reduced to two thirds of its previous value. Lacaille, by the mid-eighteenth century, left France for The Cape, requesting astronomers from Europe to provide observations of stars and objects of the solar system. In cooperation with Lalande, being in Berlin, he observed the Moon in view of its distance from the Earth. In the «Avis» he wrote, on that occasion, Lacaille mentions the focal length to be used by observers and depicts the instrument he will bring with him, «un Sextant de six pieds de rayon…». Was Lacaille the first trying to standardize the instrumentation to be used? Whatever it is, by the end of the 19th century, when another international enterprise would be launched, the same instruments would be employed. For comparing the quality of instruments, it is necessary to use instruments as different as possible, as made by Delisle checking refractors of various focal lengths. On the other hand, similarity of instruments is needed when a collective task is in view.

THE TELESCOPES OF WILLIAM LASSELL (1799-1880)

Peter Abrahams

1948 Mapleleaf Rd., 97034 Lake Oswego, Portland, Oregon, USA

Keywords: Lassell, telescope, equatorial, speculum

The notebooks of William Lassell (1799-1880), preserved at the library of the Royal Astronomical Society, are an extensive record of the experiments and accomplishments of a wealthy amateur telescope maker. Dating from the mid-1800s, and extending over many decades, these manuscript papers contain detailed accounts of the development of his telescopes. Many illustrations of his tools and telescopes were drawn by Lassell in the notebooks, considerably aiding the reader to comprehend his advanced designs.

Lassell built three important telescopes, the first of nine inches aperture, the second of twenty-four inches, and the third of forty-eight inches aperture.

His notebooks describe the casting, grinding, polishing, and testing of speculum metal mirrors. Particular emphasis was placed on the machinery, gearing, and linkages used to grind a parabolic surface for telescope mirrors of varying diameters and focal lengths.

The most important of Lassell's innovations are the mounting of the telescope mirror in an engineered cell, and the mounting of the telescope in an equatorial mount.

THE 1876 SPECIAL LOAN EXHIBITION; A GLOBAL SNAPSHOT OF ASTRONOMY?

Kevin Johnson

Science Museum (National Museum of Science & Industry)
Exhibition Road, South Kensington, SW7 2DD London, UK

Keywords: history of astronomy

In the year that the United States was celebrating its first hundred years of statehood with a world exposition, an exhibition was held at the South Kensington Museum in London. Unlike the world trade fair being held in Philadelphia, the display of scientific apparatus was arranged without national stands. Instead the exhibits were arranged under general heading with both historical and contemporary material on show. Peter de Clerq has made a thorough examination of the historic scientific instruments, publications, photographs and replicas associated with the exhibition. This was published as four instalments, in the 'Bulletin of the Scientific Instrument Society' between 2003 and 2004. By contrast, this paper is going to examine the contemporary astronomy material displayed at the South Kensington Museum. It will outline the material exhibited and analyse its relationship to the changes in global astronomical research during this period. Attention will be paid to the gradual move from meridian astronomy, with its emphasis on positional measurement, to astronomical physics using spectral analysis and photography. Most of the material submitted was from European institutions or individuals. It mostly took the form of photographs, as observatory instruments were too large to transport, while in other cases models were supplied. It will also be shown that the recent transit of Venus in 1874 also influenced the choice of material displayed.

INSTRUMENT AND IMAGE: THE NINETEENTH CENTURY ASTRONOMICAL LANTERN SLIDE

Klaus Staubermann

Dunckerstr. 29a, 10439 Berlin, Germany

Historians of science have frequently argued that the 19th century marked a shift in astronomy from demonstration instruments towards pictorial representations. Although demonstration instruments never disappeared from astronomy teaching, pictorial representations indeed played a strong role from the late 19th century onwards. However, this paper takes a different approach. It argues that already in the beginning of the 19th century new discoveries led to an increasing demand for images of the newly discovered objects. This paper examines how demonstrators and projectionists met this demand by what was already an established medium at its time: magic lantern slides. Based on my experience with original, historic slides, I will show how demonstration instruments, instead of being replaced by images, on the contrary, were at the very centre of producing those images.

TADEUSZ BANACHIEWICZ (1882 – 1954) DIRECTOR OF THE KRAKOW OBSERVATORY AND INVENTOR OF CHRONOCINEMATOGRAPH

Anna Karolina Zawada

Jagiellonian University Museum, Collegium Maius
Jagiellonska 15, 31-010 Krakow, Poland

Keywords: chronocinematograph, astronomy, Krakow Observatory, solar eclipses

Tadeusz Banachiewicz was one of the greatest modern Polish astronomers, sometimes called "first after Copernicus". He was a surveyor, mathematician and promoter of Polish astronomy. He revived the Krakow Observatory after the First World War and was its director for 35 years. Banachiewicz had outstanding achievements in theoretical astronomy (Cracovian calculus) as well as in astronomical observations. He designed the chronocinematograph – the first instrument for simultaneous recording of solar eclipses and precise time. It was connected to a chronometer and a chronograph. The Baily's pearls were used to set the time of different phases of the eclipse and to determine relative radii of the Sun and the Moon.
The paper will present Banachiewicz's life and research, focusing on the invention of the chronocinematograph. In addition a unique movie from the 30's about the Krakow Observatory, chronocinematograph and the Polish expedition to Swedish Lapland during the solar eclipses in 1927 will be shown.

SESSION IV

Instruments of the 20th Century

Chairmen: Vasily Borisov, Sofia Talas

Leonardo Gariboldi	Studying Cosmic Ray Physics in Milan: the Four Cloud chambers (1938-60)
Sofia Talas	Baloons and Nuclear Emulsions: the Role Played by the University of Padua in the 1950's European Collaborations
Josep Batlló, Carme Clemente, Francisco Pérez-Blanco, José Morales	The Seismographs of the "Observatorio de Cartuja" (Granada, Spain). Restoration of the "Cartuja Macroseismograph"
Richard Kremer	Harold E. Edgerton's High Speed Cameras
Vasily Borisov	The Birth of the Electronic Television: Cooperation and Competition
Šimon Krýsl	The resounding Heart: dr. Leo Jacobsohn's Heart Sound Transmission
Tacye Phillipson	Mallard and the Mouse Box: Prototype MRI Material from Aberdeen

STUDYING COSMIC RAY PHYSICS IN MILAN: THE FOUR CLOUD CHAMBERS (1938-1960)

Leonardo Gariboldi

Università degli Studi di Milano, Istituto di Fisica Generale Applicata
Sezione di Storia della Fisica
Via Brera 28, 20121 Milano, Italy

The cloud chamber has been one of the most important instruments used by physicists to study cosmic rays. The first cloud chamber was built in Milan in 1938 and was furthermore used by a new group of physicists who restarted the research in Milan after the end of the Second World War. The historical reconstruction of this Milanese community of cosmic ray physicists follows the developments of the studies made with the four cloud chambers built by them. In particular, they were engaged in the studies on the cosmic ray showers, the composition of the soft and hard components, the nuclear interactions, the μ- and π-mesons, and the strange particles.

BALLOONS AND NUCLEAR EMULSIONS: THE ROLE PLAYED BY THE UNIVERSITY OF PADUA IN THE 1950'S EUROPEAN COLLABORATIONS

Sofia Talas

Museum of the History of Physics, Dipartimento di Fisica, University of Padua via Marzolo 8, 35121 Padova, Italy

Keywords: 20th century scientific heritage, particle physics

In the very difficult years after World War II, the Institute of Physics of Padua University decided to focus on cosmic rays research, as this was a means to study particle physics which did not require much sophisticated and expensive apparatus. But physicists in Padua, after the war period, had to learn a lot about the various detecting techniques available at that time, and contacts were thus established between Padua and other universities in Europe. In particular, as for the nuclear emulsion technique, connections were set up with C.F. Powell's laboratory in Bristol and with G. Occhialini in Brussels.

Several new experiments were then started and from 1951, Padua was involved in an important international scientific project intended to study the so-called "strange" particles. Such particles were quite rare within cosmic rays and the collaboration of several laboratories could in fact strongly increase the statistics about these rather rare events. The idea was to expose bunches of emulsion plates to cosmic rays at very high altitudes using polyethylene balloons. The project was promoted by Powell, who had already acquired a certain experience in such experiments. Purposely made balloons were thus launched from different places in the following years and interesting physics results were obtained.

Through the analysis of instruments and documents that have been recently found and studied, the present paper will discuss the various aspects of these experiments and the role played by the University of Padua within this international collaboration.

THE SEISMOGRAPHS OF THE "OBSERVATORIO DE CARTUJA" (GRANADA, SPAIN). RESTORATION OF THE "CARTUJA MACROSEISMOGRAPH".

Josep Batlló[1], Carme Clemente[2], Francisco Pérez-Blanco[2] and José Morales[3]

(1) Observatori de l'Ebre. CSIC, c. Horta Alta 38, E-43520 Roquetes, Spain
(2) Escola d'Art i Disseny de la Diputació de Tarragona a Tortosa
Pl. Sant Joan 5, E-43500 Tortosa, Spain
(3) Inst. Andaluz de Geofísica, Campus Universitario de Cartuja s/n,
E-18071 Granada, Spain

Key words: seismograph, seismology, instrument design, Cartuja Observatory

The Cartuja Observatory, in Granada, was founded by the Society of Jesus in 1902. Soon it was widely known for its research in seismology. Special attention should be drawn to the different seismographs designed and built at the centre. This task continued for forty years, and more than twenty different models came from its workshop. Those models covered all aspects of seismic recording: from the big earthquakes to ambient noise and industrial vibrations, and even pedagogical instruments. Cartuja Observatory was the most important institute in Spain dealing with seismograph design and one of the leading centres in Europe. Its designs spread to different seismic observatories in Central and South America and to Italy.

Almost all the instruments designed and built at the centre have been lost. But, recently, what remains of the last seismograph, built in 1949, the "Cartuja macroseimograph", was found. This instrument has been restored at the restoration workshop of the Tortosa School of Art and Design. Priority in the restoration has been given to didactical insight and some parts of the instrument have been built anew to allow a good understanding of how it was operated.

Present work analyzes the importance of the seismographs built at the Cartuja Observatory, its influence in the development of the instrumental seismology and shows the results of the restoration of the "Cartuja macroseimograph".

HAROLD E. EDGERTON'S HIGH SPEED CAMERAS

Richard Kremer

Dartmouth College
6107 Carson Hall, 03755 Hanover, NH,USA

By the 1910s, motion picture photography had become an essential tool in many of the sciences, ranging from physics and zoology to ethology and human anatomy and physiology. High-speed motion pictures, projected at slower speeds, opened new worlds of "movement" to investigation, compared by contemporaries to the novel worlds of the "small" and the "far" that early microscopes and telescopes had made accessible. When in 1918 the first high-speed motion pictures (taken with a 300 frame-per-second camera commercially available from Ernemann A.G.) were presented at the Dresden meeting of the Gesellschaft für Natur- und Heilkunde, they provoked audiences, in the words of a participant, "first to laughter, then to astonishment, wonder and lively interest." By 1950, Soviet and American Cold-War scientists were photographing atomic bomb explosions at speeds exceeding 10 million frames per second, and few were laughing.

This paper will examine the role, during the 1930s, played by the MIT electrical engineer, Harold E. Edgerton, in the development of high-speed cameras. Better known for his invention of cheap, reliable high-speed stroboscopic light sources and for his modernist single-exposure photographs, Edgerton also worked with existing manufacturers of photographic equipment to design cameras capable of recording up to 10,000 frames-per-second. Although none of his early high-speed cameras are extant, Edgerton's laboratory notebooks and correspondence enable me to paint a detailed portrait of his innovative efforts at instrument design.

THE BIRTH OF THE ELECTRONIC TELEVISION: COOPERATION AND COMPETITION

Vasily Borisov

Institute of the History of Science and Technology, Russian Academy of Sciences
1/5 Staropansky per., 103012 Moscow, Russia

Keywords: history of the electronic television, radio and electronics

In 1907, a Russian professor, Boris Rosing, made improvements in the Braun cathode ray tube that permitted its adaptation for reproduction of scanned images. At about the same time a British scientist, F. Campbell Swinton, worked on a project of a television system using cathode tubes as the transmitter and receiver. The experiments kindled the imagination of a talented student in Rosing's classes of the St. Petersburg Technological Institute, Vladimir Zworykin. The student then became a notable figure in bringing ideas for electronic television to the point where it found practical use. Yet it took him and other inventors more than a quarter of the century.

V. Zworykin demonstrated his first experimental electronic TV-system in 1925 after his emigration to the USA. A year later Edouard Belen in Paris demonstrated a TV-system with cathode tubes in the M. Curie Radium Institute. His partners on that development were Fernand Holweck and a Russian Gregory Ogloblinsky. Also Dr. Alexandre Dauvillier of the Louis de Broglie Laboratory developed, at the same time, an advanced tube for reproduction of electronic images.

A Hungarian engineer K. Tihanyi invented an electronic transmitting tube with photosensitive target. He left for the USA, while another Hungarian inventor D. Mikhali dealt with the development of TV-systems in Germany. The laboratories in France, Germany, and Hungary had commercial agreements with the American Radio Group, which represented General Electric, Westinghouse, and the RCA. Collaboration and competition both took place in the movement to the goal.

THE RESOUNDING HEART: DR. LEO JACOBSOHN´S HEART SOUND TRANSMISSION

Šimon Krýsl

Medical Museum, National Medical Library
Sokolská 54, 12000 Praha 2, Czech Republic

Keywords: Leo Jacobsohn, stethoscope, history of medical examination, history of radio, Germany

In most histories of diagnostic methods of heart disease, the name of Leo Jacobsohn is missing: this Berlin doctor's 1923 invention of an apparatus using radio equipment to amplify and transmit heart sounds appears to lead into a blind alley in the history of science. As an attempt to bring one of the "boundless possibilities" of the radio, as perceived in the 1920s, to reality, it deserves attention. While no "new sounds," no extension of the system of medical signs, were produced, the device removed the doctor listening to the heart from the intimacy of auscultation – the chest, the stethoscope, the ear – to the public arena of radio reception. Yet Jacobsohn stopped short of translating the heart sounds into numbers and graphs, remaining bound to the immediacy of the voice of the heart. Presenting the technology he introduced, I want to suggest its place in the history of audition as well as in the discourse of its time.

MALLARD AND THE MOUSE BOX: PROTOTYPE MRI MATERIAL FROM ABERDEEN

Tacye Phillipson

National Museums of Scotland
Chambers Street, EH1 1JF Edinburgh, UK

Keywords: MRI, prototype

In March of 1974 the first Magnetic Resonance Image to show pathology in a complete organism, a mouse, was obtained at Aberdeen by Professor John Mallard's research group. In September of 1980 the same team presented a report including the first patient to be usefully imaged, five days previously. (One wonders how long in advance abstracts needed to be submitted.) The commercialisation of MRI did not continue the British success story, and was dominated by the USA, Japan and Germany. Credit for the development of MRI has been subject to some controversy, and this talk will focus on the Aberdeen contribution and surviving material.

SESSION V

Astronomical Observatories

Chairman: Suzanne Débarbat

James Caplan	Meridian Instruments of the Marseille Observatory
Gudrun Wolfschmidt	Developement of Radioastronomy in Germany before the Effelsberg Telescope
Françoise Le Guet Tully, Jean Davoigneau	The German Tradition and 19th Century French Observatories
Ileana Chinnici	Historical Instruments in Italian Astronomical Observatories: State of the Art and Perspectives

MERIDIAN INSTRUMENTS OF THE MARSEILLE OBSERVATORY

James Caplan

Observatoire astronomique de Marseille-Provence
2 place Le Verrier, 13248 Marseille cedex 4, France

Keywords: quadrant, transit instrument, meridian circle, prismatic astrolabe

From the beginning of the 18th century until the early 20th century, meridian observations were made at the Marseille Observatory in order to determine the time and, especially, the positions of celestial objects. What instruments and techniques were used, and why did they change? What does this tell us about the work of astronomers during two and a half centuries?
For over a century such work was done with quadrants and transit telescopes. In 1830 the observatory received its first meridian circle, by Gambey. This was the only instrument whose regular use continued after the transfer of the observatory to its present location in the 1860s. A new meridian circle, by Eichens, was installed in 1876, only to be dismantled in 1912. Then, for about ten years, the 'time service' was assured by prismatic astrolabe observations. Mysteriously, the original Gambey circle seems to have been pressed back into service in the 1940s.
These optical instruments were, of course, accompanied by accurate clocks.
I shall describe the restoration of those instruments that are extant.

DEVELOPMENT OF RADIO ASTRONOMY IN GERMANY BEFORE THE EFFELSBERG TELESCOPE

Gudrun Wolfschmidt

Institute for History of Science, Hamburg University
Bundesstrasse 55, D-20146 Hamburg, Germany

Keywords: radio telescope, reflector, amplifier, antenna, RADAR

After the discovery of electromagnetic waves by Heinrich Hertz (1857–1894) in 1887, one tried to find cosmic signals or extraterrestrial radio waves starting in 1896. In the 1930s, radio signals from the Milky Way and from the Sun were discovered with a system of antennas, or later with reflectors. A parabolic dish was used; in the focal point a vibration was induced in the dipole.

With the German "Würzburg-Riese" (7.5-m-reflector for RADAR), radio astronomy started after the war; especially in the Netherlands, UK and Australia. In Germany in the 1950s four centers were built up: Kiel (dipole antenna wall and 7.5-m-reflector), Freiburg (3-m- reflector and radiospectrograph), Berlin-Adlershof/GDR (36-m-transit telescope) and Potsdam/GDR (several antennas for solar radio astronomy).

Beginning in 1952, Friedrich Becker (1900–1985) started to plan a first large German radio telescope, a 25-m-reflector, Stockert, Eifel (1956). Shortly, together with Dwingeloo
(25-m-reflector) it was the largest in the world. Very quickly the dimensions of radio telescopes were increased – a development in the direction of Big Science.

In the 1960s one tried to get a new telescope: in 1971 the 100-m-diameter antenna was inaugurated (MPI for Radioastronomy, Bonn) – it was until 2000 the largest fully steerable radio telescope in the world.
Finally the development of amplifiers will be discussed (electronic tubes with Yagi antennas, parametric amplifiers since 1960, Maser, transistors since the 1970s, HEMT).

THE GERMAN TRADITION AND 19TH CENTURY FRENCH OBSERVATORIES

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

a) Observatoire de la Côte d'Azur, BP 4229, 06304 Nice cédex 04, France
b) Ministère de la Culture et de la Communication, Paris, France

During the first part of the 19th century when, due to the profound changes of the revolutionary period, French observational astronomy was on the decline, the situation on other side of the Rhine was quite different. The zone of influence of the astronomical tradition of Germany extended well beyond its linguistic borders. For example, at the beginning of the 19th century, the reputation of the new observatory of Dorpat (Tartu) was due not only to the personality of its German director, Wilhelm Struve (1793-1864), but equally to its 24-cm-diameter refracting telescope ordered from Fraunhofer in Munich.

Precursor of all the great refractors, this famous instrument inspired the construction, a few years later, of the principle instrument of the Pulkovo observatory near Saint Petersburg, the 38-cm refractor ordered by the same Wilhelm Struve from Merz and Mahler, the successors to Fraunhofer. The unrivaled perfection of this instrument and the many innovations in its design made the Pulkovo telescope a major symbol of 19th century observational astronomy. Copied in Europe and America, this instrument was the starting point of the international race toward giant refractors which continued until the end of the 19th century. It is this type of instrument which was to equip certain new French observatories as well as the new observatory constructed in Strasbourg shortly after that city became German following the 1870 Franco-Prussian war.

We shall first discuss the German astronomical tradition in connection with the fabulous history of the Pulkovo observatory, the “astronomical capital of the world”, inaugurated by the Tsar Nicolas 1st in 1839: the contributions of the German astronomers, the importance of the Munich and Hamburg instrument makers, the acquisition of the library of the Bremen astronomer Olbers, etc. Then we shall examine the influence exerted on French astronomy by the German tradition and the Pulkovo observatory during the second half of the 19th century.

HISTORICAL INSTRUMENTS IN ITALIAN ASTRONOMICAL OBSERVATORIES: STATE OF THE ART AND PERSPECTIVES

Ileana Chinnici et al.

INAF – Osservatorio Astronomico di Palermo
Piazza del Parlamento 1, 1- 90134 Palermo, Italy

Keywords: astronomical instruments, history, Italy

In 1999, the Italian Government established the National Institute of Astrophysics (INAF) which embodies the astronomical observatories and, since 2003, the astronomical institutes of the CNR.
An important effort has been made in the past years to preserve the historical archival heritage of the astronomical observatories: the Specola 2000 project, quite complete today, has inventoried and catalogued all the archival material, with the support of the Ministero dei Beni Culturali and the Società Astronomica Italiana.
In 2005, the INAF has established a "Servizio Musei" in order to preserve the historical collections of instruments kept in the Observatories, a heritage unique for quantity and quality.
At present, the situation is very wide-ranging: some collections have been well examined in the past, thanks to collaborations with the local Universities, and are now arranged in exhibitions open to the public; others are unfortunately still in the cases, or in rooms not accessible to visitors.
The "Servizio Musei INAF", operated by the authors of this paper, intends to promote a project analogous to Specola 2000 for the instrument collections, in order to catalogue all the material in a homogeneous way, according to the recent standard proposed by the IMSS and endorsed by the Ministero.
We hope this could be an important step to inspire the Observatories to have their instruments on adequate exhibitions and to stimulate a sound "conservation" mentality also for the instruments destined to be dismantled in a few years.
In this paper, the general plan of the project and its main aims will be presented and discussed.

SESSION V: Astronomical Observatories

SESSION VI

Instruments of the Hellenic World

Chairman: Alison D. Morrison-Low

Giorgio Strano	The In-existent Instruments of Ptolemy's "Almagest": The Mysterious Error and Oscillation of the Obliquity of the Ecliptic
Yanis Bitsakis	The Antikythera Mechanism Research Project
Michael T. Wright	The Antikythera mechanism: Hellenistic Bodging

THE IN-EXISTENT INSTRUMENTS OF PTOLEMY'S "ALMAGEST": THE MYSTERIOUS ERROR AND OSCILLATION OF THE OBLIQUITY OF THE ECLIPTIC

Giorgio Strano

Istituto e Museo di Storia della Scienza
Piazza dei Giudici 1, 50122 Firenze, Italy

In his *Mathematical Composition*, or *Almagest*, Claudius Ptolemy suggested that two instruments had to be employed in order to determine the fundamental astronomical parameter of the obliquity of the ecliptic. However, the use of the meridian (or solstitial) armillary and the plinth does not explain the error on the obliquity datum detectable in the *Almagest*. A new hypothesis on the earlier observational origin of such datum can explain the error, and also the mysterious oscillation of the angle of the obliquity that emerges from ancient astronomical sources.

THE ANTIKYTHERA MECHANISM RESEARCH PROJECT

Yanis Bitsakis

University of Athens, Physics Department
6, K. Palaiologou str., GR-16232 Byron, Greece

Keywords: Ancient Greek technology, history of astronomy

The Antikythera Mechanism is the most sophisticated mechanism known from the ancient world. It dates from around the 1st or 2nd century B.C. and nothing as complex is known for the next thousand years. Since its discovery at the beginning of the 20th century, many questions have been raised amongst the international community of experts on the ancient world: was it an astrolabe, an orrery, an astronomical clock, or even something else? It is now understood to be dedicated to astronomical phenomena and operates as a complex mechanical "computer" which tracks the cycles of the Solar System.

The Antikythera Mechanism Research Project is an international collaboration of academic researchers, supported by some of the world's best high-technology companies, which aims to completely reassess the function and significance of the Antikythera Mechanism. During the data-gathering phase in the autumn of 2005, the latest technologies were used to reveal unknown elements of the mechanism. Hewlett Packard (US) and X-Tek Systems (UK) came to Athens with two unique pieces of specialized equipment: a Dome that surrounds the sample under examination to analyze the surface structure, and a 450 kV microfocus X-Ray system that produces 3-D images of the internal structure of the Mechanism. The data collected have opened a remarkable window, both on surface and on microscopic internal details of inscriptions and gearing, at a resolution better than a tenth of a millimeter. Inscriptions can now be read that have not been seen for more than two thousand years, and this is helping to build a comprehensive picture of the functions of the Mechanism.

THE ANTIKYTHERA MECHANISM: HELLENISTIC BODGING

Michael T. Wright

Centre for the History of Science, Technology and Medicine (CHoSTM)
Central Library, Imperial College, SW7 2AZ London, UK

Keywords: ancient planetarium, eclipse, design, reconstruction

The Antikythera Mechanism, a Hellenistic instrument dating from the first century B.C., is the oldest geared device and the oldest intricate scientific instrument. Nothing closely comparable is known from antiquity. It has remained enigmatic because of its uniqueness and its fragmentary state, so that many historians have dismissed it as an oddity.
A new reconstruction of this instrument, based on close examination of the original fragments, has been developed. A working model, illustrating the possibility that the principal display functioned as a planetarium, was shown and discussed at the S.I.C. Symposium in Athens in 2002.
The remaining features of this instrument are now elucidated. For want of direct evidence the restoration of all five planetary motions to the front dial necessarily remains conjectural, but the function of the supplementary displays on the back dial is now properly understood for the first time. The model has been extended to illustrate these features. Both its working and its internal arrangement can be demonstrated.
It has also become clear that the Antikythera Mechanism was altered. The back dial, an improvised addition to the original design, was previously part of a separate instrument, which might be called an eclipse-predictor. The Antikythera Mechanism is a “marriage”. Nothing changes!
The serious point which emerges is that the sophistication of the Antikythera Mechanism was not unique; evidence is accumulating that there was an extensive practice in the making of scientific instruments in antiquity.

SESSION VII
Historical Laboratories

Chairmen: Richard Kremer, Marian Fournier

Paolo Brenni	The Physics Collection of the Istituto Tecnico Toscano: 20 Years of Work
Jan Waling Huisman	Historical Laboratories at the University of Groningen
Staffan Andersson	Acquisition of a Collection in Context - a Case Study of the Uppsala Cabinet of Physics
Tatiana Moiseeva	The Chemical Laboratory of Lomonosov is the First Scientific and Educational Laboratory in Russia
Joan Muñoz, Jaume Valentines ,Santiago Vallmitjana	The Mentora Alsina: a Century of Teaching Experimental Physics in Barcelona
Santiago Vallmitjana, Carme Clemente	The Collection of Scientific Instruments of the Faculty of Physics of the University of Barcelona
Ad Maas	Mesmerized by Onnes. Research with the Large Electromagnet of the Kamerlingh Onnes laboratory in the 1930s.
Zbigniew Bela	The "Virtual" Laboratory of Michał Sędziwój, Reconstructed from His *Operatie Elixiris Philosophici* and Andreas Libavius's *Alchimia*

THE PHYSICS COLLECTION OF THE ISTITUTO TECNICO TOSCANO: 20 YEARS OF WORK

Paolo Brenni

Fondazione Scienza e Tecnica, CNR
Via Giusti 29, 50100 Florence, Italy

In 1850, the Grand Duke of Tuscany Leopoldo II founded a technical institute for promoting the development of industries and the modernization of agriculture. In spite of the fact that because of the unification of Italy in 1861 and various school reforms, the original project of the Grand Duke could not be fully realised, the collections of the Institute were substantially increased until the early 20th century. At the time, the cabinet of physics and mechanics was extremely well equipped with more than 2000 instruments signed by the best French, German and English instrument makers. Together with a large number of didactic instruments there were many sophisticated research and measurement apparatus, which had been used by the distinguished physicists who directed the cabinet.
After WWII the collection was less and less used and was slowly abandoned but fortunately not dispersed. In the last two decades the collection was completely restored, reordered, and catalogued. The Fondazione Scienza e Tecnica was instituted in 1987 for preserving, studying, and presenting to the public the scientific heritage of the Institute. Recently the galleries of the cabinet and their original furnishings have been completely refurbished, a new lighting system has been installed, and finally the collection has been redisplayed. Today the Cabinet of Physics of the Istituto Tecnico Toscano, which will be officially opened to the public in autumn 2006, preserves, in the original setting, one of the richest European collection of physics instruments of the second half of the 19th Century.

HISTORICAL LABORATORIES AT THE UNIVERSITY OF GRONINGEN

Jan Waling Huisman

Groningen University Museum
Oude Kijk In ’t Jatstraat 7a, 9712EA Groningen, The Netherlands

Keywords: instruments, laboratory, experimental psychology

The topic of this paper will be the history of the scientific laboratories at the University of Groningen, the Netherlands. Although a relatively small university, it has had some famous scientists under its roof, all with their stories of their research. At the end of the 19th century several new laboratories and research institutes emerged. Some of them drew international attention, all of them were built according to the latest ideas and hence, state of the art. One of the most interesting examples is the laboratory for experimental psychology, founded by Prof. Gerard Heymans in 1892. Its complete history has been documented and the places where it has been housed still exist. Apart from that, almost the complete collection of instruments from the first days of the lab has been preserved and it gives a good picture of the way research was conducted in the late 19th and early 20th centuries. It is probably one of the most comprehensive and best preserved collections of this kind in Europe.
The session is to be concluded with some examples of instruments from the museum collections, which have been recently used in modern research.

ACQUISITION OF A COLLECTION IN CONTEXT – A CASE STUDY OF THE UPPSALA CABINET OF PHYSICS

Staffan Andersson[a,b]

a) Department of Physics, Uppsala University, box 530, S-751 21 Uppsala, Sweden
b) Museum Gustavianum, Uppsala University, Akademigatan 3, S-753 10 Uppsala, Sweden

Keywords: historical instrument collection acquisition

To build up a scientific instrument collection in the middle of the 18th century was a complex process. Some of the political, scientific and economic factors involved will be discussed in this presentation. The process will be exemplified by the initiation of the Uppsala Cabinet of Physics, the first large physics instrument collection in Sweden.

The initiative for the founding of an instrument collection for demonstrations and experiments in physics came from Samuel Klingenstierna, professor of mathematics in Uppsala, in February 1738. Initially he proposed building a private instrument collection. This was soon revised to a plan for building an instrument collection for the whole university. This plan gained support from both the Swedish university chancellor and the Uppsala University board.

During the autumn of 1738, Klingenstierna initiated the acquisition of the instruments, which were chosen from contemporary scientific literature. Utilizing scientific connections in London, he requested recommendations on where and how to acquire the best instruments.

Klingenstierna contacted merchants active in the Stockholm-London trade for the practical arrangements. The transfer of funds, acquisition of instruments and transportations to Sweden were all done utilizing the mercantile network of the iron trade between Sweden and England.

THE CHEMICAL LABORATORY OF LOMONOSOV IS THE FIRST SCIENTIFIC AND EDUCATIONAL LABORATORY IN RUSSIA

Tatiana Moiseeva

M.V.Lomonosov Museum, Department Peter the Great Museum of Anthropology & Ethnography (Kunstkamera)
Universitetskaya nab. 3, 199034 St. Petersburg, Russia

The first Russian scientific and educational chemical laboratory was organized in 1748 by Michael Lomonosov. Chemical laboratories existed earlier, but as usual they belonged to mining factories. After the creation of the Academy of Sciences in St.-Petersburg it was necessary to open the special laboratory for scientific researches and educational purposes. The first native Russian academician made real steps towards that end.

Lomonosov began to discuss this question soon after returning from Germany (in 1742), and he was able to realize his idea when he became Professor of chemistry (in 1746). Then Empress Elizabeth allowed the building of the Chemical laboratory in the Academic Botanical garden near the so-called "Bonov house", where Lomonosov lived.

The laboratory building had been designed by architect Johan Jacob Schumacher with the participation of Michael Lomonosov. The building included the laboratory with nine furnaces, lesson-room and storage for equipment.

Lomonosov was busy for a long time with the equipment of the laboratory. He was the designer of many scientific instruments; some of them he improved, using knowledge acquired in Germany.

There were many experiments in the Chemical laboratory, especially connected with colored glasses and optical lenses. Michael Lomonosov organized the wide program of physical and chemical research. He introduced the term of physical chemistry to the Russian language, and gave lectures on this subject for the students of the Academic University.

In 1757, after changing his home address, Lomonosov left the Chemical laboratory. There were several curators during the next 20 years. The laboratory was slowly destroyed, and in the end of the 18th century was closed.

After the creation of the Lomonosov Museum in 1947, the organizer-architect Robert Kaplan-Ingel proposed reconstructing the laboratory. He began to collect materials about it and made a model of the laboratory. Unfortunately, the idea could not be realized.

In 1988, the archaeological excavations of the laboratory were carried out.

The Lomonosov Museum has unique materials, which are now available, suggesting the possibility of opening a special exhibition about the early period of the history of chemistry in Russia. This is planned for the 300 year jubilee of Michael Lomonosov.

THE MENTORA ALSINA: A CENTURY OF TEACHING EXPERIMENTAL PHYSICS IN BARCELONA

Jaume Valentines[1], Santiago Vallmitjana[2], Joan Muñoz[3]

(1) Centre de Recerca per a la Història de la Tècnica, ETSEIB (UPC)
Av. Diagonal 645, 08028 Barcelona, Spain
(2) Departament de Física Aplicada i Òptica. Universitat de Barcelona
Av. Diagonal 647, 08028 Barcelona, Spain
(3) Museu de la Ciència i de la Tècnica de Catalunya
Rambla d'Ègara, 270, E-08221 Terrassa, Spain

Keywords: scientific instruments restoration, physics scientific instruments, experimental physics, museography

In 1907, Ferran Alsina (1861–1908), a Barcelona industrialist and enthusiast of the popularisation of physics, formed an Experimental Physics Laboratory with the aim of promoting a vocation for, and a love of, physics. The Laboratory was initially run privately, but in 1964 the Barcelona City Council took control until 1995, when the Laboratory closed and the instruments were transferred to the Museu de la Ciència i de la Tècnica de Catalunya (mNACTEC), where an exhibition has been set up to mark the centenary.

This opened last May and will be a permanent exhibition of 130 instruments used in the study of physics, chosen for their particular value and displayed following the same configuration and use as portrayed in the historical photographs taken of the laboratory at the beginning of the twentieth century.

The whole collection consists of about 200 pieces, which are in a good condition thanks to the work done by the Restoration Workshop at the mNACTEC. The authors of this work have participated in the study, both archaeological and bibliographical, of the heritage that the institution has preserved. The documentation work has concentrated on the identification of the instruments, the function and operation of the instruments, the makers, dates, etc.

The Mentora Alsina Experimental Physics Laboratory was a pioneer in the Catalonia of the early 20th century and contributed towards the formation of students and the demonstration of certain physical principles, thereby becoming an organism in continuous development.

THE COLLECTION OF SCIENTIFIC INSTRUMENTS OF THE FACULTY OF PHYSICS OF THE UNIVERSITY OF BARCELONA

Santiago Vallmitjana[(1)], Carme Clemente[(2)]

(1) Dept. De Física Aplicada i Òptica, Universitat de Barcelona
Av. Diagonal, 647, E-08028 Barcelona, Spain
(2) Escola d'Art i Disseny de la Diputació de Tarragona a Tortosa
Pl. Sant Joan 5, E-43500 Tortosa, Spain

Keywords: scientific instruments restoration, physics scientific instruments, experimental physics, museography

According to our archives, in the latter years of the 19th century it is on record that classes of Physics, Astronomy and Experimental Physics, among others, were held at the University of Barcelona. For this reason, at that time the University acquired the first instruments for the teaching of Physics, which increased notably in number until the end of the century and have continued to do so since then.
Now the collection consists of about 250 instruments from the sections of Kinematics, Mechanics, Statics, Dynamics, Hydrostatics, Acoustics, Optics, Static Electricity, Electricity and Magnetism.

As regards their state of preservation, they can be divided into three groups. A third is in an extremely poor state and has several components missing. Another third requires much restoration work, and the rest needed less repairs. We have been working on this for the last 15 years, having now approximately 50 scientific instruments in a good state and working order. Recently, very good work of restoration has been done in collaboration with the School of Art and Design of Tortosa and excellent results have been obtained. The instruments we are presenting here are good examples.

Concerning projects for the future, a number of grants will be applied for in order to increase the restoration work and the reset on the instruments. At the same time, in-depth work has to be done on cataloguing, research into function, procedence and dates and making a complete inventory. Finally, we believe it is essential to broaden our scope to other collections of scientific instruments, both national and international.

MESMERIZED BY ONNES. RESEARCH WITH THE LARGE ELECTROMAGNET OF THE KAMERLINGH ONNES LABORATORY IN THE 1930s.

Ad Maas

Museum Boerhaave
Postbus 11280, 2301 EG Leiden, The Netherlands

Keywords: Kamerlingh Onnes, De Haas, experimental physics, cryogenics

Scientific instruments sometimes can tell a lot about their users, and the research conducted with them. Occasionally, a scientific instrument even can give a revealing insight in the way a laboratory functions.
In 1932, the second largest electromagnet in the world was installed in the physics laboratory of Leiden, which had become world famous in the preceding decades by Heike Kamerlingh Onnes. The magnet nowadays is particularly known for the cold-records that were achieved with it. These records, however, were not the reason why the gigantic and costly magnet was purchased. A close look at the true reason for the purchase and the research done with it provides an interesting insight in the research-programme and the research-ethics of the laboratory.

THE "VIRTUAL" LABORATORY OF MICHAŁ SĘDZIWÓJ, RECONSTRUCTED FROM HIS *OPERATIE ELIXIRIS PHILOSOPHICI* AND ANDREAS LIBAVIUS'S *ALCHIMIA*

Zbigniew Bela

Museum of Pharmacy, Jagiellonian University
Florianska 25, 31-019 Krakow, Poland

Polish nobleman Michał Sędziwój (Latinized Michael Sendivogius, 1566–1635) was widely known in Europe as an author of alchemical books. For instance, his *Novum Lumen Chymicum* was published in several languages about 50 times in the course of the 17th and the 18th centuries. One of his works, preserved in manuscript and entitled *Operatie Elixiris Philosophici*, contains accounts of twelve attempts to yield the Philosopher's Stone. In it, Sedziwój describes the substances he used (mercury, antimony, sulphur, arsenic, vitriol, etc.) and the alchemical processes to which those substances were subjected (distilling, sublimating, dissolving, calcinating, imbibing, putrefating etc.)

The twelve attempts were carried out in laboratories belonging to members of the time's highest aristocracy, such as Duke Boncompagno or Abbot Jacopo Busenelo, and were located in several Italian cities (Rome, Bologna, Venice). Sędziwój was also known to have performed his alchemical experiments before such eminent individuals as the Czech King Rudolf II, the Polish King Sigismundus III, and Frederick, the Duke of Würtemberg, who themselves keenly indulged in alchemical experimentation.

In his book *Alchimia* (Frankfurt, 1597) Andreas Libavius (1560–1616) recommends what an upper-classman's alchemical laboratory should look like. His discourse is illustrated by drawings of "our alchemist's" entire household (including the laboratory), and of various types of alchemical furnaces and utensils.

Juxtaposition of the drawings found in the Libavius' book and of the "operatie" described by Sędziwój enables us to imagine the facilities (as represented in Libavius's figures) becoming populated with Michał Sedziwój and his mighty patrons performing alchemical experiments just as described in *Operatie Elixiris Philosophici*.

SESSION VIII

Scholars, Constructors, Mechanicians

Chairmen: Paolo Brenni, Gloria Clifton

Jim Bennett	Christopher Middleton and the Practice of Navigation, 1730-50
Hans Hooijmaijers	The True Method of Finding the Longitude at Sea
Richard Dunn	Touched, Cleaned and Repaired; Equipping and Maintaining Trading Voyages to the Baltic
Julian Holland	Angelo Tornaghi: Migrations of a Mathematical Instrument Maker
Stephen Johnston	Science, Satire and the Architectonic Sector
Alexey Emelyanov	V. Tistschenko's Work in "Druzhnaya Gorka" Glassware Factory
Vladimir Schurov, Pavel Bandakov	Ivan Kublin: Russian Leonardo or the Slave of Clockwork?
Karl Grandin	Linnaeus's Apostles and Their Instruments
Klaus Hentschel	Life and Work of the Göttingen Instrument Maker Moritz Meyerstein (1808-82)
Alberto Meschiari	The Website and the First Volume of the National Edition of the Works and Correspondence of Giovanni Battista Amici (Modena 1786 - Florence 1863) Optical Instrument Maker, Astronomer, Naturalist

CHRISTOPHER MIDDLETON AND THE PRACTICE OF NAVIGATION, 1730-50

Jim Bennett

Museum of the History of Science
Broad Street, OX1 3AZ Oxford, UK

Keywords: navigation, instruments, north-west passage

Christopher Middleton is known in the history of voyages of discovery for his attempts to find a north-west passage and his explorations in Hudson Bay in 1741. But he deserves to be better know to historians of science for his marine-based natural philosophy and his concern for the development of navigation and its instrumentation. He was one of the first practical users of Hadley's quadrant but also tried out its rivals in a systematic way and published his results. At a time when seamen were – often unfairly – criticised for their conservative attitudes to navigational technology, Middleton was an enthusiast for innovation. He provides us with a valuable, comparative record, gained under real working conditions, of the competing instruments of the 1730s and 40s.

THE TRUE METHOD OF FINDING THE LONGITUDE AT SEA

Hans Hooijmaijers

Museum Boerhaave
P.O. Box 11280, 2301 EG Leiden, The Netherlands

Keywords: Zumbach de Koesfelt, horologium autobarum, longitude, clock

In 1714 Lothar Zumbach de Koesfelt (1661-1727) invented a *horologium autobarum*, a clock driven by its own weight. This clock should be accurate enough to calculate the longitude on a ship. Lothar presented the conditions for this clock in a publication: L. Zumbach de Koesfeld, *Vera methodus inveniendi longitudines marinas, ...* (Kassel 1715).

Lothar's son Conrad (1697-1780) revised the idea 35 years later and published it as well: Conrado Zumbag de Koesfelt, *Instrumentum novum seu horologium autobarum, ...* (Leiden 1749). This time the clock was actually made by the Leiden clockmaker Franciscus le Dieu. Although it did not pass the sea trials, the clock nevertheless stayed intact and is now part of the collection of Museum Boerhaave. The Zumbach clock is a unique and interesting example of a failing instrument that has survived.

The presentation will sketch the colourful lives of both father and son, the development of the clock and the tests at sea.

TOUCHED, CLEANED AND REPAIRED: EQUIPPING AND MAINTAINING TRADING VOYAGES TO THE BALTIC

Richard Dunn

National Maritime Museum
Greenwich, London SE10 9NF, UK

Keywords: instrument makers, Ripley, navigation

Although the sale of instruments by London makers, in particular those in the City and West End of London, is quite well documented, there has been relatively little work done on the makers and suppliers working near the docks in east London, and in particular on the more routine work of maintaining and repairing instruments.

This paper will look at Ripley & Son, an east London navigational instrument supplier who had a long-standing business relationship – from at least the 1780s to the 1820s – with a local shipping firm whose ships made voyages to destinations including the Baltic ports. Surviving evidence, including a significant group of bills, sheds light on Ripley & Son's day-to-day work of repairing and maintaining instruments, as well as on the navigational equipment typically used on trading ships making voyages between England and Eastern Europe in the early 19th century.

ANGELO TORNAGHI: MIGRATIONS OF A MATHEMATICAL INSTRUMENT MAKER

Julian Holland

P.O. Box 732, Ashfield, 1800 NSW, Australia

Keywords: Tornaghi, instrument maker, Sydney

Born in Italy in 1831, Angelo Tornaghi trained with Negretti & Zambra in London in the 1850s. He migrated to Sydney, Australia, in the late 1850s. There he became a prominent retailer of instruments and clocks, but he also made some specialist instruments for observatories, and erected numerous tower clocks on official buildings. He patented a simplified form of circumferentor. The paper will outline his life and career, and draw conclusions from his eventual bankruptcy.

Julian Holland has researched scientific instrument makers and retailers in Australia, particularly in the nineteenth century. He has worked in the Powerhouse and Macleay museums in Sydney and most recently was a Research Fellow at the National Museum of Australia in Canberra. Several of his papers are available on his website: http://members.optusnet.com.au/jph8524/

SCIENCE, SATIRE AND THE ARCHITECTONIC SECTOR

Stephen Johnston

Museum of the History of Science, University of Oxford
Broad Street, Oxford, OX1 3AZ, UK

Keywords: mathematical instruments, architecture

From the Renaissance onwards, architecture was typically classed as one of the mathematical arts and sciences. One of the foundations of its status as a learned discipline was an emphasis on the proportions and forms of the five classical orders.

England, though a latecomer to neoclassical architecture, nevertheless developed a unique response to architectural problems through practical mathematics. From the 1720s onwards (and in tandem with the vogue for Palladianism) there appeared a succession of designs of architectonic sectors.

These sectors embodied the proportions of the five classical orders and allowed them to be scaled to fit any architectural scheme. They were explicitly based on the existing pattern of the sector - a key instrument of practical geometry since the late 16th century - and they were made by such leading London mathematical instrument makers as Thomas Heath and George Adams.

Only a few examples of these instruments now survive. This paper both outlines their history and, more surprisingly, shows how the pattern published by Joshua Kirby in 1761 became embroiled in the art politics of the period. How did a seemingly recondite and specialist instrument become a symbolic device in the world of satirical prints swirling around William Hogarth?

V. TISTSCHENKO'S WORK IN "DRUZHNAYA GORKA" GLASSWARE FACTORY

Alexey Emelyanov

Russian Academy of Sciences
5 Universitetskaya nab., 199034 St. Petersburg, Russia

Keywords: laboratory glassware, formulae, Druzhnaya Gorka

Every chemist knows the celebrated "Tistshenko sklyankas" (vials) for flushing and drying gases. But it is less known that laboratory glassware used daily in our research, both in scientific and in technical laboratories in Russia, is produced in accordance with the formulae elaborated by the Russian chemist Vecheslav Tistshenko, one of the best Mendeleev's pupils. In 1896 he started his work for "Druzhnaya Gorka" glassware factory. The biggest factory producing laboratory glassware in Russia at the time, founded in1800, made laboratory and other glassware for universities and scientific institutions. Druzhnaya Gorka as well as the other European glassware factories made alkaline-lime glass. The best glass (Geraeteglas) was produced in O.Schott's factory in Jena. The glass was notable for its refractive properties, thermal- and acid- resistance. Having investigated that glass, V.Tistshenko found its weaknesses, e.g., solubility in NaOH and ammonia. He added cheap and harmless ingredients, e.g., boric anhydride. The experiments lasted 3 years. There had been approximately 400 findings, when they chose 3 specimens: Nos. 13, 23 and 24. Tistshenko collected charges for 28 specimens.Very soon that glass became very popular with Russian chemists, especially glass No. 23 which was used for all the laboratory glassware and electrical equipment (Roentgen's tubes etc). It was awarded a gold medal at the World Exhibition in Paris in 1900. After WW I, the Jena factory changed its formulae. In 1927 comparative research performed by the Druzhnaya Gorka factory showed that specimens Nos. 23 and 24 needed no improvement. V.Tistshenko also improved methods of producing glass for electric lamps, which had had knag and had been badly annealed.

IVAN KULIBIN: RUSSIAN LEONARDO OR THE SLAVE OF CLOCKWORK?

Vladimir Schurov[a)], Pavel Bandakov[b)]

*a) Nizhny Novgorod State University
7 Universitetsky Lane 603000, Nizhny Novgorod, Russia*
*b) Institute of Philosophy and Sociology, Polish Academy of Sciences
Nowy Świat 72, 00-330 Warsaw, Poland*

Keywords: Kulibin, Leonardo, horology

In the Russian language, the name of Kulibin is a common noun meaning “an able amateur mechanic” (the positive connotation with a bit of irony). Ivan Petrovich Kulibin was born in 1735 in Nizhny Novgorod – at that time a peripheral town, which just started to grow as a regional economic centre – into a family of old believers (the conservative branch of the Russian Orthodoxy). Ivan Kulibin became known as a watchmaker and designed the famous egg-shaped clock which was presented to Catherine II the Great. After that audience, Kulibin was appointed the keeper of the mechanical shop of the Academy of Science in Saint Petersburg. For more than 30 years Kulibin’s inventing activity was connected to the service at the Academy of Science. At the same time he kept designing various mechanisms and devices and organized fireworks and other performances at high society celebrations. In 1801 Kulibin went back to Nizhny Novgorod and the rest of his life was dedicated to designing boats (in particular paddle-boats and other mechanisms to improve shipping).

At first glance, the list of Kulibin’s inventions strikingly reminds us of the engineering works of Leonardo: arched bridge, self-propelled carriage, lantern, clock and many others. Kulibin, just like Leonardo, tried to engineer a *perpetuum mobile*. There are amazing coincidences and striking differences in the lives and activities of Leonardo and Kulibin: both of them never had any formal education (both were self-taught), both of them were geniuses, but finally they left completely different traces in the history of culture. Leonardo is unique representative of the humankind; whereas Kulibin is an unlucky inventor, who realized himself in his children and grandchildren (the ‘dynasty’ of mining engineers and artists), and left the myth of ‘Kulibin’.

B. Pipunyrov (in his book ‘The History of Watches: from the Ancient Time to Nowadays’) presents the diagram of growth of clockwork accuracy: Leonardo worked in the prehistoric period of the mechanical watch, whereas the time of Kulibin was between the introduction of the mechanical watch and the present (beginning of the 20^{th} century). Time and place had totally determined both the activities and further roles in the culture of those two people: the break of European culture and explosion of inventiveness created Leonardo, religious conservatism and strict clockwork canon (technological tradition) made Kulibin’s universal inventiveness absurd. At the same place, in Nizhny Novgorod, the science of the world level would appear only in 1937, when one of the Leonardo’s topics (clockwork pendulum) would be realized in the ‘theory of clock’ – nonlinear theory of oscillations (A. Andronov).

LINNAEUS'S APOSTLES AND THEIR INSTRUMENTS

Karl Grandin

Royal Swedish Academy of Science, Center for History of Science
Box 50005, SE-104 05 Stockholm, Sweden

Carl Linnaeus, the Swedish botanist of the 18th century, claimed that God's creation should be approached with the naked eye. Scientific instruments might be useful, but for reading the other book of the Creator – Nature – the naked eye was more in line with the religious context of Linnaeus' thoughts. Even though some instruments can be attributed to the activities of Linnaeus, there is no specific instrument one would typically connect with him, even though there are some instruments on display at the Linnaeus Museum in Uppsala.

What about his pupils then, who were sent out all around the world to collect rare plants or anything exotic, and report on the distant places and their customs? Did they have exclusive Linnaean assignments? Did they just bring their collecting boxes; their glass jars with spirits, and their botanical hand microscopes, or just their eyes? No, Linnaeus' pupils, or apostles as they were called, were sent out by the Royal Swedish Academy of Sciences. Linnaeus was of course the main instigator, but he had to rely upon his scientific colleagues and the institution to get the means and credits to pursue these expeditions. And it was not only Linnaeus that took an interest in the possibilities these travels promised, so did several of his colleagues. Since the pupils were to undertake such costly and dangerous travel, the idea was that they should produce as much science as possible during the different parts of their travels. On the long and tedious boat travel, for example, they dutifully pursued meteorological observations, examined the saltiness of the seawater and so on, as well as defended their position on board while acting as ship priests. Therefore depending on their destinations they brought several different instruments. We know of these from lists of instruments they signed for. However, it might not be surprising that almost none of these instruments survived, or are to be found, since a substantial number of the apostles never came back themselves. They perished from diseases around the globe.

This paper discusses some of their travels and the instruments they brought and what kind of findings they were able to derive.

LIFE AND WORK OF THE GÖTTINGEN INSTRUMENT MAKER MORITZ MEYERSTEIN (1808-82)

Klaus Hentschel

University of Berne
Flurstr 1a, CH-3014 Berne 22, Switzerland

The various precision experiments and metrological research of Carl Friedrich Gauß and Wilhelm Weber would be inconceivable without their network of helpers. Their instrument-makers were particularly the ones to put their ideas for new scientific instruments into material form, producing high-quality prototypes that upon successful completion of trials and further optimization were produced in small series and used in various locations, sometimes for several decades. This talk fits together diverse pieces of a biographical puzzle into a vibrant portrait of probably the most important of Gauß's mechanics: Moritz Meyerstein (1808-82). A brief sketch of the training of this youngest son of a Jewish merchant, the circumstances surrounding his taking residence in Göttingen 1833/34 and his professional ascent to a "Universitätsmechanicus & Maschinen-Inspector" there, is followed by a focus on his collaboration with Gauß on electric telegraphy and geomagnetic research. Various allusions in Gauß's correspondence concerning scientific and university matters attest to his high regard for his “able mechanic” and co-experimenter Meyerstein. Meyerstein's assignments concerning weight and length norms will be omitted since the present speaker will have covered this topic at the immediately preceding 2nd Conference of the European Society for the History of Science.

THE WEBSITE AND THE FIRST VOLUME OF THE NATIONAL EDITION OF THE WORKS AND CORRESPONDENCE OF GIOVANNI BATTISTA AMICI (MODENA 1786 – FLORENCE 1863) OPTICAL INSTRUMENT MAKER, ASTRONOMER, NATURALIST

Alberto Meschiari

Scuola Normale Superiore di Pisa
Piazza dei Cavalieri 7, 56126 Pisa, Italy
Head and curator of the G. B. Amici National Edition

Having given a talk on *Exchanges in science between Giovanni Battista Amici and European scientists* at the previous International Conference of the European Society for the History of Science, on this occasion I would like to present the first volume of the National Edition of his works and correspondence and the Internet site hosted by Scuola Normale Superiore di Pisa entitled *Giovanni Battista Amici. Optical instrument maker, astronomer, naturalist* (http://gbamici.sns.it), which was launched online in March 2006.

As both a scientist and instrument maker, Amici explored some of the main issues debated in the European capitals, such as the mechanism of fertilisation in plants and the means of improving the achromatic compound microscope. In many cases he provided answers and solutions that were soon adopted by others (for instance the immersion technique in microscopy).

In the presentation of the website, I will focus in particular on some of Amici's instruments, including the reflecting or catadioptric microscope, the improvements to his achromatic microscope, the double-image micrometer, reflecting and achromatic telescopes, and the direct vision prism. This will allow me at the same time to discuss some of Amici's relationships with European scientists.

SESSION IX

Calculating Machines and Computers as Scientific Instruments

Chairman: Roland Wittje

Larisa Brylevskaya	Prizes of the St-Petersburg Academy of Sciences: Joining of Efforts of Russian and European Inventors in Creation of Mechanical Calculating Machines
Theodore Lekkas, Aristotle Tympas	Ideologies of World Fair Classification and Display of Calculating Artefacts, 1851-1914
Allan Olley	Digitizing Measurement: Automating Scientific Table Making
Ola Nordal	GIER - a Computer Revolution in a Wardrobe. The Birth of Digital Computing at the Norwegian Institute of Technology in 1962.
Jos Uyttenhove, Danny Segers	Nuclear Electronics as a Pioneer in the Implementation of Minicomputers and Microprocessors in Laboratory Instrumentation

PRIZES OF THE ST-PETERSBURG ACADEMY OF SCIENCES: JOINING OF EFFORTS OF RUSSIAN AND EUROPEAN INVENTORS IN CREATION OF MECHANICAL CALCULATING MACHINES

Larisa Brylevskaya

St. Petersburg Branch of the Institute for the History of Science & Technology of Russian Academy of Sciences.
5 Universitetskaya nab., St. Petersburg 199034, Russia

Keywords: Russian Academy of Sciences, mathematical instruments

The most important reforms in the field of science and education, which in many ways predetermined further development of Russian science, were carried out in Russia in the first half of the 19th century. In this period, the state began to attract private capital to stimulate scientific and inventive activity. A great role in the stimulation of inventive activity was played by the Demidov prize (1831).

Diversity of forms of invention activity encouragement attracted Russian and European inventors to St. Petersburg. The first calculating devices presented to the Imperial Academy of Sciences were unfit for mass use, however even such projects included a number of interesting discoveries in mechanics and pure mathematics. The most interesting of those are the calculating instruments of Z. Slonimsky, I. Staffel, Kummer, V. Bunyakowsky, P. Tschebyschef. The mass production of calculating machines was launched at W. Odner's factories in St. Petersburg at the end of the 19th century. Some models of mechanical calculating machines can be seen in exhibitions at Russian museums. Some of the instruments were lost forever; the Archives of the Academy of Sciences preserve its descriptions.

IDEOLOGIES OF WORLD FAIR CLASSIFICATION AND DISPLAY OF CALCULATING ARTEFACTS, 1851-1914

Aristotle Tympas and **Theodore Lekkas**

Philosophy and History of Science Department, University of Athens
P.O. Box 55, Livadia 32100, Greece

Keywords: calculation, world fairs, classification, display, ideology

Instead of the assumption that the post-World War II analog-digital demarcation can be projected onto the previous history of computing without any qualification, we start with an historical introduction to the classifications of calculating artefacts that were actually employed before the 1940s. For a reliable index of such classifications, we then focus on how calculating artefacts were presented at World Fairs and International Exhibitions. We start with the famous Crystal Palace World Fair of 1851 and conclude with a 1914 World Fair at Edinburgh, the first devoted exclusively to calculating artefacts. Our study considers issues concerning the classification and display of calculating artefacts for a representative sample of World Fairs that took place in the intervening period.
We pay special attention to contrasting evaluations of calculating artefacts, including the one involving the slide rule and the calculating machine. As our argument goes, the two differed crucially in that the process of calculation as the slide rule and the calculating machine were fully visible and partially encased respectively. We further argue that this points to the existence of a long history of competing emphases on living and stored calculating labour, which prepared for the eventual hegemony of an essential analog-digital demarcation.
Our paper is based on research at World Fair archival collections that include materials such as organization committee documents, jury reports, catalogues of exhibitors, and visitor impressions. We were able to identify calculating artefacts under the classes of mathematical, philosophical and scientific instruments, as well as under various apparatus for various processes (e.g., measurement) and initiatives (e.g. electrification).

DIGITIZING MEASUREMENT: AUTOMATING SCIENTIFIC TABLE MAKING

Allan Olley

Institute for History and Philosophy of Science and Technology, University of Toronto
Room 316, Victoria College, 91 Charles Street West, Toronto, Ontario M5S 1K7, Canada

Key words: punch cards, scientific tables, automation

Wallace J. Eckert, Columbia University astronomy professor and IBM researcher, is best known for his pioneering work with calculating machines in the mid-twentieth century in celestial mechanics. However, Eckert also did extensive work with scientific tables. In the 1930s he developed techniques with punch card machines to reduce data for star catalogues, this also made the data machine readable and sortable. This work sped up and allowed the extension of important catalogues of stars. In 1940 Eckert became director of the Naval Almanac Office of the United States. In this position he automated the calculations used in the production of the Nautical Almanac's navigation tables using punched card machines. In the process proof-reading and typesetting were also automated. At the same time Eckert organized the publication of the new Air Almanac for airplane navigation. After joining IBM in 1945 Eckert directed work to create an automatic measuring engine of star positions on photographic plates, this was completed in the early 1950s. With this work Eckert began the digitization and automation of astronomical data that has subsequently allowed every greater quantities of data to be accumulated and analyzed. My paper will draw from published accounts of Eckert's work, supplemented by archival material, to summarize this work, its character and impact.

GIER – A COMPUTER REVOLUTION IN A WARDROBE. THE BIRTH OF DIGITAL COMPUTING AT THE NORWEGIAN INSTITUTE OF TECHNOLOGY IN 1962.

Ola Nordal

Department of Computer and Information Science
Norwegian University of Science and Technology
Bakkegata 11, 7014 Trondheim, Norway

Keywords: scientific computing, Norwegian Institute of Technology

How do you talk to someone about their computer needs when they don't know what a computer is? You get a computer and show them.

In late November 1962 the Norwegian Institute of Technology (NTH) in Trondheim got its first digital electronic computer. The machine was Danish, fully transistorized, answered to the name GIER, and looked like a wardrobe. But nevertheless, it brought along a computing revolution at NTH.

GIER is an interesting piece of equipment. Not only because of its funny design, rudimentary hardware or elegant software – but also because its main mission at NTH turned out to be not so much to compute, as to persuade the slightly archaic engineering school that they stood on the brink of something that forever would change the way research was done. This paper will sketch out how the GIER computer and the Computing Centre at NTH quite successfully established digital computing as a research tool at NTH.

The GIER computer is now the key object in the historical computer collection at the Norwegian University of Science and Technology (NTNU) in Trondheim.

NUCLEAR ELECTRONICS AS A PIONEER IN THE IMPLEMENTATION OF MINICOMPUTERS AND MICROPROCESSORS IN LABORATORY INSTRUMENTATION

Jos Uyttenhove and Danny Segers

Ghent University - Museum for the History of Sciences
Krijgslaan 281 (S-30), B-9000 Ghent, Belgium

Key words: nuclear electronics, instrumentation, computers, microprocessors

Nuclear physics has been always in the frontline of innovation in instrumentation. The ingenious apparatus developed by P. and M. Curie to identify and measure the properties of radium is a striking example of this statement. During the Second World War (1940-45) the "Manhattan Project" (Los Alamos) gave a boost to nuclear instrumentation and electronics.
The first computers (electro-mechanical and vacuum-tube types) were primarily used for military calculations but very soon made an appearance in large (nuclear physics) laboratories like CERN (Geneva). The availability in the 1960s of "mini"-computers like the PDP8 had a tremendous impact. Modular computer based systems like CAMAC became a standard in large (nuclear) laboratory environments. A few years later, microprocessors (8080, 6502, Z80, etc.) allowed built-in local calculating and control power.
A spectacular example of the innovations introduced by the intensive use of computers in large nuclear physics institutions is the World Wide Web, developed at CERN around 1990.
In this paper, the impact of computers on instrumentation is illustrated in the nuclear case, but the same kind of evolution occurred with a small delay in many other fields of instrumentation (medical, space).

SESSION X

Study Through the Replica, Virtual Experiments

Chairman: Gudrun Wolfschmidt

Efthymios Nicolaidis	The Project Organothea - 19th - 20th Century Instruments and Virtual Experiments
Steven Turner	Opening a Window to the Past: James Smithson and the Chemical Blowpipe
Marvin Bolt	Databases for Instruments and Makers: Two Examples
Peter Heering	Materialised Skills and Strange Encounters: Experience from the Practice with Solar Microsopes
Danny Segers, Jos Uyttenhove	The Working of Einstein's "Maschinchen" Studied with the Help of a Replica

THE PROJECT ORGANOTHEA – 19TH - 20TH CENTURY INSTRUMENTS AND VIRTUAL EXPERIMENTS

Efthymios Nicolaidis

National Hellenic Research Foundation
Vassileos Constantinou 48, 11635, Athens, Greece

Keywords**: 19th-20th century, online experiments, physics, astronomy**

Historical scientific instruments contribute to two fields of knowledge: history of science and today's science and technology. Indeed, by presenting the instruments of the main experiments which have contributed to building contemporary scientific and technological knowledge and by giving information on these experiments and their use by scientists, we can help find a better understanding of S&T developments and also make S&T friendlier to non-professional public. Indeed, by giving information -in a user-friendly way- on the tools used for its development, science is not any more perceived as an *ad hoc* system of knowledge, but as an achievement of human craftsmanship and thinking. This can contribute to the future of science itself, involving young people in studies of physics (which is more and more abandoned today, see statistics of European Physical Society) and bringing the non-professional public to support European scientific effort.

ORGANOTHEA project aims to gather the already existing digitalised information (at a European scale) on scientific instruments of physics and astronomy of the 19th and 20th century, in order to present it in an educational way to non-professional and professional users. The Project aims to construct a multilingual website presenting interactive experiments and *in situ* virtual presentation of Observatories and Physics laboratories.

The website target groups are the following users:
- Secondary level education science teachers
- Secondary school pupils and higher education students
- Public interested in the history of science and technology
- Historians of science and scientists
- Collectors and historical scientific instrument dealers

This website aims to be complementary to the important scientific instruments on-line data bases already existing (e.g., the Online Register of Scientific Instruments of Oxford, the multimedia catalogue of the Museum of History of Science in Florence, the virtual laboratory of Max Planck Institute in Berlin etc) by providing another kind of information.

The main characteristics of ORGANOTHEA website are:
-The extensive presentation of the main instruments of Physics and Astronomy of the 19th-20th centuries.
-The interactive experiments provided for each type of instruments.
-The *in situ* presentation of instruments (especially for Observatories).
-The multi-level information on scientific instruments for various categories of users: information on the use, history and the contribution of scientific instrument to S&T developments.
-The multilingual aspect (11 languages).

OPENING A WINDOW TO THE PAST: JAMES SMITHSON AND THE CHEMICAL BLOWPIPE

Steven Turner

Smithsonian Institution NMAH, mrc 627
P.O. Box 37012, Washington, DC 20013-7012 USA

Keywords: Smithson, blowpipe, research

As museums compete for audiences (both virtual and live), research projects that produce "product" are increasingly attractive to funders. In particular, projects that replicate historic science are likely to receive support. The speaker will describe his inadvertent venture into the world of science re-creation.

DATABASES FOR INSTRUMENTS AND MAKERS: TWO EXAMPLES

Marvin Bolt

Adler Planetarium & Astronomy Museum
1300 S Lake Shore Dr Chicago, 60605 Il, USA

Keywords: instrument databases

The Adler hosts two instrument databases for general use. The first, older one comes from the efforts of Roderick and Marjorie Webster, who visited numerous collections and gathered information on instrument makers. We have developed a more powerful web interface, and solicit input for how to keep this resource useful. A recently developed database summarizes data concerning optical properties of refractors made prior to 1825. Its goal is to increase understanding of early telescopes by gathering critical information about them.

MATERIALISED SKILLS AND STRANGE ENCOUNTERS: EXPERIENCES FROM THE PRACTICE WITH SOLAR MICROSCOPES

Peter Heering

University Augsburg
Universitatstr. 1, 86159 Augsburg, Germany

Keywords: solar microscope, replication method, popular science, visual culture

During the SIC meeting in Dresden, I presented a workshop report on my project in which I attempted to analyse visual practice with the solar microscope. In doing so, I relied on the first experimental experiences I made in working with original instruments from the collection of the Deutsches Museum Munich.

In my talk I am going to discuss two aspects that had not been developed until after the presentation of the workshop report. In the first part I am going to discuss some technical developments in the solar microscope. In doing so, I will relate them to the findings that result from the examinations of still existing instruments as well as to practical experiences I made working with the two instruments in Munich.

In the second part I am going to discuss the visual appearance of the images and their difference towards common microscopic experiences. In doing so, I am attempting to relate my observations in reconstructing solar microscope demonstrations with historical accounts. The aim of this analysis is to develop an understanding of the status of the solar microscope and the practice that was related to the device towards the end of the eighteenth century.

THE WORKING OF EINSTEIN'S "MASCHINCHEN" STUDIED WITH THE HELP OF A REPLICA

Danny Segers[1, 2] and Jos Uyttenhove[2, 1]

1) Department of Subatomic and Radiation Physics, Ghent University
Proeftuinstraat 86, B-9000 Ghent, Belgium
2) Museum for the History of Sciences, Ghent University
Krijgslaan 281 (S30), B- 9000 Ghent, Belgium

Keywords : scientific instruments, electricity, Einstein, replica

Einstein, while a theoretical physicist, also contributed to practical realisations. One such instrument he invented and constructed together with the Habicht brothers was his "little machine," usually called his "Maschinchen." The intention was to measure small electrical potentials. Although Einstein proposed it as "a new electrostatic method to measure small quantities of electricity," the method was not new. As far as we know only three original "Maschinchen's" still exist. It is out of the question to perform tests with those originals, so a replica had to be built.
The physical principles on which the device is based, namely a charge amplification process, will be explained. Numerical simulations of the charge amplification will be presented. From this the equilibration time of the instrument is estimated and compared with values from the literature.
A replica of the instrument with six stages was built and tested with modern electronic measuring devices (with high input impedance). The first experimental results will be presented. The working principle of the Maschinchen is illustrated and tested with the help of the replica.
For our replica, the voltage amplification factor for each stage was about 2.8. The quality of the spring contacts and the contact bounce introduce some limitations so that the replica works perfectly only for input voltages higher than 30 mV. Possible improvements will be proposed.

Acknowledgement:
Filip Van Auwegem[1)] is thanked for the mechanical construction of the replica.

SESSION XI

Conservation and Dating of Scientific Instruments

Chairman: Peter Plaßmeyer

Krzysztof Mroczkowski, Piotr Łopalewski	Preservation of the Aviation Technology Artefacts in the Polish Aviation Museum
Sven Hauschke	Signs and Signatures on Scientific Instruments of the 15th to the 17th century. The Contribution of Instrument Makers, Patrons and Collectors
Richard Paselk	Craft Knowledge in Understanding Scientific Instruments

PRESERVATION OF THE AVIATION TECHNOLOGY ARTEFACTS IN THE POLISH AVIATION MUSEUM

Piotr Łopalewski, Krzysztof Mroczkowski

Polish Aviation Museum, Al. Jana Pawła II 39, 30-969 Krakow, Poland

Among the technical museums, those which are devoted to aviation, are something very special. Their task includes accumulation and securing of artefacts as well as the research and propagation of the technological progress typical of the each period, concerning various domains – thus teaching us the history of civilisation. Aviation is the zone combining technology and the humanities, which places it unquestionably within the historic process.

The activity concerning preservation of the aviation technology artefacts is a relatively young tendency among world museums, although several aviation exhibitions accompanied the development of aeronautics from the very beginning. It is difficult, however, to compare the term "aviation museum" of those days with 21st century standards.

Since its early days the Polish Museum conducts restoration activity within its statutory duties. The conservation programmes for the oldest part of the collection were introduced during the 80s. The outcomes of this work are two permanent exhibitions. One of them displays the restorer's accomplishments, while the other shows one of the most important milestones of mankind in pristine condition.

These exhibitions became the opportunity to display – for wide domestic and foreign audiences – the aircraft awaiting restoration for many years and never seen in public before. The specificity of this rare birds exhibition makes the 60-year old collection one of the leading museum events. The exhibition includes several aircraft ranging from the pioneer period up to the latest research studies, showing the development of aviation technology in Poland and all over the world.

The exhibition trends existing worldwide among the aviation museums do favour displaying the totally restored aircraft. However, since the end of the 20th century some changes in approach to "destruct display" can be perceived. Several museums all over the world have started showing the aircraft in their natural condition – just like they were found in the peat bog or under the water (or salvaged from bombs and fire during the war).

This way of presentation allows the museum to create an authentic atmosphere for the spectators.

SIGNS AND SIGNATURES ON SCIENTIFIC INSTRUMENTS OF THE 15TH TO THE 17TH CENTURY. THE CONTRIBUTION OF INSTRUMENT MAKERS, PATRONS AND COLLECTORS.

Sven Hauschke

Germanisches Nationalmuseum Nürnberg
Kornmarkt 1, D-90402 Nürnberg, Germany

The paper deals with the authorship and provenance of scientific instruments. The discussion will focus on documented objects made between the 15th and the 17th century. Often essential information can be read directly from the instruments: there are engraved coats of arms, inscriptions, monograms and dates, which are an integral part of the instrument. Sometimes, although not very often, we have written sources like inventories or correspondence about particular instruments.

Signs, signatures and inscriptions on instruments will be classified and analysed. The examination of these sources should reach beyond the question, whether a person mentioned on an instrument was the owner, the donor, the inventor or the maker. What is the social background of the people mentioned on instruments? Is it only coincidence that they were often clergymen and medics? Some inscriptions give hints that instruments and their owners travelled widely throughout Europe. Many instruments reveal that the links between Hungary, Poland and Germany were already very close in the 15th century.

Furthermore some words and phrases of signatures should be reconsidered. For instance, is there only one meaning for the Latin expression ”faciebat,” who was the “auctore” of an instrument and why did the English instrument maker Humphrey Cole use so many different ways to name his origin?

The paper will present some considerations about a larger project on signs and signatures not only on scientific instruments, but on works of art as well.

CRAFT KNOWLEDGE IN UNDERSTANDING SCIENTIFIC INSTRUMENTS

Richard A. Paselk

Robert A. Paselk Scientific Instrument Museum
Humboldt State University, Chemistry Department
1 Harpst Street, Arcata, California 95521, USA

Davis Baird notes that the "working knowledge" of scientists and technologists involves an understanding of materials and craft skills to make, modify and use instruments. In my presentation I will first illustrate/explore some aspects of this "working knowledge" in the making of re-creations of early instruments such as navigational tools and astrolabes. These devices have an advantage for my discussion in that their manufacture and use require relatively simple techniques and accessible levels of craftsmanship. In my own work I have explored the uses of different materials, tools and techniques. The choice of wood versus metal for a given instrument involves both economics (both in terms of the cost of the materials, and the cost of labor) and desirable characteristics (e.g. stability, density, workability, etc.). Understanding a particular instrument often requires knowledge of tools, techniques, craft traditions, labor costs etc. available to its maker. A fine polish may be for beauty and patronage or strictly functional. A craftsman's choice of incising, engraving, stamping or etching may result from tradition, skill, patronage or function.

My second focus involves a series of questions: How can multiple audiences—science historians, educators, museum professionals, philosophers etc.—gain a feel for the world of the instrument maker? Are there base sets of skills that we as a community could explore in a workshop setting? If so how might we create effective, practical workshops, perhaps at future SIC.

POSTER SESSION

Viorel Ene, Elena Helerea, Tibor Bedö, Marius Bența
The Time Measuring Instruments in Medieval Brasov - Technical, Social and Historical Aspects

Staffan Andersson, Urban Josefsson, Ing-Marie Munktell, Cecilia Ödman
The Uppsala Cabinet of Physics

Magdalena Pilska-Piotrowska, Małgorzata Czupajło
The Astronomical Instruments of the 19th Century in the Collection of Nicolaus Copernicus Museum in Frombork

Josep Batlló	Seismoscopes in Spain. Another Instrumental Seismology.
Maciej Kluza	From West to East; Gustaw Gerlach (1827-1915)
Maciej Kluza	From East to West; Adam Prażmowski (1821-1885)
Inge Keil	Georg Friedrich Brander (1713-1783), Mechanicus in Augsburg and the King of Poland, Stanislaw August Poniatowski
Michael T. Wright	The Developement of the Dividing Engine: Lucky Mr Ramsden

THE TIME MEASURING INSTRUMENTS IN MEDIEVAL BRASOV - TECHNICAL, SOCIAL AND HISTORICAL ASPECTS

Viorel Ene, Elena Helerea, Tibor Bedö, Marius Bența

Transilvania University of Brasov
29 Eroilor Str, Brasov, 500036, Romania

Key words: tower clock, hour bell, exterior and interior profile, methods of calculus

Over time **HUMANS** have learned that they are dependant on an irreversible "flow" of the phenomena that make their existence perishable, and give it a "transient" character; it is the human beings that search for a rational understanding and measuring of time.
The design of a time measuring "machine" was, without doubt, the strangest invention ever made. The time was captured in the clock and, serving as a substitute for nature, the human being kept it under control.
Not long after the 13th century, the tower clocks came out and subsequently the clockmakers guilds were developed all around Europe. Around 1450, tower clocks were assembled on the external walls of towers. After a series of continuous improvements, in about 1675, time measurement became more precise; subsequently it was **TIME** itself to be measured.
The paper presents briefly some evolutionary aspects of distinct time measuring techniques throughout the development of **HUMAN** society, while emphasizing the way the passing of time is marked in historical Brasov by the tower clocks of the main architectural and religious buildings that existed or still exist here. The paper reveals specific data by making reference to the evolution of the **Braşov Council House Tower Clock** from its origin to the present day, using various historical sources.
Special note is given to the original aspects relevant to the present tower clock with regard to its structure and evolution, beginning in 1877 to the present day, showing it together with its component parts.
The paper takes a close approach to the hour bell (the bell striking the hour) incorporated in the Council House Tower of Brasov. The first hour bell, dating back to 1520, broke down after the great fire in 1689. In 1690, a new bell was cast which still exists today. For this bell there were made determinations of the analytical equations of the curves of the exterior and interior profile, as well as its thickness in longitudinal section. The calculations were based on specific measurements as well as on graphical and graphical - analytical methods (respective time), as well as on the constructive diagram created by the Knabbe – Nystrom method.
By comparing these classic methods of calculus, the conditions of a computer were created – aiding calculation attempting to determine the variation functions of the curves of the exterior and interior profile of the bell on the basis of correlation and regression method.

THE UPPSALA CABINET OF PHYSICS

Staffan Andersson[a,b], Urban Josefsson[b], Ing-Marie Munktell[b], Cecilia Ödman[b]

a) Department of Physics, Uppsala University, box 530, S-751 21 Uppsala, Sweden
b) Museum Gustavianum, Uppsala University, Akademigatan 3, S-753 10 Uppsala, Sweden

Key words: historical instrument collection

The Uppsala Cabinet of Physics is a collection of historical physics instruments. It was founded in 1739 and formed the basis for the new physics department at Uppsala University. This reflects a general change toward a more practical attitude regarding science in Sweden.

The initial purchases were made in London on the initiative of Samuel Klingenstierna, Professor of Mathematics. Of particular interest to Klingenstierna were optical instruments, but the collection also included instruments from other fields. Klingenstierna later became the first Swedish professor of modern physics.

The professors following Klingenstierna enlarged the collection, especially in the fields of electricity and magnetism. Many instruments were ordered from England, Germany and France. Others were manufactured locally.

The importance of the Cabinet of Physics for both education and research decreased during the middle of the 19th century. This was partly due to the introduction of practical laboratory work for students. Instead of being an everyday tool for scientific work at the department, the Cabinet of Physics transformed into a historical collection.

Today the instrument collection is on display at Museum Gustavianum, the university museum in Uppsala. This collection is also the focus for a modern collaboration between the physics section at the university and the museum with research, scientific lectures and interactive experiments for visitors.

THE ASTRONOMICAL INSTRUMENTS OF THE 19TH CENTURY IN THE COLLECTION OF THE NICHOLAUS COPERNICUS MUSEUM IN FROMBORK

Magdalena Pilska-Piotrowska, Małgorzata Czupajło

Muzeum Mikołaja Kopernika we Fromborku
Katedralna 8, 14-530 Frombork, Poland

Key words: Frombork, Copernicus, 19th century refractors

The collection of astronomical instruments of the Nicholaus Copernicus Museum in Frombork consists of three 19th century refractors: the Bamberg transit instrument, the Sendter telescope (diameter of objective 12.5 cm, focal length 2.7 m), and refractor (diameter of objective 25 cm) made by A. Repsold und Söhne company. Apart from the refractors there are reconstructions of the Copernicus instruments (quadrant, parallactic ruler and armillary astrolabe) made under Dr. Tadeusz Przypkowski's direction based on descriptions by Copernicus in the *De Revolutionibus*. The collection is enriched also by reconstructions of telescopes which were used for sunspot observations; the instruments were designed in the Jesuit college in Kalisz at the beginning of the 17th century.

SEISMOSCOPES IN SPAIN. ANOTHER INSTRUMENTAL SEISMOLOGY.

Josep Batlló

Observatori de l'Ebre. CSIC
c. Horta Alta 38, E-43520 Roquetes, Spain

Key words: seismoscope, Spain, seismic instrumentation, Manila Observatory

It is usual to think about instrumental seismology as a part of seismological sciences directly related with the use of seismographs and the analysis of their records. But seismographs are not the only instrument giving us indications of an earthquake. Among others, seismoscopes were common instruments at the beginning of instrumental seismology (2nd half of the 19th century – early 20th century). They can be defined as instruments giving some kind of indication an earthquake has occurred; but not giving any record of it. Nowadays, it is not easy to define a clear line separating seismoscopes and seismographs.

At first, priority was given to these kinds of instruments over more sophisticated seismographs due to scientific and technical limitations. But, later, they kept their popularity and continued to be used at seismic observatories as early warning instruments giving indication of an earthquake. In fact they were used in the same way as the more sophisticated early seismic detection and alarm systems.

Present research, a continuation of other work presented previously about seismographs in Spain, analyzes the seismoscopes used in Spain and its colonies, also the different types and uses. The number of instruments located has been rather larger than expected. They were used in many seismic observatories and also in other places as independent instruments. In chronological order, the first one is located is in a Manila observatory, dating from around 1865, and the last one as late as in the fifties of the XX century.

FROM WEST TO EAST; GUSTAW GERLACH (1827-1915)

Maciej Kluza

Jagiellonian University Museum
Jagiellońska 15, 31-010 Krakow, Poland

Gustaw Gerlach (1827-1915) was born in Thuringia. Before he came to Warsaw, he had worked in several workshops in Dresden, Leipzig and Berlin producing mathematical and physical instruments. In Poland he worked in a small factory founded in 1816 by Józef Migdalski, mechanician of the Warsaw University. After the death of the second owner of the factory,Gustaw Groth, Gerlach helped the widow run the factory, and he finally bought it in 1852. He developed the firm, which remained one of the major suppliers of surveying instruments in Russia. The firm was given awards during several Russian National Exhibitions in Warsaw, Moscow and St. Petersburg. Additionally, in recognition of its production quality, the Gerlach factory obtained the right to put the Tsar's coat of arms on its products. The factory operated until 1944, when it was destroyed during the Warsaw Upraising.
The history of the factory, the biography of Gerlach as well as examples of products will be presented.

FROM EAST TO WEST; ADAM PRAŻMOWSKI (1821-1885)

Maciej Kluza

Jagiellonian University Museum
Jagiellońska 15, 31-010 Krakow, Poland

Adam Prażmowski (1821-1885) was born in Warsaw. From 1839 until 1866, he worked in the Warsaw Observatory, conducting meteorological and astronomical observations. In 1860 he lectured in physics at the Medical School and in the reopened University of Warsaw. After the uprising of 1863 in Poland, he had to leave the country and he settled in Paris. In 1865 Hartnack employed him as a simple worker. In a short time Prażmowski became a partner of Hartnack and after 1871 he bought out Hartnack and remained owner of the factory.

He started to develop his skills in the construction of scientific instruments during his work in the Warsaw Observatory. Due to a lack of funds, the observatory was very poorly equipped. Prażmowski organised a workshop in his private apartment to build and repair instruments and lenses for the observatory. In Paris he designed or improved several instruments, such as a new polarising prism, a new type of saccharimeter, polariscope, heliograph and heliostat.

Prażmowski also had significant achievements as a scientist. During the total eclipse of 1860 he discovered a polarisation of the solar corona. In 1852-3 he measured a meridian between the Arctic Sea and the Danube delta.

GEORG FRIEDRICH BRANDER (1713-1783), MECHANICUS IN AUGSBURG AND THE KING OF POLAND, STANISLAW AUGUST PONIATOWSKI

Inge Keil

Reisingerstr. 6, D96159 Augsburg

Georg Friedrich Brander settled in Augsburg in 1734 and became the best known instrument maker in Germany during the years that followed. He had many connections all over Europe. Starting in about 1766, he sold different instruments to Stanislaw August Poniatowski (reigned 1764-1795). In 1767 Brander dedicated the description of his "new geometrical universal surveyor´s table" to the Polish king because the king wanted to order a survey of his kingdom.

Illustrations of the instruments sold to Warsaw will be shown.

THE DEVELOPMENT OF THE DIVIDING ENGINE: LUCKY MR RAMSDEN

Michael T. Wright

Centre for the History of Science, Technology and Medicine (CHoSTM)
Room S223B, Level 2,Central Library, Imperial College, London SW7 2AZ, UK

Keywords: graduation, sextant, workshop, design, longitude

Ramsden developed the circular dividing engine in response to the need to supply instruments for finding longitude at sea by the Method of Lunar Distances. These instruments had to be compact and light, but had also to measure angles with great precision. It proved impossible to divide a scale of sufficiently small radius to the necessary precision by hand. Mechanization offered a solution to this problem.

Ramsden was not the first man to try making a dividing engine, and elements of his solution were borrowed. Even so, his first attempt was astonishingly naïve for a man celebrated as a designer of fine and innovative instruments; and, while it found low-grade uses in the workshop, it was a failure for the intended purpose.

The second engine did succeed. Comparison with the first reveals the hand of a man who could build on the inadequate design, modifying it boldly – and expensively – in the light of experience.

Even so, the design of Ramsden's second engine remained improvised and irrational. Its detail was clearly not worked through beforehand; it merely evolved. The limitations of the workshop also played a part in the final outcome.

As so often, we must distinguish between the superb products of the instrument-maker's workshop and the almost shamefully improvised means by which they were produced.

In connection with this study, the author seeks information on sextants and similar instruments, from the period c.1770 – c.1810, in participants' collections.

INDEX OF AUTHORS OF PAPERS AND POSTERS: