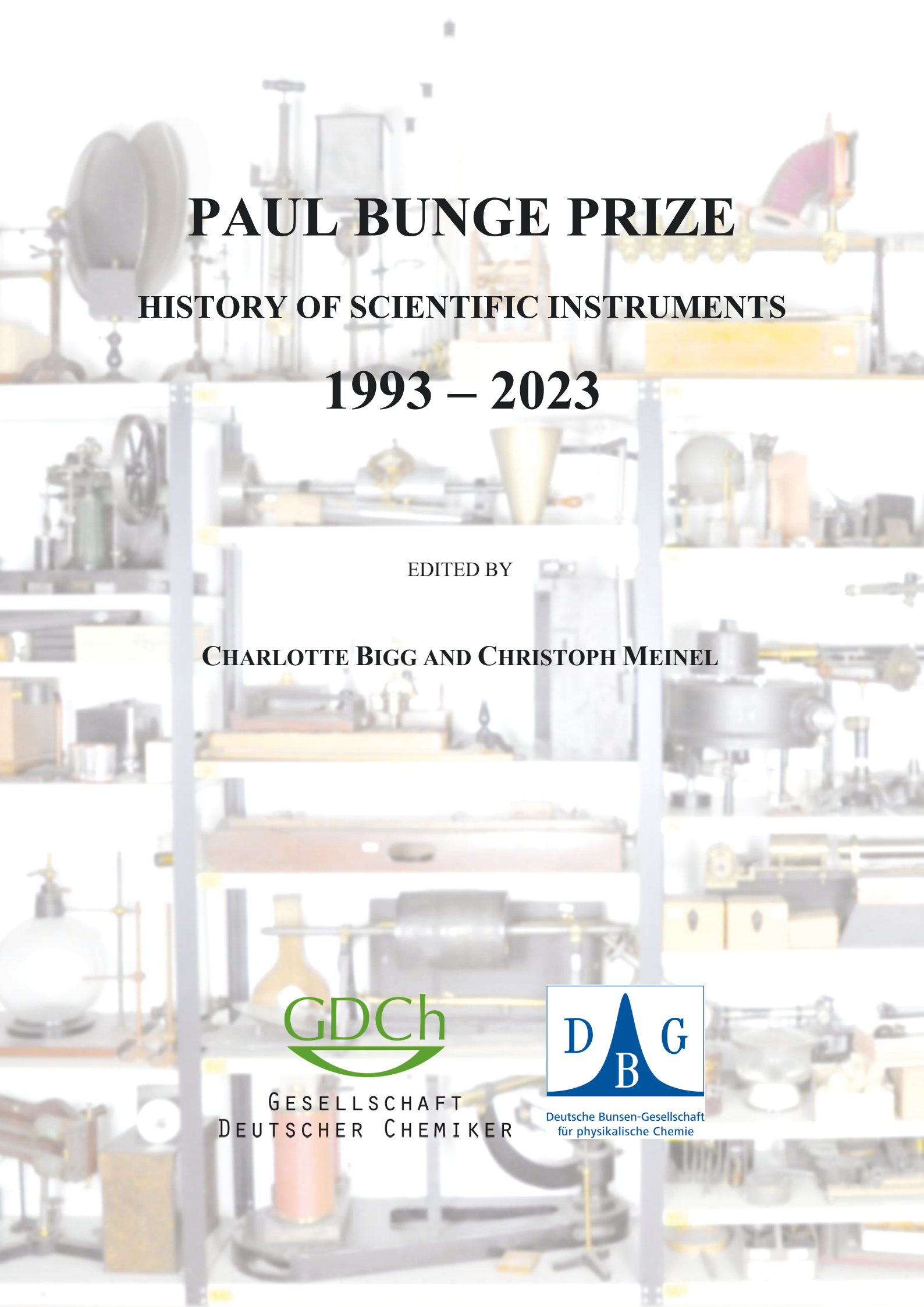

PAUL BUNGE PRIZE

HISTORY OF SCIENTIFIC INSTRUMENTS

1993 – 2023

EDITED BY

CHARLOTTE BIGG AND CHRISTOPH MEINEL

GDCh
GESELLSCHAFT
DEUTSCHER CHEMIKER

DBG
Deutsche Bunsen-Gesellschaft
für physikalische Chemie

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PREFACE

In 2023, the Hans R. Jenemann Foundation will celebrate the 30th anniversary of the Paul Bunge Prize, an award that recognises exceptional work on the history of scientific instruments. To mark this momentous occasion, the Foundation invited all living prize winners to the Deutsches Museum in Munich to discuss the current state of the art and future perspectives of "Writing the History of Scientific Instruments."

Given the significant contribution made by the Hans J. Jenemann Foundation and the Paul Bunge Prize to the recognition and development of the history of instruments, which only emerged in the 1980s, we deemed it fitting to provide a concise overview of how the foundation came into being, the founder's ambitions and motives, and the prize recipients. Although the institutions involved no longer possess archival documents from the early days, we were able to reconstruct this history from the advisory board's personal files. We also sought to provide a platform for the prize winners to share their perspectives, and asked them to reflect on the state of the field when they entered it or received the award, the impact of the prize on their work, and the evolution of the research field since then. Their insightful responses are gathered in the third part of this brochure.

We would like to take this opportunity to express our heartfelt gratitude to the Gesellschaft Deutscher Chemiker (GDCh), which has overseen the Hans J. Jenemann Foundation since 1992. We extend special thanks to Dr. Jasmin Herr, who administrates the prizes and awards, and Volker Kilz, GDCh's Commercial Director, for their continuous and lasting support.

For three decades Gesellschaft Deutscher Chemiker and Deutsche Bunsengesellschaft für Physikalische Chemie have alternately opened their annual meetings to offer a representative setting for the Paul Bunge Prize award ceremony – always a great opportunity to bring scientists and historians together. Academic specialisation makes such encounters rare, so we are all the more grateful to both societies for providing us with such a forum.

We would also like to expressly thank the distinguished colleagues in the advisory board of the Hans R. Jenemann Foundation who acted, and still act, as delegates of these two scientific societies. To cooperate with them has always been stimulating and pleasant.

In preparing this historical report Dr. Thomas Allgeier of the Jenemann Archive Project kindly provided pictures and information about the fate of Hans Jenemann's collection of analytical balances.

A very special thank you goes to our sponsor, Mettler-Toledo GmbH, Gießen, who – aware of the company's historic role in bringing the Foundation into being – supported the printing and distribution of this volume in a generous way.

Finally, we wish to express our gratitude to the Deutsches Museum for kindly offering the perfect venue for the anniversary conference, and to our friend and colleague Prof. Helmuth Trischler for making this possible.

Munich, May 2023 Charlotte Bigg and Christoph Meinel

A History of the Hans R. Jenemann Foundation, 1990 – 2023 and the Paul Bunge Prize, 1993 – 2023

Instruments are among the most significant tools of knowledge production for modern science, yet they have only recently begun receiving the attention they deserve from historians. In 1980, the historian and sociologist of science Derek J. de Solla Price remarked that the "blatant and naive insistence that scientific instruments arose as tools for measurement" was due to the erroneous view that natural science was primarily concerned with ideas, instruments being merely "tools of the scientist for the very practical purpose of making measurements and testing hypotheses by experiment."[1] This realisation opened questions about the relationships of instruments to experimental practice, knowledge construction, and theory building, as well as the social and economic contexts in which these artefacts and related practices are situated.

Since the mid-1980s, the historiography of science has contributed a wealth of excellent and methodologically innovative studies on these topics. The analytical chemist Hans Jenemann (1920–1996), a collector of balances and primarily interested in their technical details, must have been aware of this growing interest when he established an eponymous foundation specifically aimed at "the promotion of scholarship and research in the field of the history of scientific instruments." The Paul Bunge Prize awarded by the foundation is the only award of its kind worldwide.

The Hans R. Jenemann Foundation was established on 3rd June 1992.[2] It is held in trust by the German Chemical Society (GDCh) and the German Bunsen Society for Physical Chemistry (DBG). Since 1993, the foundation has awarded the Paul Bunge Prize[3] on an annual basis to honour outstanding completed work on the history of scientific instruments. It is the most highly endowed award in the field of the history of science, initially coming with DM 10,000, later DM 15,000 or € 7,500. It is named after the Hamburg precision mechanic and engineer Paul Bunge (1839–1888),[4] who set new standards in balance construction by inventing the short-arm analytical balance. This innovation significantly reduced the time needed for weighing processes. Other innovations introduced by Bunge included the 'rising' arrestment, the compensation suspension, the autocollimator reading, and the single-pan two-knife edge substitution balance with unequal arm lengths. Bunge was also responsible for making delicate balances for the Bureau International des Poids et Mesures in Paris, used to calibrate the kilogram standards according to the metre convention of 1875.

The Foundation's mission is to honour great achievements in the history of scientific instruments in the broadest sense. Books or articles published in German, English or French within the previous 3–10 years can be submitted. Alternatively, the prize can also be awarded for lifetime accomplishments.

[1] Derek J. de Solla Price, "Philosophical mechanism and mechanical philosophy: Some notes towards a philosophy of scientific instruments", *Annali dell'Istituto e Museo di Storia della Scienza di Firenze* 5 (1980), 75-85.

[2] <https://www.gdch.de/fileadmin/downloads/GDCh/Preise_und_Auszeichnungen/PDF/jenemann20.pdf>.

[3] <https://de.wikipedia.org/wiki/Paul-Bunge-Preis and https://en.wikipedia.org/wiki/Paul_Bunge_Prize>.

[4] Hans R. Jenemann, „Paul Bunge und die Fertigung wissenschaftlicher Waagen in Hamburg", *Zeitschrift für Unternehmensgeschichte* 31 (1986), 117–140 and 165–183.

Hans R. Jenemann (1920–1996)

Hans Richard Jenemann was born in Mainz on 10th March 1920. He passed his Abitur in 1938. After seven years spent in the Reich Labour Service and in the army, he was a Soviet prisoner of war until 1950. For this reason he could only begin his chemistry studies at the age of 30, which he completed with a diploma after seven semesters. Jenemann's academic teacher was Wilhelm Geilmann (1891–1967), professor of analytical chemistry at the Johannes Gutenberg University in Mainz, one of the "last masters of dry analysis",[5] and the first recipient in 1962 of the GDCh's Fresenius Prize.

From 1953, Hans Jenemann worked as an analyst at the Jena glassworks Schott & Gen., a leading manufacturer of specialty glasses located in Mainz. Over time, he became the head of the wet chemical analytical laboratory and was responsible for building up the training program for chemical and physical laboratory assistants. In 1982, Hans Jenemann ended his professional career at Schott & Gen. He passed away on 5th December 1996.

Hans Jenemann displaying his collection in Hoechst, June 1976
(private photo, courtesy Thomas Allgeier, Jenemann Archive Project)

In 1975, Hans Jenemann embarked on the study of historical balances. Two years later, on the occasion of the 125th anniversary of Bosch-Wägesysteme GmbH in Jungingen, his first historical publication[6] appeared, followed by a survey entitled *Die Waage des Chemikers*[7] (The Chemist's Balance). Ultimately Hans Jenemann authored 70 works on the history of both analytical and commercial balances. His private collection of about 300 historical balances and related source literature was impressive. In 1996, the year of his passing, the Scientific Instrument Society appointed him an honorary member for his studies on scientific instruments. Hans Jenemann's passion for collecting began during a time when electronic single-pan balances

[5] Helmut Bode and Fritz Strassmann, „Zum 60. Geburtstag von Prof. Dr. W. Geilmann", *Fresenius' Zeitschrift für analytische Chemie* 133 (1951), 1–3.

[6] Hans R. Jenemann, „Eine kurze Entwicklungsgeschichte der wissenschaftlichen Waage", in: *Festschrift zum 125jährigen Jubiläum der Firma Gebr. Bosch* (Jungingen 1977), pp. 29-66.

[7] Hans R. Jenemann, *Die Waage des Chemikers* (Frankfurt/Main 1979, 2. ed., Frankfurt/Main 1997).

were progressively replacing the cumbersome mechanical two-pan balances.[8] He visited university institutes and industrial laboratories throughout Germany, asking for discarded instruments and packing them into his rickety Ford-Taunus.

Hans R. Jenemann, December 1994 (photo: Jenemann)

In the end, his modest terraced house at Schwedenstr. 7e in Hochheim was filled to the brim with balances. His wife Inis Jenemann (1933–2008)[9] tirelessly supported him in the restoration and inventory of the collection. Eventually however, she jokingly threatened him with divorce if he brought one more piece into the house. Visitors literally had to squeeze past stacked mahogany cases in the entrance hallway to reach the living room, which also served as a study,

[8] In 1973, Mettler Instrumente AG launched the first fully electronic precision scale, the PT1200, which marked the beginning of the triumphant advance of electronic single-pan scales.

[9] Erna Irene Jenemann, née Haubelt, had come to Mainz after the war, where she worked as a physician's assistant and met her husband. She came from Hirschberg in Silesia, the birthplace of Jeremias Benjamin Richter (1762–1807), whose work *Anfangsgründe der Stöchyometrie oder Meßkunst chymischer Elemente* (Breslau/Hirschberg 1792) is considered the beginning of stoichiometry.

archive, and photo studio. In total, there were about 40 linear metres of monographs and series, 3 linear metres of trade catalogues and company publications, as well as about 250 files containing offprints, photocopies and correspondence.[10] Whoever visited Hans Jenemann in the midst of his treasures, listened to his accounts of precision weighing and constructors, technical details, and cultural-historical contexts, saw how he bustled, dragging out an essay here, a file or a catalogue there, experienced what it means to devote one's life to one single great passion. Visitors were usually handed a stack of offprints as a farewell.

I myself had been corresponding with Hans Jenemann since the 1980s, initially with regard to the cataloguing of the Liebig Museum[11] in Giessen, in which I was involved while still based in Marburg. In July 1990, I visited him for the first time at his private home in Hochheim to discuss the future of his collection and his scientific legacy for the history of metrology. His plan was to sell a portion of the collection and use the proceeds to create a foundation promoting research on the history of scientific instruments.

The Foundation

In 1990, Mettler Instrumente GmbH purchased a significant portion of the Jenemann collection to showcase it at the company's headquarters. The sale proceeds of DM 400,000 were intended to go to a "Jenemann-Mettler Foundation" to be established under the aegis of the Stifterverband für die Deutsche Wissenschaft in Essen. The trust agreement signed on 20th April and 28th May 1990 stipulated that the foundation's purpose was "the promotion of science and research in the fields of history as well as the development of scientific instruments."[12]

The agreement assigned a three-member advisory board as the decision-making body, consisting of a representative from Mettler Instrumente GmbH, Hans Jenemann, and a representative from the Stifterverband, plus "internationally recognised experts – university professors with experience in matters relating to the history of scientific instruments" in an advisory capacity.[13]

However, the trust agreement harboured potential for conflict as "the development of scientific instruments" and work on the history of instruments were put on the same level, with historians of science and technology only having an advisory function. Hans Jenemann seems to have felt tricked by the interests of the Mettler Company and the industry-friendly Stifterverband.

During this period, Hans Jenemann contacted me frequently by telephone, sometimes several times a week, to discuss the names of experts who could sit on the advisory board, the prize money in relation to other history of science prizes, possible press releases on the foundation, calls for proposals, and the like. My sons sometimes rolled their eyes when they once again

[10] On the recommendation of the Advisory Board, this material was offered to the Deutsches Museum by Inis Jenemann in 2006, but nothing came of it. The balances and many documents are now in the Sammlung Waagen und Gewichte of the Haus der 1000 Waagen in Onstmettingen, which opened in 2016. A group led by Thomas Allgeier, Ritzo Holtman, and Claus Borgelt are in the process of presenting the holdings on <http://jenemann.org/>.

[11] Hans R. Jenemann, *Die langarmigen Präzisionswaagen im Liebig-Museum zu Gießen* (Gießen 1988).

[12] Trust agreement and statutes, Jenemann-Mettler Foundation, April/May 1990, 5 pp.; copy in the author's archive. The Deutsches Stiftungszentrum GmbH, commissioned by the Stifterverband to look after the foundations, no longer has any documents on the Jenemann-Mettler Foundation; communication from Prof. Dr. Stefan Stolte, 29 November 2022.

[13] H. Jenemann to Dr. Klaus Neuhoff, Stifterverband (15 August 1990); copy in the author's archive.

handed me the telephone receiver with the words: "That's for you: Mr Jenemann from Hochheim!" They knew it was going to be a long conversation.

The constituent meeting took place at Mettler in Gießen on 7th September 1990. It was attended by Hans Jenemann, Jochen Wienbeck, Managing Director of Mettler's marketing department, Karl H. Kusmenskij from Mettler's planning department, and Dr. Klaus Neuhoff on behalf of the Stifterverband as the designated chair of the advisory board. In addition, two historians of science with advisory voice were invited: Prof. Dr. Fritz Krafft from the University of Marburg, and me, working at the time at the University of Mainz.

Neither handwritten notes nor the minutes of the meeting reflect how controversial the proceedings were.[14] However, it is evident that the views of the representatives of Mettler Company and the Stifterverband differed from the views of the two historians of science present on certain issues. Financial aspects – "remuneration of the members, e.g. for reviewing papers, expenses, costs of the award ceremony, administrative costs of the Stifterverband, etc." – were discussed in detail since "the attractiveness of the prize and the remuneration of the committee's work may be decisive for one or the other scientist to participate in the prize committee."[15] At the express wish of Hans Jenemann, who was keen to secure a long-term income, the Foundation's capital was invested "exclusively in fixed-interest federal securities" yielding just under 9% per annum at the time.

In accordance with the practice of industrial foundations, the original plan was to provide the members of the advisory board with an expense allowance of DM 20,000 per year.[16] Hans Jenemann, however, was afraid that "significant sums of money would have to be spent from the current yields."[17] As a result, the issue of remuneration for the committee members was postponed until the financial situation was clarified.[18] Mettler agreed to take over the press work, as well as the organisation and costs of the award ceremonies, while the Stifterverband requested 7-8% of the Foundation's annual yield as administrative overheads.

[14] Minutes of a meeting of the Jenemann-Mettler-Stiftung, Gießen, 7 September 1990 (24 September 1990), including 3 pp. manuscript notes; copies in the author's archive.

[15] Ibid., Minutes, fol. 2.

[16] Following the argument, put forward on behalf of the Stifterverband, that each member of the Board and the Prize Committee would have to spend about five days a year, which would have to be remunerated at a rate between DM 500–1,000, resulting in a total expenditure of DM 20,000 DM plus travel expenses; cf. ibid., my own notes.

[17] Hans R. Jenemann, „Zur Hans R. Jenemann Stiftung", 4 fols; copy of a signed typoscript of 28 January 1993; author's archive.

[18] Minutes, fol. 2. According to my recollection, Hans Jenemann, who as a thrifty person (except when it came to balances) and did not treat himself to anything, was quite unhappy about the conditions negotiated with the Stifterverband.

As far as the mission of the Foundation was concerned, the historians of science demanded that "the development of scientific instruments", as outlined in the original draft, be removed from the statutes since they anticipated a "conflict of goals between 'history' and 'development.'" The statutes and trust agreement were to be revised accordingly. It was also noted that the intention "to promote in particular young scholars" was difficult to reconcile with the awarding of an internationally recognized prize for outstanding academic work.

For the prize statutes, it was proposed that the advisory board appoint a three-member prize committee with expertise in the history of instrumentation, to be supplemented by additional experts on a case-by-case basis. In addition, a representative of the advisory board was to participate in the prize committee in an advisory capacity. The Paul Bunge Award, endowed with DM 10,000, was to be presented preferably at the Analytica, an international fair for laboratory technology, analytics, and biotechnology, held biennially in Munich. There was a discussion on whether research on the history of scientific instruments could be better stimulated by special prize questions or whether thematic calls to tackle specific fields such as control technology or automation, would be more sensible.

To finalise the statutes and the trust agreement, Hans Jenemann convened a final meeting with representatives from Mettler Instrumente GmbH and the Stifterverband that took place in Gießen on 28th September 1990. Though the two historians of science were not invited, their proposals were accepted. In addition to Hans Jenemann, the advisory board was to include one representative each from Mettler and the Stifterverband, with Dr. Klaus Neuhoff from the Stifterverband as executive chair. At the beginning of 1991, Mettler's marketing department issued a first press release announcing the Paul Bunge Prize, worth DM 10,000, to be awarded for the first time the following year.[19]

On 22nd July 1991 the advisory board held its inaugural meeting at the Deutsches Museum in Munich. The key features of the prize statutes were established, and a first call for submissions was drafted along with an information sheet to be sent to 100 selected institutions in Germany and abroad.[20] It is unclear, however, whether the call was in fact sent out or if the prize became known solely through Mettler's press release and a note published in the spring of 1991 in *Berichte zur Wissenschaftsgeschichte*.[21]

In September 1991, however, Mettler unexpectedly declared that it withdrew from the Foundation.[22] The exact reasons behind this decision are not known, but it can be assumed that they were related to recent restructuring within the company.[23] In 1989, Mettler Instrumente AG (whose shareholders since 1980 had been the Basel-based chemical and pharmaceutical company Ciba-Geigy), had merged with Toledo Scale Corporation, the largest US manufacturer of industrial balances, giving rise to Mettler-Toledo AG, with headquarters in Switzerland as well

[19] Letter by Mettler Instrumente GmbH to Prof. Fritz Krafft, Marburg, 29 January 1991, containing two undated press releases „Jenemann-Mettler-Stiftung gegründet"; copy in the author's archive.

[20] Jenemann, „Zur Hans R. Jenemann Stiftung", cited above.

[21] *Berichte zur Wissenschaftsgeschichte* 14 (1991), 136.

[22] Letter by Mettler-Toledo to Hans Jenemann, 24 September 1991; see also letter by Hans Jenemann to the author, 10 January 1992; copy in the author's archive.

[23] Unfortunately, the Corporate Archive of Mettler, Gießen, did not respond to my inquiries.

as in Columbus, Ohio. As a result, the company in Giessen lost its independence and was apparently unable to continue its commitment to historical research.[24]

After withdrawing from the foundation, Mettler transferred its voting rights to Hans Jenemann so that he could decide on a new sponsorship and new statutes. Jenemann in turn reached out to the German Chemical Society (GDCh) and the German Bunsen Society for Physical Chemistry (DBG), of which he was a long-standing member. On 24th November 1991, a meeting was held in Essen to clarify the modalities of the transfer, attended by Dr. Klaus Neuhoff of the Stifterverband, Dr. Heinz Behret, and Peter Müllergroß[25] on behalf of the GDCh, as well as Hans Jenemann. Compared to the original statutes drawn up between Mettler-Toledo and the Stifterverband, the hurdles to dissolving the foundation and changing the foundation's mission were significantly raised. Additionally, the advisory board was supplemented by professionally competent members, rendering a separate prize committee redundant.[26]

In line with Hans Jenemann's original intention, the foundation, initially designed as kind of industrial foundation, became more academic. The sponsorship was transferred to two high-ranking scientific societies corresponding more closely to Jenemann's scientific background. The foundation was formally established on 3rd June 1992 with the Gesellschaft Deutscher Chemiker (GDCh) and the Deutsche Bunsengesellschaft für Physikalische Chemie (DBG).[27] On 5th August 1992, the Stifterverband approved the new statutes and the transfer of a capital of DM 400,000. In 1993, Hans Jenemann deposited an additional DM 63,000, proceeds from the sale of another portion of his collection of balances to DECHEMA, Gesellschaft für Chemische Technik und Biotechnologie e.V., in Frankfurt am Main, where it was, and still is, presented in a special cabinet.[28] With a starting capital of DM 463,000 (equivalent to € 236,728), the Hans R. Jenemann Foundation is the most generously endowed of the many foundations administered by the GDCh.

Advisory Board

The new Advisory Board of the Foundation met for the first time on 29th January 1993 at the GDCh headquarters in Frankfurt. Ex-officio members (authorised to name a representative) are the current President of the German Chemical Society, the current First Chairman of the German Bunsen Society, the director of a natural science or technical museum (such as the Deutsches Museum in Munich), and the chair or director of a university institute for the history

[24] The 150 boxed balances that Hans Jenemann had sold to Mettler-Toledo GmbH in Giessen were exhibited there for a while in a showroom, but were later no longer accessible. In 2008, the pieces were given on permanent loan to the Philipp-Matthäus-Hahn-Museum in Albstadt-Onstmettingen. In the same year, this museum also took over the approximately 100 balances that had remained in Mrs. Jenemann's private home in Hochheim at the time of her death, along with the associated documentation, which amounted to 120 folders; vgl. <http://www.jenemann.org/>.

[25] GDCh Administrative Director until 2010, see *Nachrichten aus der Chemie* 55 (2007), 357-357.

[26] Jenemann, „Zur Hans R. Jenemann Stiftung", cited above.

[27] The fact that it was these two societies – and not, for example, the Scientific Instruments Society – is explained by the fact that Hans Jenemann was their member and therefore regarded them as his intellectual home.

[28] Letter by Hans Jenemann to the author, 10 December 1993; author's archive. They are still on display at DECHEMA Gesellschaft für Chemische Technik und Biotechnologie, Theodor-Heuss-Allee 25, Frankfurt.

of science or technology. Until his death in 1996, Hans Jenemann also served as personal member of the Board.

The establishment of the Foundation was overseen by Kurt Begitt, the head of the Public Relations Department of the GDCh. The founding members of the Advisory Board included Prof. Heinrich Nöth (GDCh President), Dr. Alto Brachner (representing the Deutsches Museum from 1994 to 2000, followed by Prof. Wolf Peter Fehlhammer), Dr. Heinz Behret (Managing Director of the DBG), Prof. Christoph Meinel (University of Regensburg, chair from 2001 to 2020), and Hans Jenemann until his passing. At present, the Advisory Board is composed of Dr. Charlotte Bigg (Paris, chair since 2021), Prof. Helmuth Trischler (Munich, representing the Deutsches Museum since 2001), Prof. Jürgen Janek (Gießen, representing the DBG since 2001), and Prof. Henning Hopf (Braunschweig, representing the GDCh since 2003).

From 2001 to 2003 and then again from 2007 onwards, the annual Board meetings at the GDCh headquarters in Frankfurt/Main were replaced by a circulation procedure. As a rule, the two historians of science and technology who served on the Board prepared comparative reviews of the received applications and circulated them with all the necessary documents to the other members. Initially, this process was conducted by post, and those involved vividly recall the physical effort of collecting the heavy boxes of submitted work from the post office and forwarding them to the next addressee. In recent years, this cumbersome process has been entirely replaced by the electronic circulation of documents. The GDCh Secretariat deserves special recognition for carefully and punctually organizing the circulation procedure. This was initially overseen by Dr. Kurt Begitt, then by Jutta Bröll, followed, from 2005 to 2020, by Barbara Köhler, and now by Dr. Jasmin Herr.

The announcement of the prize is made in early Summer each year by the Public Relations departments of the GDCh and the DBG through standard scientific media contact lists and more specific mailing lists in the history of science community (such as Rete, Oldenburg, Mersenne, Chem-Hist, H-Soz-Kult, and HSS), reaching practically everyone working in this particular field worldwide. The deadline for submissions is 30th September, and the Advisory Board typically reaches its decisions in the following November or December.

Paul Bunge Prize

On 19th March 1993, the Paul Bunge Prize was awarded for the first time at a meeting of the GDCh History of Chemistry Division in Jena. Due to the transition from the Stifterverband to GDCh/DBG, no prize was awarded in 1992. But since enough qualified applications had already been received in response to the first press releases, the award was given twice in 1993. Mara Miniati, the curator of the Museo di storia della scienza (now Museo Galileo) in Florence, received the prize in recognition of her 1991 catalogue of the important collection of the Museo, which includes the instruments of Galileo Galilei and his students. At the same ceremony, Klaus Hentschel received the prize for his Hamburg Habilitation thesis on the interpretation of the red shift in the solar spectrum.[29] In addition Sabine Ernst (Mainz) was awarded the Bettina

[29] Mara Miniati, *Museo di storia della scienza: Catalogo* (Firenze 1991); Klaus Hentschel, *Zum Zusammenspiel von Instrument, Experiment und Theorie: Rotverschiebung im Sonnenspektrum und verwandte spektrale Verschiebungseffekte von 1880 bis 1960*, 2 vols (Hamburg 1998).

Haupt Prize for young historians of chemisty, sponsored by the GDCh, for her doctoral thesis on the correspondence between Lise Meitner and Otto Hahn.[30]

Award ceremony in Jena 1993 (from left to right): Heinz Behret (GDCh), Sabine Ernst, Klaus Hentschel, Mara Miniati, and Christoph Meinel; from: *Chemie & Schule* 3/93, p. 20.

Since then, the Paul Bunge Prize has been awarded alternately at GDCh and DBG events. The latter is usually the annual Bunsentagung, which takes place in the Spring at different venues and is attended by about 700 participants. The former is either the biennial GDCh general meetings or the Wissenschaftsforum Chemie with about 2000 participants, or preferably at the biennial meetings of the GDCh History of Chemistry Division, which offers a more intimate and more appropriate, historically-minded setting. The GDCh and the Bunsen Society's PR departments document the award ceremonies and ensure their visibility through press releases.

The Paul Bunge Prize is the world's most highly endowed prize in the history of science and the only one in the field of the history of scientific instruments. From 1992 to 2023, 214 persons applied or were nominated for the prize, with applications – including multiple ones – coming from Germany (75), UK (57), USA (45), India (8), France (8), Canada (5), Italy (4), Israel (4), Australia (4), Hungary (3), Ireland (2), the Netherlands (2), Switzerland (2), Spain (2), and one application each from Denmark, Greece, Poland, Portugal, China, and Ukraine. The awardees come from Great Britain (13), the USA (10), Germany (9), Italy (3), Canada (2) and one each from France and Australia. However, this information does not indicate the nationality of the applicants, which has never been requested.

The following table shows the number of applications or proposals, the respective countries of origin (not necessarily nationality), the name and place of activity of the laureates, including the subject of the prize, and the age at the time of the award.

[30] Sabine Ernst, *Lise Meitner an Otto Hahn, Briefe aus den Jahren 1912 bis 1924: Edition und Kommentierung*, Quellen und Studien zur Geschichte der Pharmazie, vol. 65 (Stuttgart 1992).

Year	Σ	Countries (ISO 3166-1)	Prize winner and place of work at the time / awarded for	Country	Age
1993	4	DE (2), HU, IT	**Mara Miniati**, Florence *Museo di Storia della Scienza: Catalogo* (Firenze 1991)	IT	54
			Klaus Hentschel, Hamburg *Zum Zusammenspiel von Instrument, Experiment und Theorie: Rotverschiebung im Sonnenspektrum und verwandte spektrale Verschiebungseffekte von 1880 bis 1960*, Habilitation thesis, University of Hamburg	DE	32
1994	5	DE (3), GB, HU	**Matthias Dörries**, Munich "Balances, spectroscopes, and the reflexive nature of experiment", *Studies in the History and Philosophy of Science* 25 (1994), 1-36, and "Prior History and Aftereffects: Hysteresis and Nachwirkung in 19th Century Physics", *Historical Studies in the Physical Sciences* 22:1 (1991), 25-55	DE	34
			Heinz Otto Sibum, Cambridge "Reworking the mechanical value of heat: Instruments of precision and gestures of accuracy in early Victorian England", *Studies in History and Philosophy of Science* 26 (1995), 73–106	GB	38
1995	8	US (3), GB (2), DE (2), IT	**Gerard L'Estrange Turner**, Oxford Lifetime achievement, and in particular his work on the history of the microcope	GB	58
1996	9	US (4), DE (2), GB (2), HU	**David King**, Frankfurt/Main Lifetime achievement, and in particular his word on astrolabes	DE	54
			Stuart Feffer, Aberdeen NJ "Microscope to munitions: Ernst Abbe, Carl Zeiss and the transformation of technical optics, 1850–1914", PhD Diss. Berkeley 1994	US	32
1997	9	DE (4), US (3), AUS, FR	**Silvio A. Bedini**, Washington DC Lifetime achievement, partly collected in: *Science and Instruments in Seventeenth-Century Italy* (Aldershot 1994)	US	80
1998	5	GB (2), DE (2), US	**Robert Bud**, London (with Deborah Warner) *Instruments of Science: An Historical Encyclopedia* (New York 1998)	GB	46
			Deborah J. Warner, Washington DC (with Robert Bud) *Instruments of Science: An Historical Encyclopedia* (New York 1998)	US	57
1999	3	AUS (2), DE	**Nicolas Rasmussen**, Sydney *Picture Control: The Electron Microscope and the Transformation of Biology in America, 1940–1960* (Stanford 1997)	AUS	37
2000	6	DE (3), US, GB, CH	**Alan Q. Morton**, London *Public and Private Science: The King George III Collection* (Oxford 1993)	GB	50
			Richard J. Sorrenson, Bloomington IN *"George Graham, visible technician", British Journal of the History of Science 32 (1999), 203–222;* "The ship as a scientific instrument in the 18th century", *Osiris* 11 (1996), 221–236	US	39
2001	13	GB (4), DE (4), US (3), CA (2)	**Jim Bennett**, Oxford Lifetime achievement	GB	54
2002	2	IT, IE	**Paolo Brenni**, Florence Lifetime achievement, and in particular the catalogues of the *Museo Galileo* and the *Istituto Tecnico Toscano*	IT	48
2003	6	GB (2), DE (2), US, IL	**Sean F. Johnston**, Glasgow *A History of Light and Colour Measurement* (Bristol 2001)	GB	46
2004	9	DE (4), US (3), GB, UA	**Carsten Reinhardt**, Regensburg "Physical Instrumentation and its Impact on Chemistry: Nuclear Magnetic Resonance and Mass Spectrometry, 1950–1980", Habilitation thesis, University of Regensburg 2004	DE	38

Year	*Σ*	*Countries (ISO 3166-1)*	*Prize winner and place of work at the time / awarded for*	*Country*	*Age*
			Jobst Broelmann, Munich *Intuition und Wissenschaft in der Kreiseltechnik, 1750–1930 (*Munich 2003)	DE	61
2005	3	US (2), DE	**Myles W. Jackson**, Salem OR *Spectrum of Belief: Joseph von Fraunhofer and the Craft of Precision Optics* (Cambridge, MA 2000)	US	41
2006	6	DE (4), GB (2), US,	**Davis Baird**, Columbia SC *Thing Knowledge: A Philosophy of Scientific Instruments (Berkeley 2004)*	US	51
			Inge Keil, Augsburg *Augustanus Opticus: Johann Wiesel (1583–1662) und 200 Jahre optisches Handwerk in Augsburg* (Berlin 2000)	DE	75
2007	5	US (3), DE (2)	**Charlotte Bigg**, Berlin "Behind the lines: Spectroscopic enterprises in early twentieth-century Europe", PhD diss., Univ. of Cambridge 2002	DE	31
2008	4	GB (2), DE (2)	**Alison D. Morrison-Low**, Edinburgh *Making Scientific Instruments in the Industrial Revolution (Edinburgh 2007)*	GB	53
2009	10	GB (4), DE (2), US (2), IL (2)	**Jutta Schickore**, Bloomington, IN *The Microscope and the Eye: A History of Reflections, 1740–1870* (Chicago 2007)	US	45
2010	6	GB (3), DE (3)	**Henning Schmidgen**, Berlin *Die Helmholtz-Kurven: Auf der Spur der verlorenen Zeit* (Berlin 2009)	DE	44
2011	7	GB (2), US (2), DE, DK, IE	**Matteo Valleriani**, Berlin *Galileo Engineer* (Heidelberg/New York 2010)	DE	39
2012	4	DE (3), CA	**David Pantalony**, Ottawa *Altered Sensations: Rudolph Koenig's Acoustical Workshop in 19th-Century Paris* (Dordrecht 2009)	CA	40
2013	9	DE (4), US (2), GB, CA, IT	**Marco Beretta**, Bologna *The Alchemy of Glass: Counterfeit, Imitation and Transmutation in Ancient Glassmaking* (Sagamore Beach 2009) and his work on A.L. Lavoisiers' instruments	IT	51
2014	10	DE (6), GB (2),US, ES	**Cyrus C.M. Mody**, Houston TX *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (Cambridge, MA 2011)	US	40
2015	6	US (2), DE, CH, GB, ES	**Brian Gee**, Chelsea *Francis Watkins and the Dollond Telescope Patent Controversy*, ed. by Anita McConnell und A.D. Morrison-Low (Farnham 2014)	GB	70
2016	6	GB (4), DE, US	**Robert Anderson**, Cambridge Lifetime achievement	GB	72
2017	7	GB (4), US (2), IN	**Simon Schaffer**, Cambridge Lifetime achievement	GB	62
2018	6	GB, FR, US, PT, IN (2)	**Anthony J. Turner**, Le Mesnil-le-Roi Lifetime achievement since *Early Scientific Instruments, Europe, 1400–1800* (London 1987)	FR	72
2019	6	GB (2), DE (2), FR, GR, US, IN	**Sara J. Schechner**, Cambridge MA Lifetime achievement	US	62
2020	7	GB (3), US, FR, IL, IN	**Simon Werrett**, London *Thrifty Science: Making the Most of Materials in the History of Experiment* (Chicago 2019)	GB	49
2021	10	GB (3), DE (3), US, FR, NL, IN	**Liba Taub**, Cambridge Lifetime achievement	GB	67

Year	Σ	Countries (ISO 3166-1)	Prize winner and place of work at the time / awarded for	Country	Age
2022	14	DE (3), US (3), Ca (2), FR, NL, GB, IN, CN, AU	**Matthew L. Jones,** New York NY *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago 2016)	US	48
2023	9	DE (5), CH, FR, PL, CA	**Robert W. Smith,** Edmonton Lifetime achievement	CA	70

Between 1992 and 2021, the Paul Bunge Prize was awarded to a total of 31 men and 7 women, resulting in a female representation of 18%. The prize was given 28 times for exceptional individual publications and 12 times for lifetime accomplishments. Two groups can thus be identified: the pioneers in the field, often academically-active curators recognized for their entire body of work, and young scholars bringing new perspectives to the history of instruments. The Advisory Board has always aimed to keep a balance between recognising past achievements and honouring particularly innovative new approaches. The youngest recipient was 31 years old, the oldest 80.

In early years the Paul Bunge Prize was occasionally awarded twice, because the revenues from the foundation's capital allowed this. Those days are long gone. Since then, the Advisory Board has decided to award only one prize per year. In the Spring of 2020 the Bunge prize could not be awarded since conferences were cancelled in the midst of the Covid-19 pandemic. The prizes for 2020 and 2021 were awarded remotely in May 2021 at the online Bunsen Tagung.

Additional measures

Apart from the primary purpose of awarding the Paul Bunge Prize, the Hans R. Jenemann Foundation may also use its funds to recognize other work or activities in the history of scientific instruments. In early years, when the income from the foundation allowed it, this option was occasionally used by granting small awards for proposals that were not eligible for the Paul Bunge Prize: thus in 2001 a sum of DM 2,500 to Penelope Gouk, Manchester, for her book *Music, Science and Natural Magic in Seventeenth-Century England* (New Haven 1999). From 1994 to 2001 and again in 2005, small grants of DM 2,500 to DM 5,000 were awarded to help towards printing costs, small research projects, and conferences.[31] However, the Council was cautious about this practice, advocated only by Hans Jenemann himself, from the very beginning; for the external impact of such measures is limited, and the selection too contingent and not transparent enough. The Advisory Board discontinued this practice after 2005. Instead, provisions were made to celebrate the 30th anniversary of the Paul Bunge Prize via an international conference.

[31] E.g. 1996 DM 3,000 to Dr. Günther Oestmann for writing a study on the astronomical clock in Olomouc/ Olmütz; 1997 DM 4,000 for travel grants to 20 younger scholars at the conference "Instrument – Experiment" in Regensburg; 1998 DM 3,000 for the international conference "Artefacts and Systems in Transport" at the Deutsches Museum in Munich; 2000 DM 2,000 for the meeting "Science, Technology, and Nature at the Time of Pompei" in the Deutsches Museum; 2000 DM 10,000 to the IUHPS/DHS Commission on the History of Modern Chemistry for the international symposium "From the Test Tube to the Autoanalyzer: The Development of Chemical Instrumentation in the Twentieth Century" in London.

Financial situation

For more than two decades, the Hans R. Jenemann Foundation has had a capital stock of exactly € 236,728.14. In addition, there are free reserves amounting to € 65,800 (withdrawal of € 7,500 in 2021). The assets of the Foundation are invested in the financial and capital markets, taking into account the "Investment Principles of the GDCh" in the version of December 2020. The income generated there, primarily from interest, dividends and sales proceeds, is used exclusively to realize the mission of the Foundation. The annual expenses for the statutory purposes generally range between € 7,500 and € 11,000 and include, in addition to the prize money (€ 7,500), primarily expenses for travel and postage, as well as for the necessary meetings of the Advisory Board.

The free reserves are not subject to the legal requirement of timely use of funds. The importance of the free reserves, which have been built up over many years, can be seen from the fact that they currently more than compensate for the negative endowment funds used for the Foundation's running business. The Foundation is invested without exception in securities whose issuers have first-class ratings. Temporary losses may occur from time to time, mainly as a result of the economic situation, but even in these years there were dividend payments.

Although the last two decades have seen enormously volatile financial markets as a result of various events (subprime, financial and euro crises, or the low interest rates that have persisted for a decade, in some cases with negative yields on German government bonds), the foundation has always been able to realize its mission without having to reduce the capital stock. Until 2006, asset management was in the hands of the former Administrative Director of the GDCh, Peter Müllergroß. Since 2007, it has been the responsibility of the Commercial Director of the GDCh, Volker Kilz.

The finances of the Foundation have been in good standing from the very beginning, and the higher expenses on the occasion of the 30th anniversary of the Paul Bunge Prize, which are not fully covered by current income, will be compensated by withdrawals from free reserves. The GDCh deserves special recognition for the dependable and cost-neutral management of the Foundation.

Outlook

Over the last three decades, the Hans R. Jenemann Foundation has firmly established the Paul Bunge Prize as the leading international award in the history of scientific instruments. The prize has gained an appropriate prestige and visibility, with the most distinguished historians worldwide among the prize winners, from pioneers in the field recognized for their lifetime achievements to young historians exploring new directions. Initially established by Hans Jenemann with a focus on the history of metrology and the technical aspects of the history of instruments, the prize also increasingly awarded histories of the manufacture of instruments and the instruments trade. Recent historiography has opened up new perspectives on practices associated with instruments, on the significance of material and materiality, and on the means and techniques of visualisation. Over the last three decades the history of scientific instruments has evolved into a well-established, multi-perspectival, and highly dynamic area of research, with scholars coming from all kinds of disciplines and institutions.

The Hans R. Jenemann Foundation takes great pride in its contribution to this development. In 1983, the Scientific Instrument Society was established in London, and in 1996, Hans Jenemann was granted the title of Honorary Member. In 1997, the author of this text, with the

support of the Hans R. Jenemann Foundation, organised a conference on "Instrument – Experiment" in Regensburg, aimed at making an historiographical and methodological assessment of the state of the research, as well as discussing future prospects.[32] The conference was attended by two effective and four future Bunge Prize winners. For the history of objects and collections, a similar objective was pursued by the collective volume *European Collections of Scientific Instruments, 1550-1750,*[33] edited by three Bunge Prize winners in 2009, and the subsequent volume *How Scientific Instruments have changed Hands* (2016),[34] also edited by three Bunge Prize winners. Finally, in September of 2022, the Scientific Instrument Society hosted a conference in Athens to commemorate its 40th anniversary with the theme "The Past, Present, and Future of Scientific Instrument Studies", in which at least five Bunge Prize winners actively participated.

In 2023, the Hans R. Jenemann Foundation has invited all Bunge Prize winners to the symposium "Writing the History of Scientific Instruments: State of the Art and Future Perspectives" at the Deutsches Museum in Munich, to celebrate the 30th anniversary of the Paul Bunge Prize. The aim of the symposium is to deepen the long-standing connections between the awardees, to facilitate new contacts within the worldwide community of instrument historians, and to emphasize once again the importance of the Paul Bunge Prize for this thriving field of research.

Christoph Meinel

[32] Christoph Meinel (ed.), *Instrument – Experiment: Historische Studien* (Diepholz/Berlin 2000).

[33] Giorgio Strano, Stephen Johnston, Mara Miniati und Alison Morrison-Low (eds.), *European Collections of Scientific Instruments, 1550–1750* (Leiden 2009).

[34] Alison Morrison-Low, Sara J Schechner and Paolo Brenni (eds.), *How Scientific Instruments have changed Hands* (Leiden/Boston 2016).

GESCHICHTE DER HANS R. JENEMANN-STIFTUNG, 1990 – 2023 UND DES PAUL-BUNGE-PREISES, 1993 – 2023

Instrumente sind die Erkenntnismittel der modernen Wissenschaft. Seitens der historischen Forschung haben sie jedoch erst in jüngerer Zeit die gebührende Aufmerksamkeit erfahren. Noch 1980 musste der Wissenschaftshistoriker und –soziologe Derek J. de Solla Price pointiert feststellen, dass sich die "blatant and naive insistence that scientific instruments arose as tools for measurement", der irrigen Auffassung verdanke, Naturwissenschaft habe es im wesentlichen mit Ideen zu tun und Instrumente seien nichts weiter als "tools of the scientist for the very practical purpose of making measurements and testing hypotheses by experiment."[35] Das führte zu Fragen nach den Beziehungen zwischen Instrumenten, experimenteller Praxis, Erkenntnisgewinn und Theoriebildung, aber auch nach den sozialen und ökonomischen Kontexten, in denen diese Artefakte und die daran geknüpften Praktiken stehen.

Seit Mitte der 1980er Jahre hat die Wissenschaftsgeschichtsschreibung eine Fülle hervorragender und methodisch innovativer Studien zu diesen Themen beigesteuert. Hans R. Jenemann (1920–1996), ein Analytischer Chemiker und leidenschaftlicher Sammler von Waagen, dessen primäres Interesse den konstruktiven Details galt, und der in seinen historischen Arbeiten die Präzision und das methodische Bewußtsein des Chemikers verinnerlicht hatte, hatte die Zeichen der Zeit offenbar erkannt, als er für ein Forschungsgebiet, das ihm in besonderer Weise förderungswürdig erschien, eine Stiftung einrichtete, deren einziger Zweck „die Förderung von Wissenschaft und Forschung in dem Bereich der Geschichte wissenschaftlicher Instrumente" war. Der von der Stiftung vergebene Paul-Bunge-Preis wird international ausgeschrieben und ist die einzige derartige Auszeichnung weltweit.

Die Hans R. Jenemann-Stiftung wurde am 3. Juni 1992 durch Hans Jenemann bei der Gesellschaft Deutscher Chemiker (GDCh) und der Deutschen Bunsengesellschaft für Physikalische Chemie (DBG) eingerichtet.[36] Sie trägt seitdem den Namen des Stifters. Die Stiftung vergibt seit 1993 im jährlichen Rhythmus den anfangs mit 10.000 DM, später mit 15.000 DM bzw. 7.500 Euro dotierten Paul-Bunge-Preis,[37] mit dem herausragende abgeschlossene Arbeiten zur Geschichte wissenschaftlicher Instrumente ausgezeichnet werden. Es ist die höchstdotierte Auszeichnung im Bereich der Wissenschaftsgeschichte weltweit. Der Name des Preises erinnert an den Hamburger Feinmechaniker und Ingenieur Paul Bunge (1839–1888)[38], der im Waagenbau neue Maßstäbe setzte, indem er die kurzarmige Analysenwaage einführte, mit welcher Wägevorgänge wesentlich weniger Zeit beanspruchten. Andere der von Bunge eingeführten Neuerungen waren die 'steigende' Arretierung, das Kreuzschneidengehänge, die Autokollimatorablesung oder die Substitutions-Zweischneidenwaage mit verschiedenen Armlängen. Mit der von Paul Bunge für das Bureau International des Poids et Mesures in Paris gefertigten

[35] Derek J. de Solla Price, "Philosophical mechanism and mechanical philosophy: Some notes towards a philosophy of scientific instruments", *Annali dell'Istituto e Museo di Storia della Scienza di Firenze* 5 (1980), 75-85.

[36] <https://www.gdch.de/fileadmin/downloads/GDCh/Preise_und_Auszeichnungen/PDF/jenemann20.pdf>.

[37] <https://de.wikipedia.org/wiki/Paul-Bunge-Preis sowie https://en.wikipedia.org/wiki/Paul_Bunge_Prize>.

[38] Vgl. Hans R. Jenemann, „Paul Bunge und die Fertigung wissenschaftlicher Waagen in Hamburg", *Zeitschrift für Unternehmensgeschichte* 31 (1986), 117–140 und 165–183.

Waage wurden die Kilogramm-Standards nach der 1875 abgeschlossenen Meter-Konvention geeicht.

Ziel der Hans R. Jenemann-Stiftung ist, Wissenschaft und Forschung auf dem Gebiet der historischen wissenschaftlichen Instrumente zu unterstützen und herausragende Arbeiten auszuzeichnen. Dafür können Buchveröffentlichungen oder Aufsätze eingereicht werden, die innerhalb der letzten 3–10 Jahre publiziert wurden. Alternativ kann der Preis auch für ein Lebenswerk vergeben werden. Die Publikationen sollen die Geschichte wissenschaftlicher Instrumente in den unterschiedlichsten Aspekten beleuchten, müssen auf eigenen wissenschaftlichen Untersuchungen der Bewerbenden beruhen und sind in deutscher, englischer oder französischer Sprache einzureichen.

Hans R. Jenemann (1920–1996)

Hans Richard Jenemann wurde am 10. März 1920 in Mainz geboren. 1938 legte er das Abitur ab. Nach sieben Jahren Arbeits-, Wehr- und Kriegsdienst gelangte er in sowjetische Kriegsgefangenschaft, aus der er 1950 nach Hause entlassen wurde. So konnte er erst mit 30 Jahren sein Chemiestudium beginnen, das er nach sieben Semestern mit dem Diplom abschloss. Jenemanns akademischer Lehrer war Wilhelm Geilmann (1891–1967), a.o. Professor für Analytische Chemie an der Johannes-Gutenberg-Universität Mainz, einer der „letzten Meister der Analyse auf trockenem Wege“[39] und 1962 erster Träger des Fresenius-Preises der GDCh.

Von 1953 an arbeitete Hans Jenemann als Analytiker in den Jenaer Glaswerken Schott & Gen. in Mainz, einem führenden Hersteller von Spezialgläsern. Später wurde er Leiter des nasschemischen Analytischen Laboratoriums und der von ihm aufgebauten Ausbildung von Chemie- und Physiklaborantinnen und -laboranten. 1982 beendete er seine berufliche Tätigkeit bei Schott. Am 5. Dezember 1996 ist er gestorben.

Hans Jenemann bei einer Ausstellung seiner Sammlung in Hoechst, Juni 1976
(Foto: privat, zur Verfügung gestellt von Thomas Allgeier, Jenemann Archive Project)

[39] Helmut Bode und Fritz Strassmann, „Zum 60. Geburtstag von Prof. Dr. W. Geilmann“, *Fresenius' Zeitschrift für analytische Chemie* 133 (1951), 1–3.

1975 begann Hans Jenemann mit Studien zur Geschichte der Waage; seine erste einschlägige Veröffentlichung kam 1977 aus Anlass des 125jährigen Firmenjubiläums der Bosch-Wägesysteme GmbH in Jungingen heraus.[40] Zwei Jahre später folgte als Übersichtswerk *Die Waage des Chemikers*.[41] Insgesamt liegen 70 abgeschlossene Arbeiten zur Geschichte der Waage aus seiner Feder vor. Beeindruckend war seine ca. 300 Stücke umfassende Sammlung historischer Waagen und der zugehörigen Spezialliteratur. 1996, im Jahr seines Todes, ernannte ihn die international tätige Scientific Instrument Society für seine Studien über wissenschaftliche Instrumente zum Ehrenmitglied. Der Beginn seiner Sammelleidenschaft fiel in die Zeit, als überall die umständlich zu bedienenden mechanischen Zwei-Schalen-Waagen durch elektronische Ein-Schalen-Waagen ersetzt wurden.[42] Quer durch die Republik hat Hans Jenemann damals Universitätsinstitute und Industrielaboratorien aufgesucht, sich die ausgemusterten Stücke geben lassen und sie in seinen klapprigen Ford-Taunus gepackt.

Bis in den letzten Winkel hinein hatte er das bescheidene Reihenhaus in der Schwedenstr. 7e in Hochheim schließlich mit Waagen vollgestellt. Seine Frau Inis Jenemann (1933–2008)[43], die ihn bei der Restaurierung und Inventarisierung der Sammlung unermüdlich unterstützt hat, soll ihm zuletzt halb im Scherz mit der Scheidung gedroht haben, sollte er noch ein einziges weiteres Stück ins Haus bringen. Im Eingangsflur musste man sich an den aufeinander gestapelten Mahagonigehäusen regelrecht vorbeizwängen, um ins Wohnzimmer zu gelangen, das zugleich als Arbeitszimmer, Archiv und Photoatelier diente. Hier standen auch ca. 40 Regalmeter an Monographien und Serien, 3 Regalmeter an Katalogen und Firmenschriften sowie etwa 250 Aktenordner Materialsammlung und Korrespondenz.[44] Wer ihn inmitten seiner Schätze besucht und wem Hans Jenemann dann von Präzisionswägung und Konstrukteuren, von technischen Details und kulturhistorischen Zusammenhängen erzählt hat, wobei er in der Regel wie ein Wiesel hier einen Aufsatz, dort ein Aktenstück, da einen Katalog hervorkramte und einem zum Abschied oft noch einen Stapel von Sonderdrucken in die Hand drückte, der hat erfahren, was es heißt, sein Leben einer einzigen großen Passion zu widmen.

Persönlich stand ich mit Hans Jenemann seit den 1980er Jahren in brieflichem Kontakt, zunächst im Zusammenhang der Bestandserschließung am Liebig-Museum in Gießen, an der ich, damals noch von Marburg aus, beteiligt war.[45] Im Juli 1990 habe ich ihn erstmals in seinem Privathaus in Hochheim besucht. Das Treffen stand in Zusammenhang mit Überlegungen, wie sich die Zukunft seiner Sammlung und sein wissenschaftliches Vermächtnis für die Geschichte der Metrologie in einer zukunftsweisenden Form sichern ließe. Sein Plan war, einen Teil der

[40] Hans R. Jenemann, „Eine kurze Entwicklungsgeschichte der wissenschaftlichen Waage“, in: *Festschrift zum 125jährigen Jubiläum der Firma Gebr. Bosch* (Jungingen 1977), S. 29-66.

[41] Hans R. Jenemann, *Die Waage des Chemikers* (Frankfurt/Main 1979, 2. Aufl. (Frankfurt/Main 1997).

[42] Die Mettler Instrumente AG hatte 1973 eine erste vollelektronische Präzisionswaage, die PT1200, auf den Markt gebracht, mit der der Siegeszug der elektronischen Ein-Schalen-Waagen begann.

[43] Eigentlich Erna Irene Jenemann, geb. Haubelt, war nach dem Krieg nach Mainz gekommen, wo sie als Arzthelferin gearbeitet und dort auch ihren Mann kennengelernt hatte. Sie stammte aus Hirschberg in Schlesien, dem Geburtsort von Jeremias Benjamin Richter (1762–1807), dessen Werk *Anfangsgründe der Stöchyometrie oder Meßkunst chymischer Elemente* (Breslau/Hirschberg 1792) als der Beginn der Stöchiometrie gilt.

[44] Auf Empfehlung des Beirats wurde dieses Material 2006 von Inis Jenemann dem Deutschen Museum angeboten, doch ist daraus nichts geworden. Waagen und Unterlagen befinden sich jetzt in der Sammlung Waagen und Gewichte des 2016 eröffneten Haus der 1000 Waagen in Onstmettingen, und eine Gruppe um Thomas Allgeier, Ritzo Holtman und Claus Borgelt sind dabei, den Bestand auf der Seite <http://jenemann.org/> zu präsentieren.

[45] Hans R. Jenemann, *Die langarmigen Präzisionswaagen im Liebig-Museum zu Gießen* (Gießen 1988).

Sammlung zu verkaufen und den Erlös in eine Stiftung einzubringen, aus deren Erträgen instrumentengeschichtliche Arbeiten gefördert und ausgezeichnet werden sollten.

Hans R. Jenemann, Dezember 1994 (Photo: Jenemann)

Stiftung

Nachdem 1990 die Mettler Instrumente GmbH in Gießen einen Großteil der Jenemannschen Sammlung gekauft hatte, um sie am Firmensitz in einem Schauraum zu präsentieren, und damit ein Grundkapital in Höhe von 400.000 DM zur Verfügung stand, wurde zunächst eine „Jenemann-Mettler-Stiftung“ unter der Ägide des in Essen ansässigen Stifterverbands für die Deutsche Wissenschaft eingerichtet. Der am 20. April und 28. Mai 1990 unterzeichnete Treuhandvertrag[46] bestimmte als Stiftungszweck „die Förderung von Wissenschaft und Forschung in den Bereichen der Geschichte sowie der Entwicklung wissenschaftlicher Instrumente. Die Verwirklichung der Stiftungszwecke erfolgt insbesondere durch die Vergabe des ‚Paul-Bunge-Preises’ zur Förderung von abgeschlossenen Publikationen in deutscher, englischer oder französischer

[46] Treuhandvertrag und Satzung, Jenemann-Mettler-Stiftung, April/Mai 1990, 5 S.; Kopie im Archiv des Verf. Die vom Stifterverband mit der Betreuung der Stiftungen beauftragte Deutsche Stiftungszentrum GmbH besitzt keine Unterlagen zur Jenemann-Mettler-Stiftung mehr; Mitteilung von Prof. Dr. Stefan Stolte vom 29. November 2022.

Sprache, die nicht notwendigerweise schon veröffentlicht bzw. verlegt sein müssen, aus den Bereichen der Geschichte sowie der Entwicklung wissenschaftlicher Instrumente."

Als einziges und beschließendes Gremium setzte der Treuhandvertrag einen dreiköpfigen Beirat ein, bestehend aus einem Vertreter der Mettler Instrumente GmbH, Hans Jenemann und einem Vertreter des Stifterverbandes. An den Sitzungen des Beirates sollten „international anerkannte Fachleute – Universitätsprofessoren, die in Fragen der Geschichte wissenschaftlicher Instrumente Erfahrung besitzen – beratend teilnehmen."[47]

Der Treuhandvertrag barg allerdings Konfliktpotential, weil außer instrumentengeschichtlichen Arbeiten auch „die Entwicklung wissenschaftlicher Instrumente" gefördert werden sollte, wobei die hinzugezogenen Wissenschafts- oder Technikhistoriker lediglich beratende Funktion haben sollten. Hier hatte sich Hans Jenemann – so mein Eindruck – von den Interessen der Firma Mettler und dem durchaus industrienahen Stifterverband möglicherweise über den Tisch ziehen lassen.

In diesen Monaten hat mich Hans Jenemann mehrmals pro Woche angerufen. Es ging um die Namen von Experten, die den Beirat beraten könnten, um die Höhe des Preisgeldes in Relation zu anderen Preisen der internationalen Wissenschaftsgeschichte, um den Entwurf einer Pressenotiz über die Einrichtung der Stiftung, den Ausschreibungstext und dergleichen mehr. Meine Söhne haben manchmal schon die Augen gerollt, wenn sie mir wieder einmal den Telephonhörer mit den Worten übergaben: „Das ist für dich: Herr Jenemann aus Hochheim!". Sie wussten dann, dass es ein langes Gespräch werden würde.

Am 7. September 1990 fand bei Mettler in Gießen die konstituierende Besprechung statt. Neben Hans Jenemann nahmen daran teil: seitens der Mettler Instrumente GmbH Jochen Wienbeck, Geschäftsführer der deutschen Marktorganisation, und Karl H. Kusmenskij vom Bereich Unternehmensplanung, seitens des Stifterverbandes Dr. Klaus Neuhoff, außerdem in beratender Funktion die Wissenschaftshistoriker Prof. Dr. Fritz Krafft, Universität Marburg, und ich selbst, damals noch Universität Mainz. Als Beirat vorgesehen wurden die Herren Jenemann, Neuhoff und Wienbeck; den Vorsitz sollte Herr Neuhoff übernehmen.

Wie kontrovers der Verlauf war, geht aus meinen handschriftlichen Notizen und dem Protokoll der Besprechung[48] nicht hervor. Dass die beiden Repräsentanten der Firma Mettler, der Vertreter des der Industrie nahestehenden Stifterverbandes und die beiden anwesenden Wissenschaftshistoriker an einigen Punkten unterschiedliche Auffassungen hatten, wird jedoch deutlich. Eingehend diskutiert wurden „die Kostenaspekte (Honorierung der Mitglieder wie z.B. für die Sichtung der Arbeiten, Spesen, Kosten der Preisverteilung [recte: Preisverleihung],

[47] H. Jenemann an Dr. Klaus Neuhoff, Stifterverband (15. August 1990), Kopie im Archiv des Verf.

[48] Protokoll der Besprechung der Jenemann-Mettler-Stiftung, Gießen am 7. September 1990 (24. September 1990); dazu drei Blätter handschriftlicher Notizen; beides im Archiv des Verf.

Verwaltungskosten des Stifterverbandes, etc.)“, weil „sowohl die Attraktivität des Stiftungspreises als auch die Entgeltung der Gremiumsarbeit für den einen oder anderen Wissenschaftler ausschlaggebend sein können, im Preiskomitee mitzuwirken.“[49] Auf ausdrücklichen Wunsch von Hans Jenemann, dem an der langfristigen Sicherung der Erträge lag, war das Stiftungskapital „ausschließlich in festverzinslichen Bundes-Wertpapieren“ angelegt worden, und zwar zu dem damals noch erzielbaren Ertrag von knapp 9% jährlich.[50]

In Anlehnung an Gepflogenheiten von Industriestiftungen war ursprünglich an eine Aufwandsentschädigung für die Mitglieder des Beirats Höhe von 20.000 DM/Jahr gedacht.[51] Da dies offenbar nicht konsensfähig war, weil Hans Jenemann fürchtete, dass dafür „beträchtliche Geldsummen aus den laufenden Erträgen des Stiftungskapitals hätten aufgewendet werden müssen“,[52] sollte „die Frage der Entgeltung der Gremiumsmitglieder“ bis zur Klärung der Finanzsituation zurückgestellt werden.[53] Die Firma Mettler erklärte sich bereit, die Pressearbeit sowie Organisation und Kosten der Verleihungsveranstaltungen zu übernehmen; der Stifterverband bestand auf einer Verwaltungspauschale in Höhe von 7-8% der Stiftungserträge.

Inhaltlich forderten die anwesenden Wissenschaftshistoriker, dass der im ursprünglichen Entwurf vorgesehene Förderzweck „Entwicklung wissenschaftlicher Instrumente“ als vorprogrammierter „Zielkonflikt zwischen ‚Historie’ und ‚Entwicklung’“ aus dem Stiftungszweck gestrichen und Satzung wie Treuhandvertrag entsprechend geändert werden müssten. Kritisch angemerkt wurde auch, dass sich die im Entwurf vorgesehene Absicht, mit der Stiftung „insbesondere den wissenschaftlichen Nachwuchs … zu fördern“, mit der Verleihung eines international wahrgenommenen Preises für herausragende wissenschaftliche Arbeiten schwer vereinbaren lasse. Für die Preissatzung war vorgesehen, dass der Beirat ein dreiköpfiges instrumentengeschichtlich ausgewiesenes Preisgremium einsetzt, das sich fallweise um zusätzliche Experten ergänzen könne; in jedem Fall aber sollte ein Vertreter des Beirats mit beratender Stimme im Preisgremium mitwirken. Für die Verleihung des auf 10.000 DM dotierten Paul-Bunge-Preises war vorzugsweise die alle zwei Jahre in München stattfindende Analytica, die internationale Fachmesse für Labortechnik, Analytik und Biotechnologie, vorgesehen. Ergebnisoffen diskutiert wurde, ob man die instrumentengeschichtliche Forschung gezielter mit Preisfragen anregen könne oder ob thematische Ausschreibungen, z.B. zum Thema Regelungstechnik oder Automatisation, sinnvoll wären.

Zur endgültigen Fixierung von Satzung und Treuhandvertrag fand am 28. September 1990 in Gießen ein letztes Treffen von Hans Jenemann mit den Vertretern der Mettler Instrumente GmbH und des Stifterverbandes statt. Die beiden Fachvertreter der Wissenschaftsgeschichte waren dazu zwar nicht eingeladen worden, die von ihnen geforderten Änderungen wurden jedoch übernommen. Dem Beirat sollten neben Hans Jenemann jeweils ein Vertreter der Firma Mettler Instrumente GmbH und des Stifterverbandes angehören, die Federführung bei

[49] Ebd., Protokoll, Bl. 2.

[50] Hans R. Jenemann, „Zur Hans R. Jenemann Stiftung“, 4 Bll., Kopie eines signierten unveröffentlichten Typoskripts vom 28. Januar 1993, im Archiv des Verf.

[51] Meinen Aufzeichnungen zufolge aufgrund des vom Stifterverband vorgetragenen Standpunktes, wonach eine „ehrenamtliche Tätigkeit nicht zu verantworten“ sei, für die jedes Mitglied von Beirat und Preiskomitee ca. fünf Tage im Jahr aufwenden müssten, was pauschal mit 500 bis 1000 DM zu vergüten sei, so dass man zuzüglich der Reisekosten auf einen Gesamtaufwand von 20.000 DM komme.

[52] Hans R. Jenemann, „Zur Hans R. Jenemann Stiftung“, 4 Bll., Kopie eines signierten unveröffentlichten Typoskripts vom 28.1.1993, im Archiv des Verf.

[53] Protokoll, Bl. 2. Meiner Erinnerung nach war Hans Jenemann, der sich als sparsamer Mensch (außer Waagen) nichts gönnte, über die mit dem Stifterverband ausgehandelten Bedingungen nicht sehr glücklich.

Dr. Klaus Neuhoff vom Stifterverband liegen. Anfang 1991 verschickte die Marketing-Abteilung von Mettler dann eine Presseinformation, mit der der mit 10.000 Mark dotierte Paul-Bunge-Preis zur Verleihung im darauffolgenden Jahr erstmals ausgeschrieben wurde.[54]

Zu seiner konstituierenden Sitzung traf sich der Beirat am 22. Juli 1991 im Deutschen Museum in München. Dabei wurden die Grundzüge eines Preisstatuts festgelegt und der Ausschreibungstext samt Infoblatt entworfen, das an 100 ausgewählte Institutionen des In- und Auslandes verschickt werden sollte.[55] Ob die Ausschreibung dann tatsächlich erfolgt ist oder der Preis nur durch die Pressemitteilung von Mettler sowie eine im Frühjahr 1991 in den *Berichten zur Wissenschaftsgeschichte* erschienene Notiz[56] bekannt wurde, war nicht zu ermitteln.

Zur großen Überraschung des Stifters erklärte dann aber Mettler im September 1991, dass die Firma sich aus der Stiftung zurückziehe.[57] Die genauen Gründe dafür sind mir nicht bekannt,[58] doch in den kurz zuvor erfolgten Umstrukturierungen innerhalb der Firma zu vermuten: 1989 hatte die Mettler Instrumente AG, die seit 1980 dem Baseler Chemie- und Pharmaunternehmen Ciba-Geigy gehörte, mit der Toledo Scale Corporation, dem größten US-amerikanischen Hersteller von Industriewaagen, fusioniert, und daraus war die Mettler-Toledo AG mit Sitz in der Schweiz sowie in Columbus, Ohio, hervorgegangen. Das Gießener Stammhaus hatte dadurch seine Unabhängigkeit verloren und konnte, wie aus der Korrespondenz hervorgeht, sein instrumentengeschichtliches Engagement offenbar nicht weiter fortführen.[59]

Nach Rückzug aus der Stiftung übertrug Mettler sein Stimmrecht auf Hans Jenemann, damit dieser über eine neue Trägerschaft und eine neue Stiftungssatzung entscheiden könne. Daraufhin wandte sich Jenemann an die Gesellschaft Deutscher Chemiker (GDCh) und die Deutsche Bunsengesellschaft für Physikalische Chemie (DBG) in Frankfurt, weil er in beiden selbst Mitglied war. Am 24. November 1991 fand ein Gespräch in Essen statt, an dem Dr. Klaus Neuhoff vom Stifterverband, Dr. Heinz Behret und Peter Müllergroß[60] seitens der GDCh sowie Hans Jenemann teilnahmen, um die Modalitäten der Übergabe zu klären. Gegenüber der ursprünglichen, zwischen Mettler-Toledo und dem Stifterverband ausgearbeiteten Satzung wurden dabei die Hürden gegenüber einer Auflösung der Stiftung und einer Änderung des Stiftungszwecks deutlich erhöht, außerdem wurde der Beirat um fachlich kompetente Mitglieder ergänzt, wodurch ein eigenes Preisgremium mit bloß beratender Funktion überflüssig wurde.[61]

[54] Schreiben von Mettler Instrumente GmbH an Prof. Fritz Krafft, Marburg, vom 29. Januar 1991 mit Anlage der zweiseitigen undatierten Presseinformation „Jenemann-Mettler-Stiftung gegründet“, im Archiv von Fritz Krafft.

[55] Hans R. Jenemann, „Zur Hans R. Jenemann Stiftung“, 4 Bll., Kopie eines signierten unveröffentlichten Typoskripts vom 28.1.1993, im Archiv des Verf.

[56] *Berichte zur Wissenschaftsgeschichte* 14 (1991), 136.

[57] Schreiben von Mettler-Toledo an Hans Jenemann vom 24. September 1991; vgl. auch Brief von Hans Jenemann an den Verf. vom 10. Januar 1992.

[58] Das Firmenarchiv von Mettler, Gießen, hat auf meine Anfragen nicht reagiert.

[59] Der 150 Waagen umfassende Bestand, den Hans Jenemann an die Mettler-Toledo GmbH in Gießen verkauft hatte, war dort eine Zeitlang in einem Schauraum ausgestellt, später aber nicht mehr zugänglich. 2008 wurden die Stücke als Dauerleihgabe dem Philipp-Matthäus-Hahn-Museum in Albstadt-Onstmettingen überlassen. Dieses übernahm im gleichen Jahr auch die etwa 100 beim Tod von Frau Jenemann noch im Privathaus in Hochheim verbliebenen Waagen samt der zugehörigen Dokumentation im Umfang von 120 Aktenordnern; vgl. <http://www.jenemann.org/>.

[60] GDCh-Verwaltungsdirektor bis 2010, vgl. *Nachrichten aus der Chemie* 55 (2007), 357-357.

[61] Hans R. Jenemann, „Zur Hans R. Jenemann Stiftung“, 4 Bll., Kopie eines signierten unveröffentlichten Typoskripts vom 28.1.1993, im Archiv des Verf.

Die ursprünglich als eine Art Industriestiftung angelegte Konstruktion war damit, wie auch mit dem Übergang der Trägerschaft an zwei hochrangige naturwissenschaftliche Fachgesellschaften, zu einer Wissenschaftsstiftung geworden, was dem ursprünglichen Anliegen von Hans Jenemann sehr viel besser entsprach. Förmlich wurde die Stiftung dann am 3. Juni 1992 bei der Gesellschaft Deutscher Chemiker (GDCh) und der Deutschen Bunsengesellschaft für Physikalische Chemie (DBG) eingerichtet;[62] am 5. August 1992 stimmte der Stifterverband der neuen Satzung und damit der Übertragung des Stiftungskapitals von 400.000 DM auf die GDCh zu. 1993 führte Hans Jenemann der Stiftung noch einmal weitere 63.000 DM zu, die aus dem Verkauf eines weiteren Teils seiner Waagensammlung an die DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V. in Frankfurt am Main stammten, bei der sie seitdem in einem besonderen Waagen-Kabinett präsentiert werden.[63] Mit einem Stiftungskapital von 463.000 DM (ab 2002: 236.728 Euro) als fixem Grundstock ist die Hans R. Jenemann-Stiftung die am besten ausgestattete der von der GDCh verwalteten Stiftungen.

Beirat

Der Beirat der Stiftung traf sich erstmals am 29.1.1993 in der GDCh-Geschäftsstelle in Frankfurt. Satzungsgemäß gehören dem Beirat ex officio an der jeweilige Präsident der Gesellschaft Deutscher Chemiker, der jeweilige Erste Vorsitzende der Deutschen Bunsen-Gesellschaft, der Leiter eines naturwissenschaftlichen oder technischen Museums (beispielsweise des Deutschen Museums in München) sowie der Vorstand oder Leiter eines Universitätsinstituts für Wissenschafts- oder Technikgeschichte, außerdem Hans Jenemann als persönliches Mitglied. Die drei ex-officio-Vertreter hatten laut Satzung das Recht, einen Vertreter zu entsenden.

Seitens der GDCh-Geschäftsstelle wurde die Einrichtung der Stiftung von Kurt Begitt, dem Leiter der Abteilung Öffentlichkeitsarbeit, betreut. Anfangs waren im Beirat: Prof. Dr. Heinrich Nöth (GDCh-Präsident), Dr. Alto Brachner (als Vertreter des Deutschen Museums, von 1994–2000 Prof. Dr. Wolf Peter Fehlhammer), Dr. Heinz Behret (Geschäftsführer der DBG), Prof. Dr. Christoph Meinel (Universität Regensburg; Vorsitz von 2001–2020) und bis zu seinem Tode Hans Jenemann. Die derzeitige Zusammensetzung des Beirats ist: Dr. Charlotte Bigg (Paris, Vorsitzende seit 2021), Prof. Dr. Helmuth Trischler (München, für das Deutsche Museum, seit 2001), Prof. Dr. Jürgen Janek (Gießen, für die DBG, seit 2001) und Prof. Dr. Henning Hopf (Braunschweig, für die GDCh, seit 2003).

Von 2001 bis 2003 und dann wieder von 2007 an wurden die jährlichen Treffen des Beirats in der GDCh-Geschäftsstelle durch ein Umlaufverfahren abgelöst, für das sich im Laufe der Jahre eine bewährte Routine entwickelte: Zunächst fertigten die beiden dem Beirat angehörenden Vertreter der Wissenschaftsgeschichte vergleichende Gutachten über die eingegangenen Bewerbungen an und ließen diese dann mit sämtlichen Unterlagen zirkulieren. Anfangs geschah dies noch auf dem Postweg, und die Beteiligten werden sich noch gut an die physische Anstrengung erinnern, die gewichtigen Kartons mit den eingereichten Arbeiten von der Poststelle zu holen und wieder zur Post zu bringen. In den letzten Jahren wurde dieses umständliche Verfahren fast vollständig durch die Zirkulation elektronischer Unterlagen abgelöst. Besonderer Dank gebührt in diesem Zusammenhang der GDCh-Geschäftsstelle, die den Umlauf stets sorg-

[62] Dass es diese beiden Gesellschaften waren – und nicht z.B. die Scientific Instruments Society – erklärt sich daraus, dass Hans Jenemann dort Mitglied war und sie daher als seine geistige Heimat ansah. [Quelle: Hans Jenemann, „Zur Hans R. Jenemann Stiftung“ (28. Januar 1993), Typoskript beim Verf.].

[63] Brief von Hans Jenemann an den Verf. vom 10. Dezember 1993, im Archiv des Verf. Adresse: DECHEMA Gesellschaft für Chemische Technik und Biotechnologie, Theodor-Heuss-Allee 25, Frankfurt/Main.

fältig und pünktlich organisiert hat und nach wie vor organisiert, wobei die Betreuung von Dr. Kurt Begitt auf Jutta Bröll und 2005 auf Barbara Köhler überging, die diese Aufgabe 2020 an Dr. Jasmin Herr übergeben hat.

Die Ausschreibung des Preises erfolgt jeweils im Frühsommer durch die Öffentlichkeitsarbeit der GDCh und der DBG über die chemie-üblichen Presseverteiler; an die spezifische Fachcommunity verschickt sie der Beirat über Mailinglisten und einschlägige Foren der Wissenschaftsgeschichte (Rete, Oldenburg, Mersenne, Chem-Hist, H-Soz-Kult, HSS). Damit werden praktisch sämtliche einschlägig arbeitenden Wissenschaftler/innen weltweit erreicht. Deadline für die Einsendungen ist jeweils der 30. September. Die Beschlussfassung im Beirat erfolgt in der Regel im November oder Dezember.

Paul-Bunge-Preis

Erstmals vergeben wurde der Paul-Bunge-Preis am 19. März 1993 auf der Vortragstagung der GDCh-Fachgruppe ‚Geschichte der Chemie' in Jena. Da aufgrund des Übergangs vom Stifterverband auf GDCh und DBG im Jahr davor noch kein Preis vergeben werden konnte, auf die ersten Pressemitteilungen hin allerdings schon genügend qualifizierte Bewerbungen eingegangen waren, wurde die Auszeichnung 1993 doppelt vergeben: Mara Miniati, die Kustodin des Museo di storia della scienza (heute: Museo Galileo) in Florenz erhielt ihn in Anerkennung ihres 1991 publizierten Katalogs dieser bedeutenden Sammlung, zu deren Kernbestand die Instrumente Galileo Galileis und seiner Schüler gehören; Klaus Hentschel für seine Hamburger Habilitationsschrift zur Diskussion um die Rotverschiebung im Sonnenspektrum.[64] Im Rahmen

Preisverleihung 1993 in Jena (v.l.n.r.): Heinz Behret (Geschäftsführer der GDCh), Sabine Ernst, Klaus Hentschel, Mara Miniati, Christoph Meinel; aus: *Chemie & Schule* 3/93, S. 20.

[64] Mara Miniati, *Museo di storia della scienza: Catalogo* (Firenze 1991); Klaus Hentschel, *Zum Zusammenspiel von Instrument, Experiment und Theorie: Rotverschiebung im Sonnenspektrum und verwandte spektrale Verschiebungseffekte von 1880 bis 1960*, 2 Bde (Hamburg 1998).

der gleichen Festsitzung wurde Sabine Ernst für ihre in Mainz als Dissertation vorgelegte Edition des Briefwechsels zwischen Lise Meitner und Otto Hahn[65] mit dem ebenfalls von der GDCh betreuten Bettina-Haupt-Förderpreis für Geschichte der Chemie ausgezeichnet.

Die Verleihungen des Paul-Bunge-Preises finden im Wechsel auf Veranstaltungen der GDCh und der DBG statt. Bei letzterer ist es in der Regel die jährlich an wechselnden Orten stattfindende Bunsentagung im Frühjahr mit etwa 700 Teilnehmern; bei der GDCh geschah dies entweder im Rahmen der alle zwei Jahre stattfindenden GDCh-Hauptversammlungen bzw. des Wissenschaftsforum Chemie mit etwa 2000 Teilnehmern, vorzugsweise aber auf den im zweijährigen Turnus abgehaltenen Vortragstagungen der GDCh-Fachgruppe 'Geschichte der Chemie', die einen persönlicheren und wegen der historischen Ausrichtung auch fachlich besser passenden Rahmen bieten. Die Öffentlichkeitsarbeit von GDCh und Bunsengesellschaft dokumentiert die Verleihung und sorgt über Pressemitteilungen für Sichtbarkeit.

Der Paul-Bunge-Preis ist der höchstdotierte wissenschaftshistorische Preis weltweit und der einzige im Bereich der Geschichte wissenschaftlicher Instrumente. Im Zeitraum 1992–2023 haben sich für den Preis insgesamt 217 Personen beworben. Die Bewerbungen kamen – Mehrfachbewerbungen eingerechnet – aus Deutschland (72), Großbritannien (50), den USA (44), Indien (7), Frankreich (7), Kanada (7), Italien (4), Israel (4), Australien (4), Ungarn (3), der Schweiz (3), Irland (2), den Niederlanden (2), Spanien (2) und je eine Bewerbung aus Dänemark, Griechenland, Polen, Portugal, China und der Ukraine. Die Preisträger/innen kamen aus Großbritannien (12), den USA (10), Deutschland (9), Italien (3), Kanada (2) und je einmal aus Frankreich und Australien.

Die folgende Tabelle zeigt jahrgangsweise die Zahl der Bewerbungen bzw. Vorschläge, die Herkunftsländer der Kandidatinnen und Kandidaten (nicht notwendigerweise deren Nationalität), Name und Wirkungsort der Laureaten samt Gegenstand des Preises, ihr Land und das Alter zum Zeitpunkt der Preisverleihung.

Jahr	*Σ*	*Länder (ISO 3166-1)*	*Preisträger/in, Ort zum Zeitpunkt der Preisverleihung / verliehen für*	*Land*	*Alter*
1993	4	DE (2), HU, IT	**Mara Miniati**, Florenz *Museo di Storia della Scienza: Catalogo* (Firenze 1991)	IT	54
			Klaus Hentschel, Hamburg *Zum Zusammenspiel von Instrument, Experiment und Theorie: Rotverschiebung im Sonnenspektrum und verwandte spektrale Verschiebungseffekte von 1880 bis 1960*, Habil.-Schrift, Univ. Hamburg	DE	32
1994	5	DE (3), GB, HU	**Matthias Dörries**, München "Balances, spectroscopes, and the reflexive nature of experiment"*, Studies in the History and Philosophy of Science* 25 (1994), 1-36, und "Prior History and Aftereffects: Hysteresis and Nachwirkung in 19th Century Physics", *Historical Studies in the Physical Sciences* 22:1 (1991), 25-55	DE	34
			Heinz Otto Sibum, Cambridge "Reworking the mechanical value of heat: Instruments of precision and gestures of accuracy in early Victorian England", *Studies in History and Philosophy of Science* 26 (1995), 73–106	GB	38

[65] Sabine Ernst, *Lise Meitner an Otto Hahn, Briefe aus den Jahren 1912 bis 1924: Edition und Kommentierung*, Quellen und Studien zur Geschichte der Pharmazie, Bd. 65 (Stuttgart 1992).

Jahr	*Σ*	*Länder (ISO 3166-1)*	*Preisträger/in, Ort zum Zeitpunkt der Preisverleihung / verliehen für*	*Land*	*Alter*
1995	8	US (3), GB (2), DE (2), IT	**Gerard L'Estrange Turner**, Oxford (1926–2012) Lebenswerk, insbes. für seine Arbeiten zur Geschichte des Mikroskops	GB	58
1996	9	US (4), DE (2), GB (2), HU	**David King**, Frankfurt Lebenswerk, insbes. für seine Arbeiten über Astrolabien	DE	54
			Stuart Feffer, Aberdeen NJ "Microscope to munitions: Ernst Abbe, Carl Zeiss and the transformation of technical optics, 1850–1914", PhD Diss. Berkeley 1994	US	32
1997	9	DE (4), US (3), AUS, FR	**Silvio A. Bedini**, Washington DC Lebenswerk, z.T. versammelt in: *Science and Instruments in Seventeenth-Century Italy* (Aldershot 1994)	US	80
1998	5	GB (2), DE (2), US	**Robert Bud**, London (mit Deborah Warner) *Instruments of Science: An Historical Encyclopedia* (New York 1998)	GB	46
			Deborah J. Warner, Washington DC (mit Robert Bud) *Instruments of Science: An Historical Encyclopedia* (New York 1998)	US	57
1999	3	AUS (2), DE	**Nicolas Rasmussen**, Sydney *Picture Control: The Electron Microscope and the Transformation of Biology in America, 1940–1960* (Stanford 1997)	AUS	37
2000	6	DE (3), US, GB, CH	**Alan Q. Morton**, London *Public and Private Science: The King George III Collection* (Oxford 1993)	GB	50
			Richard J. Sorrenson, Bloomington IN *"George Graham, visible technician", British Journal of the History of Science 32 (1999), 203–222;* "The ship as a scientific instrument in the 18th century", *Osiris* 11 (1996), 221–236	US	39
2001	13	GB (4), DE (4), US (3), CA (2)	**Jim Bennett**, Oxford Lebenswerk	GB	54
2002	2	IT, IE	**Paolo Brenni**, Florenz Lebenswerk und insbes. die Kataloge des *Museo Galileo* und des *Istituto Tecnico Toscano*	IT	48
2003	6	GB (2), DE (2), US, IL	**Sean F. Johnston**, Glasgow *A History of Light and Colour Measurement* (Bristol 2001)	GB	46
2004	9	DE (4), US (3), GB, UA	**Carsten Reinhardt**, Regensburg "Physical Instrumentation and its Impact on Chemistry: Nuclear Magnetic Resonance and Mass Spectrometry, 1950–1980", Habil.-Schr. Univ. Regensburg 2004	DE	38
			Jobst Broelmann, München *Intuition und Wissenschaft in der Kreiseltechnik, 1750–1930* (München 2003)	DE	61
2005	3	US (2), DE	**Myles W. Jackson**, Salem, OR *Spectrum of Belief: Joseph von Fraunhofer and the Craft of Precision Optics* (Cambridge, MA 2000)	US	41
2006	6	DE (4), GB (2), US,	**Davis Baird**, Columbia, SC *Thing Knowledge: A Philosophy of Scientific Instruments* (Berkeley 2004)	US	51
			Inge Keil, Augsburg *Augustanus Opticus: Johann Wiesel (1583–1662) und 200 Jahre optisches Handwerk in Augsburg* (Berlin 2000)	DE	75

Jahr	*Σ*	*Länder (ISO 3166-1)*	*Preisträger/in, Ort zum Zeitpunkt der Preisverleihung / verliehen für*	*Land*	*Alter*
2007	5	US (3), DE (2)	**Charlotte Bigg**, Berlin "Behind the lines: Spectroscopic enterprises in early twentieth-century Europe", PhD diss., Univ. of Cambridge 2002	DE	31
2008	4	GB (2), DE (2)	**Alison D. Morrison-Low**, Edinburgh *Making Scientific Instruments in the Industrial Revolution* (Edinburgh 2007)	GB	53
2009	10	GB (4), DE (2), US (2), IL (2)	**Jutta Schickore**, Bloomington, IN *The Microscope and the Eye: A History of Reflections, 1740–1870* (Chicago 2007)	US	45
2010	6	GB (3), DE (3)	**Henning Schmidgen**, Berlin *Die Helmholtz-Kurven: Auf der Spur der verlorenen Zeit* (Berlin 2009)	DE	44
2011	7	GB (2), US (2), DE, DK, IE	**Matteo Valleriani**, Berlin *Galileo Engineer* (Heidelberg/New York 2010)	DE	39
2012	4	DE (3), CA	**David Pantalony**, Ottawa *Altered Sensations: Rudolph Koenig's Acoustical Workshop in 19th-Century Paris* (Dordrecht 2009)	CA	40
2013	9	DE (4), US (2), GB, CA, IT	**Marco Beretta**, Bologna *The Alchemy of Glass: Counterfeit, Imitation and Transmutation in Ancient Glassmaking* (Sagamore Beach 2009) und seine Arbeiten über die Instrumente A.L. Lavoisiers	IT	51
2014	10	DE (6), GB (2),US, ES	**Cyrus C.M. Mody**, Houston, TX *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (Cambridge, MA 2011)	US	40
2015	6	US (2), DE, CH, GB, ES	**Brian Gee**, Chelsea *Francis Watkins and the Dollond Telescope Patent Controversy*, ed. by Anita McConnell und A.D. Morrison-Low (Farnham 2014)	GB	70
2016	6	GB (4), DE, US	**Robert Anderson**, Cambridge Lebenswerk	GB	72
2017	7	GB (4), US (2), IN	**Simon Schaffer**, Cambridge Lebenswerk	GB	62
2018	6	GB, FR, US, PT, IN (2)	**Anthony J. Turner**, Le Mesnil-le-Roi Lebenswerk seit *Early Scientific Instruments, Europe, 1400–1800* (London 1987)	FR	72
2019	6	GB (2), DE (2), FR, GR, US, IN	**Sara J. Schechner**, Cambridge MA Lebenswerk	US	62
2020	7	GB (3), US, FR, IL, IN	**Simon Werrett**, London *Thrifty Science: Making the Most of Materials in the History of Experiment* (Chicago 2019)	GB	49
2021	10	GB (3), DE (3), US, FR, NL, IN	**Liba Taub**, Cambridge Lebenswerk	GB	67
2022	14	DE (3), US (3), CA (2), FR, NL, GB, AU, IN, CN	**Matthew L. Jones,** New York NY *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago 2016)	US	48
2023	9	DE (5), CH, FR, PL, CA	**Robert W. Smith,** Edmonton Lebenswerk	CA	70

Von 1992 bis 2023 erhielten insgesamt 31 Preisträger und 7 Preisträgerinnen den Paul-Bunge-Preis; der Frauenanteil liegt damit bei 18 Prozent. 27mal wurde der Preis aufgrund herausragender Einzelwerke zugesprochen, 11mal für das jeweilige Lebenswerk. Dementsprechend lassen sich zwei Kohorten unterscheiden: (i) Pioniere dieses Gebiets, meist wissenschaftlich besonders aktive Kuratoren, die für ihr gesamtes Oeuvre ausgezeichnet wurden, und (ii) Nachwuchswissenschaftler/inne/n, die der Instrumentengeschichte neue Perspektiven eröffnet haben. Dem Beirat war es dabei immer wichtig, hier das richtige Verhältnis zu finden, weil nicht nur vergangene Leistungen geehrt, sondern auch innovative neue Ansätze ausgezeichnet und auf diese Weise Akzente gesetzt werden sollen. Die jüngste Preisträgerin war zum Zeitpunkt der Zuerkennung des Preises 31 Jahre alt, der älteste Preisträger 80.

Anfänglich wurde der Bunge-Preis gelegentlich doppelt vergeben, weil die Erträge aus dem Stiftungskapital dies erlaubten. Diese Zeiten sind lange vorbei; und seitdem hat der Beirat entschieden, grundsätzlich an der Vergabe nur eines einzigen Preises pro Jahr festzuhalten.

Weitere Fördermaßnahmen

Der Satzung der Hans R. Jenemann-Stiftung zufolge kann der Stiftungszweck – neben der Hauptaufgabe, der jährlichen Verleihung des Paul-Bunge-Preises – „soweit noch Mittel vorhanden sind, außerdem durch Vergabe von Geldsummen für andere Arbeiten aus dem Bereich der Geschichte wissenschaftlicher Instrumente verwendet werden." In den Anfangsjahren, als die Erträge aus der Stiftung noch hoch genug waren, wurde von dieser Möglichkeit gelegentlich Gebrauch gemacht. So wurden gelegentlich kleinere Anerkennungspreise für Vorschläge gewährt, die nicht mit dem Paul-Bunge-Preis ausgezeichnet werden konnten, so im Jahre 2001 ein Betrag von 2.500 DM an Penelope Gouk, Manchester, für ihr Buch *Music, Science and Natural Magic in Seventeenth-Century England* (New Haven 1999). Außerdem wurden von 1994 bis 2001 und dann noch einmal im Jahre 2005 jeweils Beträge zwischen 2.500 und 5.000 für Druckkostenzuschüsse, kleinere Projektbeihilfen und Zuschüsse zu Tagungen gewährt.[66] Allerdings war der Beirat hinsichtlich dieser vor allem von Hans Jenemann selbst befürworteten Praxis von Anfang an zurückhaltend; denn die Außenwirkung solcher Maßnahmen ist gering, und die Vergabe zusätzlicher Fördergelder erfolgte zu kontingent, d.h. ohne öffentliche Ausschreibung und vergleichende Bewertung, und war daher wenig transparent. Eine förmliche Ausschreibung zusätzlicher Fördermöglichkeiten verbietet sich allein schon deshalb, weil dies zu einer Fülle von Anträgen führen und die Stiftung überfordern würde. Deshalb hat der Beirat von diesem Instrument von 2005 an keinen Gebrauch mehr gemacht, zumal rückläufige Erträge die finanziellen Spielräume beschränken. Statt dessen wurde empfohlen, die Rücklagen zu verwenden, um 2023 das Jubiläum 30 Jahre Paul-Bunge-Preis mit einer internationalen Tagung zu feiern.

[66] So z.B. 1996 3.000 DM an Dr. Günther Oestmann für die Erstellung einer Monographie über die astronomische Uhr in Olmütz; 1997 4.000 DM für 20 Teilnahmestipendien für die Tagung „Instrument – Experiment" in Regensburg an Nachwuchsleute; 1998 3.000 DM für die internationale Tagung „Artefacts and Systems in Transport" am Deutschen Museum in München; 2000 2.000 DM für die Tagung „Science, Technology, and Nature at the Time of Pompei" im Deutschen Museum; 2000 10.000 DM an die Commission on the History of Modern Chemistry der IUHPS/DHS für die internationale Tagung „From the Test Tube to the Autoanalyzer: The Development of Chemical Instrumentation in the Twentieth Century".

Finanzlage

Die Stiftung verfügt seit mehr als zwei Jahrzehnten über einen Kapitalstock von exakt 236.728,14 Euro. Hinzu kommen freie Rücklagen in Höhe von 65.800 Euro (mit einer Entnahme von 7.500 Euro in 2021). Das Vermögen der Stiftung wird an den Finanz- und Kapitalmärkten unter Berücksichtigung der „Anlagengrundsätze der GDCh“ in der Fassung vom Dezember 2020 angelegt. Die dort erzielten Erträge vor allem aus Zinsen, Dividenden und Verkaufserlösen dienen ausschließlich dazu, den Stiftungszweck zu realisieren. Die jährlichen Aufwendungen für die Realisierung des Satzungszweckes bewegen sich in der Regel zwischen 7.500 Euro und 11.000 Euro und beinhalten neben dem Preisgeld (7.500 Euro) vor allem Aufwendungen für Reise- und Portokosten sowie für Ausgaben, die durch die notwendigen Sitzungen des Stiftungsbeirates entstehen.

Die freien Rücklagen unterliegen nicht dem Gebot der zeitnahen Mittelverwendung. Wie wichtig die über viele Jahre gebildeten freien Rücklagen sind, wird daran deutlich, dass diese aktuell die negativen Stiftungsmittel, die für das laufende Geschäft der Stiftung verwendet werden, überkompensieren. Die Stiftung ist ausnahmslos in Wertpapieren investiert, deren Emittenten (Rentenpapiere) über eine erstklassige Bonität verfügen. Auch wenn immer wieder einmal konjunkturbedingt vorübergehende Kursverluste eintraten, kam es auch in diesen Jahren immer zu Ausschüttungen in Form von Dividenden.

Obwohl in den letzten zwei Jahrzehnten durch verschiedene Ereignisse (Subprime-, Finanz- und Eurokrise oder das ein Jahrzehnt lang andauernde Niedrigzinsniveau mit zum Teil Negativrenditen bei deutschen Staatsanleihen) die Finanzmärkte enorm volatil waren, konnte die Stiftung ihren Stiftungszweck immer realisieren, ohne dass der Kapitalstock zu irgendeinem Zeitpunkt abgesenkt werden musste. Bis 2006 lag die Vermögensverwaltung in der Hand des ehemaligen Verwaltungsdirektors der GDCh Peter Müllergroß. Seit 2007 liegt diese in der Verantwortung des Kaufmännischen Direktors der GDCh Volker Kilz.

Die Finanzen der Stiftung sind seit Aufnahme des Stiftungszweckes wohl geordnet und erlauben es, die aus Anlass des 30jährigen Bestehens des Paul-Bunge-Preises höheren – und nicht durch die laufenden Erträge vollständig gedeckten – Aufwendungen über eine Entnahme aus den freien Rücklagen zu kompensieren. Für die langjährige, zuverlässige und kostenneutrale Verwaltung der Stiftung gebührt der GDCh-Geschäftsstelle ganz besonderer Dank.

Ausblick

In den vergangenen drei Jahrzehnten ist es der Hans R. Jenemann-Stiftung gelungen, den Paul-Bunge-Preis als wichtigste Auszeichnung auf dem Gebiet der Geschichte wissenschaftlicher Instrumente international fest zu etablieren sowie ihm Prestige und Sichtbarkeit zu verleihen. Der Beirat ist überzeugt, dass tatsächlich die prominentesten Instrumentenhistoriker weltweit zu den Preisträgern zählen, und zwar nicht nur die Pioniere dieses Gebiets, die für ihr Lebenswerk ausgezeichnet wurden, sondern auch junge Historikerinnen und Historiker, die mit besonders innovativen Arbeiten neue Richtungen aufgewiesen haben. Hatte Hans Jenemann bei Einrichtung der Stiftung auch primär an die Geschichte der Metrologie und die eher technisch-apparativen Aspekte der Instrumentengeschichte gedacht, so trat im Laufe der Zeit auch die Bedeutung des Instrumentenbaus und -handels hinzu; ferner haben Anstöße aus der neueren Historiographie die an die Instrumente geknüpften Praktiken, die Bedeutung von Material und Materialität oder die unterschiedlichen Verfahren der Visualisierung neu in den Blick genommen. Auf diese Weise haben sich die Ansatzpunkte für eine historische Erforschung wissenschaftlicher Instrumente sowohl inhaltlich als auch methodisch wesentlich erweitert. Auf diese

Weise ist die Instrumentengeschichte in den vergangenen drei Jahrzehnten zu einem multiperspektivischen, gut etablierten und überaus lebendigen Forschungsgebiet geworden, dessen Protagonisten aus allen möglichen Disziplinen und Institutionen kommen.

Die Hans R. Jenemann-Stiftung ist stolz darauf, Teil dieser Entwicklung zu sein und ihren Teil dazu beigetragen zu haben. 1983 war die Scientific Instrument Society mit Sitz in London gegründet worden, die Hans Jenemann 1996 zum Ehrenmitglied ernannt hat. 1997 hatte der Verfasser dieser Zeilen mit Unterstützung der Hans R. Jenemann-Stiftung in Regensburg eine Tagung zum Thema „Instrument – Experiment" organisiert, auf der in historiographischer und methodologischer Hinsicht eine Art Zwischenbilanz des Forschungsstandes gezogen und künftige Perspektiven diskutiert werden sollten.[67] Zwei effektive und vier nachmalige Bunge-Preisträger/innen haben damals an der Tagung in Regensburg teilgenommen. Ein historiographisch vergleichbares Ziel auf dem Gebiet der Objekt- und Sammlungsgeschichte verfolgt der 2009 von drei Bunge-Preisträger/inne/n herausgegebene Sammelband *European Collections of Scientific Instruments, 1550–1750*,[68] und auch der 2016 erschienene Band *How Scientific Instruments have changed Hands*[69] wurde von drei Bunge-Preisträger/inne/n herausgegeben. Im September vergangenen Jahres schließlich hat die Scientific Instrument Society aus Anlass ihres 40jährigen Bestehens in Athen eine Tagung zum Thema „The Past, Present, and Future of Scientific Instrument Studies" veranstaltet, an der mindestens fünf Bunge-Preisträger aktiv teilgenommen haben.

Zum 30jährigen Bestehen des Paul-Bunge-Preises lädt die Hans R. Jenemann-Stiftung sämtliche Bunge-Preisträger zu einem Symposium „Writing the History of Scientific Instruments: State of the Art and Future Perspectives" ins Deutsche Museum nach München ein, um sich über den Stand und künftige Perspektiven der Instrumentengeschichte auszutauschen. Das Symposium wird die seit langem bestehenden Verbindungen unter den Preisträgern noch einmal verstärken, neue Kontakte innerhalb der Community der Instrumentenhistorikerinnen und –historiker ermöglichen und gleichzeitig auch nach außen hin noch einmal deutlich machen, welche Bedeutung der Paul-Bunge-Preis für dieses Forschungsgebiet hat.

Christoph Meinel

[67] Christoph Meinel (Hrsg.), *Instrument – Experiment: Historische Studien* (Diepholz/Berlin 2000).

[68] Giorgio Strano, Stephen Johnston, Mara Miniati und Alison Morrison-Low (Hrsg.), *European Collections of Scientific Instruments, 1550–1750* (Leiden 2009).

[69] Alison Morrison-Low, Sara J Schechner u. Paolo Brenni (Hrsg.), *How Scientific Instruments have changed Hands* (Leiden/Boston 2016).

BUNGE PRIZE AWARDEES, 1993 – 2023: REFLECTIONS AND STATEMENTS

In 2023, the Paul Bunge Prize celebrates its thirtieth anniversary. On this occasion all living prizeholders were asked to reflect on the following three questions:

- Where did the history of scientific instruments stand when I was awarded the Bunge prize?
- What effect did the prize have for me?
- How has the field of research for which I received the prize changed since?

The last part of this booklet contains the answers we received, together with a biography of the respective awardee, arranged according to the year when she or he received the Prize. For the sake of brevity the biographical notes do not normally include scholarly awards and functions in scientific societies. Instead, reference is made to the personal homepages on which further information can be found. In the case of colleagues who have passed away, we refer to obituaries.

*

1993 **Mara Miniati**, Florence, Italy

Bunge Prize awarded for: *Museo di Storia della Scienza: Catalogo* (Firenze: Giunti, 1991)

Mara Miniati is emeritus curator of the Museo Galileo in Florence. In 1971 she earned a degree in philosophy from the University of Florence. She collaborated on the exhibition "The Rebirth of Science" at the Biblioteca Laurenziana that was part of the great "Firenze e la Toscana dei Medici nell'Europa del Cinquecento" event in 1980. The Scientific Secretary of the Istituto e Museo di Storia della Scienza in Florence since 1979, she curated the permanent exhibition "The Age of Galileo" (1987). In 1994 she became Deputy Director of the Istituto e Museo, a position she held until 2003. Subsequently she worked as Curator of the Koelliker Collection in Milan until 2008.

Her numerous publications on collections and Early Modern scientific instruments were complemented by the development of professional training courses in museology and exhibition design, and by defining standards for the cataloguing and the conservation of cultural heritage. Internationally she is best known as editor of beautiful catalogues and as curator of major exhibitions, such as "I Medici e le scienze: Strumenti e macchine nelle collezioni granducali" in Palazzo Pitti in 2008, and "Firenze scienza: le collezioni, i luoghi e i personaggi dell'Ottocento" in Palazzo Medici Riccardi and Museo di Storia Naturale in 2009, both in Florence.

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Between the 1980s and 1990s, the attention for historical scientific instruments in Italy had a strong impulse. The Florentine Istituto e Museo di storia della scienza was the leader of initiatives of not only local importance. Relations with the international community were constant: scholars and specialists in scientific instruments were frequent visitors to the Florentine Museum, whose rich specialized library attracted scholars from all over the world. The museum renewed the layout, published catalogs and enriched the material available to visitors, increasingly becoming both a scientific and museological point of reference.

When I received the award, I didn't give much importance to it: it was new, nobody talked about it. It was delivered to Jena, a city I knew: I had been there on an official visit in 1985 to arrange the exhibition "Occhiali da vedere" (Spectacles to see), which would bring to the Florentine museum a large part of the collection of instruments and graphics from the Optisches Museum of the Carl-Zeiss-Stiftung. On the occasion of the award ceremony, I found myself among people I didn't know, extraneous to the international community of scholars of scientific instruments that I usually frequented. Unfortunately, there were no opportunities for exchanges or meetings, either official or friendly, and therefore it was not possible for me to establish any kind of relationship at the time. Nothing changed for me in relation to the prize.

Time has passed: the work on instruments has greatly expanded, even if often with significant problems. There are numerous colleagues from various institutions in Italy who are carrying out first-rate work on the history of ancient equipment and research even on more recent ones, abandoned by schools and institutes. From the North of Italy to Sicily there is no shortage of examples. Furthermore, new technologies are an excellent resource for disseminating otherwise invisible or little-known collections and collections.

1993 Klaus Hentschel, then Hamburg; now Stuttgart, Germany

Bunge Prize awarded for: *Zum Zusammenspiel von Instrument, Experiment und Theorie: Rotverschiebung im Sonnenspektrum und verwandte spektrale Verschiebungseffekte von 1880 bis 1960* (Hamburg: Kovač, 1998)

Klaus Hentschel holds the chair for history of science and technology in the History Department of the University of Stuttgart since 2006. After receiving a PhD from the University of Hamburg in 1989, he was appointed assistant professor at the University of Göttingen in 1991, followed by fellowships at the Dibner Institute for the History of Science and Technology and the Massachusetts Institute of Technology in Boston, an Ernst-Cassirer guest professorship at the University of Hamburg, and a research position at the University of Bern.

His research interests include the history and philosophy of modern physics, the science of materials, the interplay of instrumentation, experiment and theory, invisible hands in research practice, and visual cultures of science and technology.

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When I received the PBP in 1992/93 as one of the first two prize-winners, the history of scientific instruments was to a large extent a historiographic niche, busily frequented by private collectors and museum curators, lovingly tending their collections and documenting these treasures in fine catalogues of their holdings, often limited to specific historical periods (such as Elizabethan, Georgian or Victorian) or to the holdings of specific institutions (such as the Science Museum or Greenwich Observatory). These enthusiastic collectors and curators also published beautifully illustrated anthologies of specific types of instruments such as thermometers and barometers, microscopes and telescopes, or precision balances (most notably by Hans R. Jenemann, donor of the Paul Bunge Prize). My own historical research heavily relied on these publications as documents about specific instruments and I was – and still am – deeply impressed by the breadth of knowledge which people like Gerard l'Estrange Turner (Paul Bunge Prize 1995), David King (Paul Bunge Prize 1996) or Jim Bennett (Paul Bunge Prize 2001) had acquired about the instruments in their collections and world-wide holdings of similar instruments. However, frequently the style of their publications was somehow antiquarian.

They often did not sufficiently interconnect with the many other fields of historiography then under discussion in the history of science community, be it the history of experimentation (in the manner of David Gooding, Peter Galison or Allan Franklin), social history (in the manner of Robert Darnton, Natalie Zemon Davis, or Myles Jackson (Paul Bunge Prize 2005) or the history of material cultures which was also in its formative stage at this time. For someone mostly interested in the history of scientific, esp. experimental practice (in my case esp. spectroscopy, astrophysics and allied sciences), these published inventories of instruments were insufficient because they lacked information about usage and skill of their users. Not that these skilled experts did not know these tricks of the trade – quite the contrary: in conversation, they could unpack a lot of such details about tacit knowledge acquired from long practice in handling these instruments. But this implicit knowledge was absent in their publications which focussed on detailed descriptions and on the history of their preservation in collections. Instrument makers were often mentioned but also often only as supplementary background information, making systematic searches for specific makers and their instruments across collections worldwide difficult. Only a few prosopographic dictionaries for specific professions such as clockmakers, barometer- or thermometer-makers existed, and these in turn only listed basic and condensed information on living dates (if known at all), regions of activity and specific groups of instruments produced.

Since 1990 an intensification of prosopographic studies has taken place, first and foremost exemplified by Gloria Clifton's and G. L'Estrange Turner's *Directory of British Scientific Instrument Makers, 1550–1851* which appeared in 1995 and lists over 5000 scientific instrument makers and retailers working in the British Isles, together with 10000 names of apprentices and associates. Unfortunately, until now no similar comprehensive dictionaries for other countries have appeared. Recently, a project by Liba Taub and associates has been launched to integrate this dictionary into an even broader online database, albeit also confined to the British isles.

Concerning the history of the scientific instrument-making trades we have the compendiums *The Finest Instruments Ever Made: A Bibliography of Medical, Dental, Optical, and Pharmaceutical Company Trade Literature; 1700–1939* (Arlington 1986), J.E. Burnett and A.D. Morrison-Low: *Vulgar and Mechanick: The Scientific Instrument Trade in Ireland 1650–1921* (Dublin 1989), and Gerard L'E Turner: *Elizabethan Instrument Makers: The Origins of the London Trade in Precision Instrument Making* (Oxford 2000). The Scientific Instrument Commission has published comprehensive *Online Scientific Instrument Trade Catalogues* (see <https://www.scientific-instrument-commission.org/online-catalogues>). Various other workshops and conferences also led to recent publications by the Scientific Instrument Commission, see <https://www.scientific-instrument-commission.org/publications>, including the most recent anthology on *How Scientific Instruments Have Changed Hands* (2016), edited by A.D. Morrison-Low (Paul Bunge Prize 2008), Sara J. Schechner (Paul Bunge Prize 2019) and Paolo Brenni (Paul Bunge Prize 2002), discussing the marketing of scientific and medical instruments from the 18th century to World War I.

Concerning dictionaries of scientific instruments, the one outstanding reference work which has appeared since 1993 and thus complementing earlier work by Maurice Daumas and others is Robert Bud and Deborah Warner (eds.): *Instruments of Science: An Historical Encyclopedia* (London 1998), presenting 325 historically significant scientific instruments from antiquity to the present and appropriately honored with the Paul Bunge Prize within the same year, thus also acknowledging their life-long work as curators of the collections at the Science Museum in London and the Smithsonian Institution in Washington, D.C. For select groups of instruments (such as angular-measuring instruments as well as microscopes), fine studies have been published (such as, e.g., Klaus-Dieter Herbst's monograph *Die Entwicklung des Meridiankreises*

1700–1850 (1996), Jutta Schickore (Paul Bunge Prize 2009) on microscopes, or Nicolas Rasmussen (Paul Bunge Prize 1999) on electron microscopes). I myself have contributed studies on diffraction gratings and on spectroscopes and spectrographs (1996 and 2002), and *The Making of the Spectroscope workshop held at the Deutsches Museum* (Munich 2001) produced various further papers published in *Nuncius* in 2002 and 2003. Sean Johnston and others examined interferometers and holograms. The jubilee of the telescope in 2009 led to a plethora of related publications, and the list goes on. Today, many select groups of instruments are well-covered, but by no means all.

With respect to the social history of instrument makers, pathbreaking research has been undertaken by Paolo Brenni (Paul Bunge Prize 2002) on Italian and French instrument makers. I myself also followed this strand of research and published a book-length documentary biography of *Moritz Meyerstein (1808–1882), the instrument maker of Carl Friedrich Gauss and Wilhelm Weber in Göttingen* (Göttingen 2005). Similar endeavors have been made, e.g., by J.R Millburn on *Benjamin Martin: Author, Instrument-Maker, and 'Country Showman'* (Springer 1976), or by Richard Sorrenson (Paul Bunge Prize 2000) on George Graham. Altogether, far too few instrument makers have been researched indepth using historiographic techniques from social history and civil sources such as birth and marriage certificates, tax declaration, or testaments and inventaires après décès which allow new insights into living and working conditions, institutional and social contexts of important instrument makers. Still far too many are "invisible hands" about which not much more than their names and approximate dates of activity are known (cf. the work by Stephen Shapin 1989 on invisible technicians and various contributions in the anthology edited by myself on invisible hands in scientific practice [*Unsichtbare Hände. Zur Rolle von Laborassistenten, Mechanikern, Zeichnern u. a. Amanuenses in der physikalischen Forschungs- und Entwicklungsarbeit* (Stuttgart 2008)]. Altogether, a lot more work in this direction of social history is needed which requires special methodological training offered in only a few graduate centers for history of science worldwide (Barcelona and Lisbon, Cambridge, Edinburgh or Manchester, Paris, Stuttgart or Munich). For general historians, history of scientific instrumentation is usually beyond their horizon of interest and expertise, whereas historians of science and technology with a background in science usually lack the methodological skills to work along these lines.

The new field of digital humanities offers new possibilities to researchers for the systematic collection and distribution of their prosopographic findings in addition to printed dictionaries and research articles. Prosopographic databases are thus emerging at an increasing rate. For a long time, the online version of the old compilation of *Websters Catalogue of Scientific Instrument Makers*, first issued as an incomplete series of index-entries in a very low print run and thus available in but a few libraries, subsequently provided online on the Adler planetarium website <http://historydb.adlerplanetarium.org/signatures/> was the only systematic online source for instrument makers, cf. also the bibliographic part of it still available under <http://historydb.adlerplanetarium.org/signatures/wbiblio.html>. Later, the previously mentioned *Directory of Scientific Instrument Makers*, compiled by Gloria Clifton, was transformed into an online dataset SIMON by the National Maritime Museum, including more than 10,000 records, alas limited to instrument makers and firms from Great Britain and Ireland. Currently, an AHRC-funded project based at the Whipple Museum in Cambridge, called 'Tools of Knowledge: Modelling the Creative Communities of the Scientific Instrument Trade, 1550–1914' takes up this line with an interdisciplinary team, inter alia also including the Royal Museums Greenwich and the Science Museum, London, Alex Butterworth from the University of Sussex and Rebekah Higgitt from the National Museums Scotland. 'Tools of Knowledge' applies cutting-edge methods of digital analysis such as social network analysis, gif-based geographic location coding, semantic harvesting technologies and other techniques to four

centuries of the scientific instrument trade in Britain with a specific focus on commerce, industry, teaching, and questions of local, national and international geography. We would need an international follow-up project also including American, Dutch, French, German, Italian, Portugese and Spanish instrument makers. The least I would expect from a 21st century museum is a freely available list of scientific instrument makers who produced the instruments in their collections, somewhat like the one provided in Birmingham: <https://www.bcu.ac.uk/conservatoire/research/hic/how-to-use-the-collection/instrument-makers-index>, but most museums are not yet far enough along in the digitization of their holdings.

For another group of invisible contributors to scienfic practice, i.e. illustrators, I have compiled a truly international database of scientific illustrators 1450–1950 (DSI) based at my section for the history of science and technology at the University of Stuttgart. It currently includes 12,790 entries with 20 searchable fields (such as name and living dates, preferred technique, region of activity, important clients etc.) about illustrators in more than 100 countries, including c. 11% females and providing links to viaf-entries (if available). A similar international database for instrument makers worldwide, with links to specific sites giving further information, photographs of select instruments or listing museums with holdings is sorely needed since instrument makers (just as illustrators) are only sparingly mentioned and often not contained in scientific dictionaries of important personnel, thereby still remaining ‚invisible hands'.

How are these various instrument makers linked to each other and to institutions and their social contexts? Social network studies are trying to answer this important question. Methodologically exemplary for this new field of study are Matteo Valleriani's recent publications on *Sacrobosco's Sphaera and its commentators* (Cham 2020) and <https://sphaera.mpiwg-berlin.mpg.de/visualizations/> – similar work for the analysis of instrument makers and their interconnections is still a serious lacuna for further research. Cultural studies in the manner of Simon Schaffer (Paul Bunge Prize 2017) tie in very well with this contextualizing approach and provide further interconnections to other strata of the population.

To return from the instrument makers to the scientic instruments themselves, digital humanities also offers new options to document and visualize scientific instruments, their makes and functioning. Many museums are nowadays experimenting with augmented reality and 3D-documentation and analysis of scientific instruments – see, for instance the sites <https://digital.deutsches-museum.de/de/>, <https://virtualtour.deutsches-museum.de/> or https://www.3dvista.com/en/project/science-museum/>. In the Stuttgart-based project Gyrolog, these techniques were applied to a collection of gyro-compasses at the institute for aviation research in conjunction with our team of historians of science and technology, thus providing new insights into this unique collection and also assisting in the explanation of the workings of these intricate gyroscopes and navigation aids; see <https://www.cis.iti.uni-stuttgart.de/files/gyrolog/> and especially <https://www.cis.iti.uni-stuttgart.de/files/gyrolog/technische_umsetzung.shtml> on the innovative combination of photogrammetry and computer-tomography to also grant insights into the quintessential interior of these objects.

One of the – in my opinion – most insightful approaches to the history of scientific instrumentation comes from the team of Falk Riess, originally situated at the University of Oldenburg. Riess and his students, most prominently Otto Sibum (Paul Bunge Prize 1994), Peter Heering and Falk Müller, have done indepth historical replication studies, using original materials, relearning old skills of production and handling fragile instruments and thereby allowing fascinating glimpses into former scientific practice which are not documented in printing or in the sparse preserved lab notebooks or illustrations. If I had to single out one of the above strands of research, I would name this one as the most rewarding, with surprising results on famous ex-

periments such as Joule's paddle-wheel experiment or Coulomb's precision measurements of electric attraction and repulsion. Unfortunately, this approach is still very rarely practised – the very successful Oldenburg program was closed in 2010 with the retirement of Falk Riess; its only surviving branch is now situated in Flensburg in the team led by Peter Heering under the aegis of science didactics.

Aside from the manual skills and labor involved, the material aspects are also of crucial importance to this historical replication approach. Curators of museums, of course, always had to keep a keen eye on material specifics, crucial for conservation and restoration purposes. However, until recently this strand of research was not very well connected to the remainder of history of science. In the past decade, this has changed. Simon Werrett's work on fireworks and pyrotechnics (2010) as well as on recycling and *Thrifty Science* (2019) is exemplary for the insights obtainable in this direction. Since 2016, Christian Forstner (†), Jan Hagmann and Richard Kremer have now repeatedly offered a seminar on "Material Culture in the History of Physics", and I hope more research in this direction is to follow.

The most exciting contribution from philosophy of science to this practice-oriented approach is the book by Davis Baird: *Thing Knowledge: A Philosophy of Scientific Instruments* (Berkeley 2004) – Otherwise, philosophy of science is quite remote from the intricacies of experimental and instrumental practice and thus the earlier impetus of Ian Hacking is not really followed up.

The Paul Bunge Prize in 1992/93 acknowledged my work on Rowland diffraction gratings with which redshift in the solar spectrum was discovered in the early 1890s. Henry A. Rowland (1848–1901) is well-known, of course, but many invisible hands participated in Baltimore in the production of these concave Rowland gratings, esp. the instrument maker Theodor(e) Schneider and the research assistant Lewis E. Jewell, about whom nothing was known – so part of my work was also to unravel their stories. The discovery of solar redshift (actually made by Jewell and not by his boss who was away from his lab when the discovery was made) took place long before Einstein predicted a gravitational redshift in 1907, and it was interpreted in various ways, with gravitational redshift being only one of various competing effects, many of which are actually superimposed in the solar atmosphere. Thus it took until 1960 to confirm Einstein's prediction in a precise manner with ultraprecision measurements, using the Mössbauer effect in a terrestrial laboratory. The convoluted and highly interesting story of this complex interplay of scientific instrumentation, experimentation and theory development was the topic of my habilitation thesis on redshift and related effects in spectroscopy and astrophysics, submitted to the University of Hamburg in 1995 and published in 1996, i.e., a few years after I had obtained this award.

To receive this prize in the midst of my intense historical research was of great importance to me in order to confirm that I was on the right track and that further investment of time and energy was worth the effort. The situation at my institute in Göttingen was unstable since its director, Lorraine Daston, had just decided to leave, so her newly created chair was vacant for many years). To have already obtained this international prize and two other national prizes for my dissertation also gave more impetus in habilitation degree proceedings and in the nasty institutional fights taking place in order to rescue the Göttingen professorship for history of science which survived for another decade until it was finally dismantled in 2009 (after I had left Göttingen and Nicolas Rupke was retired). The prize probably also helped me in applications for professorships elsewhere even though I had to wait until 2006 to get two calls to Halle and Stuttgart (the latter of which I accepted).

Prizes such as the Paul Bunge Prize are thus of special value for younger, not yet tenured researchers in bolstering their standing in the heterogeneous community of history of science. The Paul Bunge Prize is the only international prize focussing on the history of scientific instrumentation (broadly conceived) and thus it is of particular importance in supporting this direction of historical research. Grosso modo, the work of the prize-winners helped to broaden the field and to integrate it more fully into the multifacetted historiography of science and technology in the 20th and 21st centuries. On behalf of all of us, thanks to the donor Hans R. Jenemann, to the selection committees and to the scientific societies involved in providing this high-profile prize for the history of scientific instrumentation.

1994 Matthias Dörries, then Munich, Germany; now Strasbourg, France

Bunge Prize awarded for: "Balances, spectroscopes, and the reflexive nature of experiment"*, Studies in the History and Philosophy of Science* 25 (1994), 1–36, and "Prior History and Aftereffects: Hysteresis and Nachwirkung in 19th Century Physics", *Historical Studies in the Physical Sciences* 22:1 (1991), 25–55

Matthias Dörries is professor for history and epistemology of science at the University of Strasbourg since 1999. He received a PhD in the history of science from the Free University of Berlin in 1989, followed by fellowships at the University of California at Berkeley, at the Centre for Research in History of Science and Technology in Paris, the Forschungsinstitut für Technik- und Wissenschaftsgeschichte, Munich, and at the Max Planck Institute for the History of Science in Berlin.

His research focuses on the history of the (geo)physical sciences from the 18th to the 20th centuries, particularly the history of the atmospheric sciences and climate change; history of science in France, and the history of the relationship between humanities, literature, language, and the natural sciences.

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I hesitate to make general statement about the field around 1995 and prefer rather to speak about who and what publications have influenced my own work on scientific instruments. Living in the Bay area during the late 1980s and early 1990s, I profited from two lines of work within the history of science: one the one hand, at the University of California at Berkeley, John Heilbron's studies on 18th-century and also 20th-century instrumentation in physics and my cooperation with him on a heavily illustrated volume on instruments in the Italian publication *Storia delle scienze* (Einaudi, 1991, 594 pages), and on the other hand, at Stanford University, meaning first of all Ian Hacking's hugely influential *Representing and Intervening* (1983), which inaugurated a turn towards philosophical and historical study of experimental practice and instruments, followed by the works of Nancy Cartwright, *How the Laws of Physics Lie* (1983), Simon Schaffer and Steve Shapin, *Leviathan and the Air-Pump* (1985), Peter Galison's *How experiments end?* (1987), and Crosbie Smith and M.N. Wise, *Energy and Empire: William Thompson, Lord Kelvin, 1824–1907* (1989). Subsequently, I had the chance to put my familiarity with these lines of research to work in the context of two museums: first in 1991 and 1992as a CNRS scholar at La Villette's Centre de recherches en histoire des sciences et des techniques, where I worked with Dominique Pestre, Paolo Brenni and Christine Blondel, and co-organized a conference on the replication of experiments with Coulomb's torsion balance (publication: *Restaging Coulomb – Usages, controverses et replications autour de la balance de torsion*, 1994). At that time, lots of historical inquiries went into retrieving the tacit

knowledge that was required to repeat experiments and to build instruments. During my stay at the Forschungsinstitut of the Deutsches Museum in Munich (1993–1998) I organized a workshop on Objektforschung (1996) and seminars together with curators of the Deutsches Museum to reflect upon the uses and exhibition of scientific instruments and how to exhibit them. I also put together a bibliography of secondary publications on scientific instruments. My own work looked at how 19th-century scientists started to investigate and study their instruments, turning them into objects of research, something I called the reflexive nature of experiment (an article published in *Studies in the History and Philosophy of Science*, 1994). To summarize, around 1995 the history of scientific instruments exemplified the turn of the field of history of science towards the study of experimental practices.

Obviously, the prize was a recognition of my work on scientific instruments and encouraged me to continue this line of work by organizing workshops and seminars, particularly in the context of my stay at the Forschungsinstitut für Technik- und Wissenschaftsgeschichte at the Deutsches Museum.

Again, I do not dare to say something general about the field, preferring to speak rather about some influences of subsequent work on my own work. I have always been interested in an epistemological dimension when studying scientific instruments. Continuing in the line of Ian Hacking's 1983 book, the history of scientific instruments and experiments has evolved during the last 20 years into something larger, perhaps best encapsulated in the term material culture, and publications, such as Lorraine Daston's volume on *Biographies of Scientific Objects* (2000) with contributions by Hans-Jörg Rheinberger amd Bruno Latour. My recent article "The Art of listening: Hugo Benioff, Seismology and Music" (*Historical Studies in the Natural Sciences*, 2021) fits into this line of historical epistemology and material culture, looking at how music and seismology merged in the daily work of the Caltech professor and instrument builder Hugo Benioff (1899–1968), who incorporated the technology of the transducer in both, his seismographs as well as his electrical musical violins, cellos and pianos.

1994 Heinz Otto Sibum, then Cambridge, UK; now Uppsala, Sweden

Bunge Prize awarded for: "Reworking the mechanical value of heat: Instruments of precision and gestures of accuracy in early Victorian England", *Studies in History and Philosophy of Science* 26 (1995), 73–106

Otto Sibum is Hans Rausing Professor and Director of the Office for History of Science at the University of Uppsala since 2007. He was previously Director of Research at the Max Planck Institute for History of Science in Berlin as well as Research Associate at the Department of History and Philosophy of Science in Cambridge, UK. He holds a doctoral degree in physics from Oldenburg University and an habilitation in history from the Technical University Braunschweig. He has held visiting positions in Cambridge, Tel Aviv, the Ecole des Hautes Etudes en Sciences Sociales in Paris and at Si-Mian Center for Advanced Studies in the Humanities at East China Normal University, Shanghai.

His research covers the history of the physical sciences from the 18th century to present times. His work explores new approaches in social and cultural history of the sciences.

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In the early 1990s the history of scientific instruments was a rather marginalised field of historical research, mostly, if at all, performed by museum curators. Only a few historians of science then suggested including the hardware of science in their historical investigations – but always keeping enough analytical distance to these objects of study. Building a replica of an historical scientific instrument and performing experiments with such a device was not considered as belonging to the historian's methodological tool kit. In the contrary, it was foremost considered as anachronistic.

Hence, the prize award in 1994 came rather unexpectedly. Furthermore, it had a tremendous effect for me personally. In Germany, I was quite unknown as a historian of science, because I had left the country in 1990 as a physicist with little publication in history of science. Only in the History and Philosophy Department at Cambridge University I could develop fully my skills as a historian of science. With the prize award my unconventional approach in history of science became widely known and heavily debated. It even gave me the opportunity to start on working in Germany as a historian of science and develop further this historiographical approach.

Meanwhile, historians widely acknowledge the study of material culture and have developed various ways to explore the meaning of the hardware of science, but the performative approach still remains a challenge.

1995 Gerard L'Estrange Turner, Oxford, UK (1926–2012)

Bunge Prize awarded for: *Lifetime achievement* and in particular for his research on microscopes

Gerard L'E Turner was a Senior Research Associate at the Museum of the History of Science, Oxford. A physics graduate University of London, specialised in crystallography, he joined the Museum of the History of Science in Oxford in 1963. He remained at the Museum until 1987, when he retired as the senior assistant curator. He was then appointed visiting professor in history of scientific instruments at Imperial College London.

Renaissance and Elizabethan mathematical instruments, and above all microscopes, were among his preferred objects of investigation. Detailed catalogues of the microscope collections of the Museo Galileo in Florence and of the Royal Microscopical Society were the result. He also published on optical toys, philosophical apparatus of the 18th and 19th centuries, and on the manufacture of and trade in instruments.

Obituary: Paolo Brenni, "Gerard L'Estrange, Turner 22 January 1926 - 19 July 2012", *Nuncius* 28 (2013), 217–222

1996 David A. King, Frankfurt/Main, Germany
Bunge Prize awarded for: *Lifetime achievement*, and in particular for his research on Islamic astrolabes

From 1985 to his retirement in 2007 David King was professor of history of science at the Johann Wolfgang Goethe University Frankfurt/Main. He studied mathematics, education and Near Eastern languages in Cambridge, Oxford and at Yale University, worked for the Sudan Government Ministry of Education in Atbara and El-Fasher, Darfur, and directed a Smithsonian Institution project in the history of Islamic astronomy in Egypt, cataloguing the medieval Arabic

scientific manuscripts. From 1979 to 1985 he was professor of Near Eastern Languages and Literatures at New York University.

His life's work has been to document the use of astronomy – mathematical astronomy and folk astronomy – in the service of Islamic civilisation for well over a millennium. His magnum opus of 2004/05 deals with the astronomical tables with which Muslims have regulated the times of their prayers, and with the instruments that they used for timekeeping – sundials, astrolabes and quadrants. In the field of instrumentation he has published all instruments known from the Islamic East up to 1100 and many later ones, including some important medieval European examples.

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Essentially, the subject of Islamic and medieval Islamic instrumentation was previously restricted to some surveys (R.T. Gunther and E. Zinner) and a few excellent antiquarian studies of individual instruments (W. Morley). Inscriptions were documented irrespective of the actual instruments (L.A. Mayer). Recent surveys are less complete and less accurate than previous ones (A. Brieux and F. Maddison). Early studies in Islamic instrumentation were reprinted in Frankfurt in 12 volumes.

The Paul Bunge Prize 1996 enabled me first to document the earliest 20 Islamic astrolabes, most of which had not been previously published. It also enabled me to redress the damage that had been inflicted on some later instruments. An astrolabe in the New York Met bears the signature of a Yemeni sultan 1295. A leading historian of science declared it a fake because there was no astronomy in the Yemen. My first book documented 100 astronomical manuscripts from the Yemen, one of which was a monumental book on the astrolabe by the Sultan. Appended to this were notes by his teacher of the Sultan describing six astrolabes which the Sultan had made, one of which was the Met piece.

The German Research Foundation (DFG) later enabled me to embark on a catalogue of all – several hundred – Islamic and medieval European instruments, but this proved too difficult to complete because the time allotted was inadequate and the funding expired (salaries for too many assistants, too much travel, too many photos of instruments, and, last but not least, too many important instruments appearing in the auction houses, mainly London and Paris). The two-part catalogue, as it is, is available on the internet. People can still enjoy an unfinished symphony.

Many of these instruments are beautiful objects. My wife coined the phrase 'scientific works of art'. At the time we did not know that a beautiful astrolabe would lead us to the deciphering of the most enigmatic painting of the Renaissance.

For an exhibition 'Focus Behaim Globus' at the Germanisches Nationalmuseum, which contains the largest collection of Islamic, medieval and Renaissance instruments in Germany, I prepared detailed descriptions of each piece. Meanwhile, my doctoral student Burkhard Stautz catalogued all of the numerous instruments in Munich (Deutsches Museum and Bayerisches Nationalmuseum). My former doctoral student François Charette catalogued the rich collection of Arabic astronomical manuscripts in the Chester Beatty Library, Dublin. In one of these, the 14th-century Egyptian author describes and illustrates 100 different kinds of instruments. Charette chose this remarkable work for his doctoral thesis.

For me personally, the Bunge Prize marked a change of direction from the the history of Islamic astronomy per se to the history of Islamic astronomy and astronomical instruments and the

obvious (but undocumented) influence on medieval European and Renaissance astronomy and astronomical instrumentation.

The importance of certain medieval European instruments lies in the fact that certain features are unique in the history of human endeavour. For example, we find a 14th-century French astrolabe from Picardy with all numerals expressed in a cipher notation also found in manuscripts (especially in Bayerische Staatsbibliothek Munich, documented by Bernhard Bischoff). When the astrolabe became available for study, it transpired that it was from Picardy and of monastic origin. The ingenious idea behind the ciphers – appendages to a vertical stem – was to be sought in Ancient Greek tachygraphy. Apart from its use as letters, the medieval ciphers were conceived so as to uniquely represent any integer from 1 to 9999 by a single geometric figure. My detailed study of the history of the ciphers over two millennia was published by Franz Steiner Verlag.

The Regiomontanus fiasco in England revolved around an elegant little astrolabe by the leading astronomer in Europe, Regiomontanus, dedicated in Rome in 1462, to his patron, the Greek Cardinal Bessarion – leading experts declared it a fake. I was able to point to another 10 astrolabes, albeit unsigned, from the same Vienna workshop that they had overlooked. Gerard Turner and I published in Florence a detailed survey of all of these unpublished pieces.

There followed two monumental discoveries by my Instrument Seminar participant, Berthold Holzschuh. First, that the 'problematic' Latin inscription was an acrostic with hidden meanings in seven vertical axes, Then, the discovery that monograms in the eight intervening spaces correspond to the names of eight individuals featured in the enigmatic 'Flagellation of Christ' by Piero della Francesca. I regard this as one of the most exciting discoveries in the history of science, let alone the history of art (over 50 attempts had been made previously to identify the three principal personages in the painting). An entire book on the subject was published by Franz Steiner Verlag.

Again, the so-called 'Carolingian astrolabe' was declared a fake by leading astrolabe specialists in Paris. In fact, it is the oldest known European astrolabe, from 10th-century Catalonia. We showed how the month-names are in medieval Catalan and discussed why one of the plates could serve Rome. A whole conference panel was devoted to this piece (Saragossa 1993).

Two former doctoral students of mine – Petra Schmidl and François Charette – have published widely on the history of Islamic instrumentation – the earliest Arabic texts on the magnetic compass and the newly-discovered minor works of al-Khwarizmi. A former Seminar-participant – mathematician Karl-Heinz Schaldach – has independently become the world's leading specialist on Ancient Greek sundials, this by inspecting each one in situ, and publishing the entire corpus. Another – Silke Ackermann – is Director of the Museum of the History of Science at Oxford, the largest collection of historical scientific instruments in the world.

But there is more, and I can barely stop. Recently, together with two doctoral students (Petra Schmidl and Mohammed Abu Zayed), we deciphered an enigmatic 13th(?)-century astrolabe with inscriptions in Judaeo-Arabic, identifying the 10th-century Arabic poem on which the garbled inscription was based. Again recently, I published an astrolabe, clearly Iberian, with successive inscriptions in Hebrew, Latin and Arabic, clearly from 14th-century Toledo. With François Charette, I am currently writing up a unique example of a universal horizontal sundial made for the Sultan Mehmet II. This is the only known example of such a device, and the only known instrument dedicated to the Sultan.

The Frankfurt Institute for the History of Science was closed when I retired in 2006. But on the international level, we have a discussion group on instruments – called RETE. Out of this have emerged a growing number of serious enthusiasts and competent researchers. And there is no shortage of materials in the museums and the auction houses. What is important for the future is that museums have come to realize the importance of the instruments they house.

1996 Stuart M. Feffer, Aberdeen NJ, USA

Bunge Prize awarded for: "Microscope to munitions: Ernst Abbe, Carl Zeiss and the transformation of technical optics, 1850–1914", PhD dissertation, Berkeley 1994 (Ann Arbor: University Microfilms, 1998)

Stuart was co-founder and CEO of Reality Analytics Inc, a Columbia, Maryland-based software company that helps R&D engineers design products using sensors. Previously, he worked for Wells Fargo, LaCrosse Global Fund Services, Deloitte Consulting and other US capital markets consulting firms.

1997 Silvio A. Bedini, Washington, DC, USA (1917–2007)

Bunge Prize awarded for: *Lifetime achievement* as collected in: *Science and Instruments in Seventeenth-Century Italy* (Aldershot: Variorum, 1994)

Silvio A. Bedini was appointed curator in the Department of Mechanical and Civil Engineering at the Smithsonian Institution in the new Museum of History and Technology (now the National Museum of American History) in 1961. By 1965, he had become Assistant Director of the Museum of History and Technology, and in 1972 he was appointed Deputy Director of the National Museum of History and Technology. From 1978 until his retirement in 1987 he served as Keeper of Rare Books at the Dibner Library of the History of Science and Technology, a branch of the Smithsonian Institution Libraries.

More than twenty books showcase his research on Early Modern scientific instruments and on scientific personalities including Leonardo, Galilei and Jefferson and less well known ones such as Banneker, Lamb and Campani.

Obituary: Robert C. Post, "Silvio A. Bedini, 1917–2007", *Technology and Culture* 49 (2008), 522–529

1998 Robert Bud, London, UK

Bunge Prize awarded for: *Instruments of Science: An Historical Encyclopedia* (London and New York: Science Museum, 1998) – together with Deborah Warner

Robert Bud is Emeritus Keeper of the Science Museum, London, Senior Honorary Research Fellow in the Department of Science and Technology Studies, University College London and Associated Research Scholar, Department of History and Philosophy of Science, University of Cambridge. Trained in Manchester and Philadelphia, he received a PhD in History and Sociology of Science from the University of Pennsylvania in 1980. From 1978 to 2018 he held various positions in the Science Museum, London: Head of Life and Environmental Sciences from 1991 to 2000, Principal Curator of Medicine in 2004, Keeper of Science and Medicine in 2012, and Research Keeper from 2016 to 2018. He was the Museum's Head of Research (Collections) from 1988 to 2000.

His books span applied science from the history of chemistry to modern biotechnology; exhibitions he curated at the Science Museum dealt with topics such as petroleum, plastics, and the story of penicillin.

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In 1998 the study of scientific instrument history was itself in a state of dynamic change. Scientific instruments have long filled the stores of major science museums and, more recently, the catalogues of major auction houses. In the distant past, when their study was marginal to the academic study of the history of science it was characterised by connoisseurship, museum cataloguing and attractive instruments from the 19th century and earlier. However, by the 1980s many historians of science were beginning to take an interest in the material culture of experiment. This change was perhaps most vividly exemplified by Shapin and Schaffer's 1985 *Leviathan and the Airpump*. In 1992 the Toronto Three Society meeting was entitled 'History of Laboratories and Laboratory Science'. Major museums were recruiting qualified historians of science, so the opportunity and challenge of integrating the disciplines of history of science and technology with museum curation through the study of scientific instruments were timely. As the newly appointed head of collections research at the Science Museum, I saw two obvious disjunctions between the outside world and scientific instrument scholarship.

The huge expansion and transformations of the twentieth century were not represented and there was a particular paucity of study of the numerous specialised instruments characteristic of applied science. The first was about to be addressed. The leap in scholarship dealing with twentieth-century instrument history was indicated by the *HSS Current Bibliography*. At the beginning of the nine years period 1987 to 1995, there were few, but the quantity and quality of 20th century instrument scholarship was rising at the end of this period with four articles listed by 1995. The production rate of articles on twentieth-century instruments kept increasing, doubling by the twenty-first century's second decade, often with more than ten a year. Such numbers, of course, reflect keyword choices as well as substantive content but changes in either and both point to a radical change in fashion. More generally, this growth was just one part of the radical shift to scholarship dealing with the twentieth century in general.

Applied science was a trickier issue. It is less public than pure science and has a lower status. However, in the absence of publications, artefacts, whether instruments or products have a correspondingly higher importance for the museum curator. Major machines, particularly in the biomedical area, came to attract attention. Devices such as gene sequencers were prominent members of what Simon Schaffer labelled 'scientific megafauna'. In a section of her 2020 doctoral dissertation published in 2019 in the *Journal of the History of Collections*, my former colleague Alison Boyle reflected on scholars' continuing lack of interest in the quotidian devices such as voltmeters, nonetheless used in their hundreds of thousands across the twentieth and twenty-first centuries.

Instruments of Science for which Deborah Warner and I were awarded the Paul Bunge Prize is rich in its treatment of the material culture of 20th-century applied science, including the voltmeter and other common devices of the technician, but these are not ghettoised. Instead, we treated them alongside the classic telescopes and microscopes. Editing the book and the subsequent award was particularly pleasing as collaborative endeavours between partner institutions. We edited between the National Museum of American History and the Science Museum. The medal was awarded in Munich, and I was able to talk at the Deutsches Museum. This was the moment in which the three institutions were beginning to collaborate in the 'Artefacts' series of

conferences and publications intended to integrate academic scholarship with the study of museum artefacts. So the Paul Bunge Prize was an early opportunity to celebrate this important collaboration till vibrant a quarter of a century later. At a time when increasing visitor numbers were an urgent priority for my institution, the prize was also significant as an internationally-won symbol of the prestige that the institution could acquire through scholarship.

How has the field changed? Interest in twentieth century instruments, in the processes of working with them and their development has exploded. Even applied-science instruments are winning attention. However, I should like to point to an obvious remaining lacuna – and an opportunity for further discovery. The shift from analogue devices and transducers to digital instrumentation has been profound. It offers great opportunities to explore the changing skills required of manufacturers, technicians and scientists.

1998 Deborah J. Warner, Washington, DC, USA

Bunge Prize awarded for: *Instruments of Science: An Historical Encyclopedia* (London and New York: Science Museum, 1998) – together with Robert Bud

Deborah Warner was Curator in the Division of Medicine and Science of the National Museum of American History in Washington. She studied at the University of Chicago and at Harvard, and worked for the Smithsonian Institution since 1963, being responsible for astronomy, geodesy, navigation, meteorology, and physics.

Her published research is in the history of science and technology, particularly on scientific instruments; she curated major exhibitions and developed online catalogues of surveying, geodetic, navigational and geophysical instruments.

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In the U.S. where I live and work, the history of scientific instruments stands between history of science and history of technology, with connections to education, enterprise, and national defense. Recent years have seen increased interest with aspects of social and cultural history.

During much of my career, both before the Bunge Prize and after, the primary instrumental challenge has been simple identification: of functions, designers, makers, users, locations, dates, materials, costs, etc. The advent and distribution of computers clearly simplified these tasks; lets us share our collections and related information with students, collectors, and scholars around the world; and facilitates communication with colleagues both near and far.

As an historian, I am delighted to see science and related instruments included in the stories we tell about the past. As a museum visitor, however, I wonder why instruments (and other non-decorative things) are on display. And this wonder increases as these things become more difficult to see and/or understand. This, I would suggest, is an important question for us to tackle.

1999 Nicolas Rasmussen, Sydney, Australia

Bunge Prize awarded for: *Picture Control: The Electron Microscope and the Transformation of Biology in America, 1940–1960* (Stanford: Univ. Press, 1997)

Nicolas Rasmussen is a historian of life sciences and medicine, and an Emeritus Professor in the History and Environment and Society programs at the University of New South Wales in Sydney. He received his education at Chicago, Stanford, and Cambridge, received a PhD in biology from Stanford, followed by positions at Princeton, Harvard, and UCLA. In 1994 he moved to a teaching position in history and philosophy of science at Sydney University and, in 1997, to a full professorship the University of New South Wales in Sydney.

His research interests include the history of cell and molecular biology since the 1930s, the history of clinical trials and their regulation in the US, the history of collaborations between academic biomedical scientists and the drug industry, the history of prescription drug abuse and control policy, and the history of obesity as a public health problem. He is now working on the history of the symbiotic microbiome concept since the 1950s, and is serving as co-Chief Editor of the *Journal of the History of Biology*.

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When I wrote the 1997 book *Picture Control* for which I was awarded the Bunge Prize, which was about the electron microscope in biology, the history of life science greatly lagged the history of physics on questions of instrumentation and technology. History of modern biology was mainly about ideas and institutions, although there was the beginning of interest in model organisms. As a historian of molecular biology, to me the most important existing work was Lily Kay's about instrumentation as a vehicle for the manipulation of biology by the Rockefeller Foundation. By funding scientists who were developing instruments and techniques that explored macromolecules, her argument went, between the wars the Foundation successfully carried out a plan to make biology a science that focussed on the machinery of life at the molecular level. Looking at this story from a Deweyian philosophical perspective, I thought there was something to it: instruments are devices that shape both scientific disciplines and the questions they ask – and through them, the answers that constitute our understanding of the world. This was the insight I pursued, in a manner modelled in part on the work Peter Galison was doing on the way particle physics communities were structured by their detectors (later published as *Image and Logic*).

It turned out my work was part of a larger pragmatist wave in history of science in the late 1990s and 2000s – although I am not sure how many people would agree with me that actor network theory is another form of pragmatism. For many the meaning of that work, and the way forward, was a frank sociological constructionism, an approach that to me seems to have since exhausted itself. In any case, the history of modern biology in the 2000s saw a great deal of research into how experimental technologies informed disciplines and scientific communities, through work on model organisms, gene sequencing, etc. But there was not much interrogation of the way knowledge of the world is construed through the choice of particular technologies (beyond some extravagant and poorly developed constructionism, which attracted the 'science wars' backlash). I feel pragmatism may have been the baby thrown out with that bathwater, and still holds fresh promise for the history of scientific instruments and technique more generally.

The recognition associated with the prize helped my career of course, and although it did not encourage me to write more books on instruments per se, it confirmed my interest in studying the role of technology in the shaping of biomedical knowledge, and the industrial concerns be-

hind the techniques and instruments. I now perceive all my work – on biological electron microscopy, on molecular biology, on pharmaceuticals development, and on epidemiology – as a venture in the history of capitalism, within the domain of biomedical knowledge.

2000 Alan Q. Morton, London, UK

Bunge Prize awarded for: *Public and Private Science: The King George III Collection* (Oxford: Univ. Press, 1993)

Alan Morton studied history and history of science in London and Oxford. In 1975 he joined the Royal Scottish Museum in Edinburgh and moved, in 1979, to become Senior Curator of Modern Physics in the Science Museum London. With responsibility for the King George III Collection of 18th-century scientific instruments, he worked on galleries, "Nuclear physics and nuclear power" and the "King George III collection" and several temporary exhibitions. Leaving the Science Museum in 2003 he joined NESTA, the National Endowment for Science, Technology and the Arts, from 2004 until 2008. With long-standing interests in climate change, he helped establish a community energy company in 2010 and chaired its Board.

His research interests reach from Early Modern natural philosophy to twentieth-century physics and technology. Now retired, he is an independent researcher working on work and labour in 18th century Britain with the advent of the steam engine.

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At the time when I was awarded the Paul Bunge Prize it seemed the history of scientific instruments was emerging as a distinctive subfield of history of science and technology as small special interest groups – collectors of instruments, museum curators, historians, and scientists with antiquarian interests, gradually came together. They coalesced around both new and established bodies such as the Scientific Instrument Society, the Scientific Instrument Commission or attended annual meetings such as Artefacts. Of course, the founding of the Bunge Prize itself helped to bring the work of the individuals involved in these activities to the attention of wider audiences.

But what was evident at that time was that while studies of 18th century instruments, for example, illuminated the range of uses for instruments, from the very practical to the ornamental, they also provided evidence of changes in the way the trades were organized. Whilst there might be the name of an individual maker on a particular instrument, the instruments themselves were the products of many hands – evidence for the growing division of labour – with subcontractors who specialized in particular processes. A huge contrast with the anonymous 'black boxes' of today carrying but the name of a firm and a model number.

The award of the prize coincided with my interests changing to include the study of instruments in wider contexts and the development of specialized spaces where scientific instruments were developed and put to use such as laboratories – both government and in industry – and other workplaces. As large-scale industries developed, the need for a widening range of measurements of commodities or processes arose. For example, the focus of my current research is on 18th century Britain and the establishment, dissemination, and adoption of standards of measurement of commodities such as land, corn, and the work of horses or human labour. These activities required the use of instruments by technically adept users and were important aspects of the development of industrial production at the time.

Another dimension of the cultures of instruments in this period, are the changes in division of labour seen in the careers of individuals, 'civil engineers', such as John Smeaton and James Watt, who used the skills they learned from training as instrument makers to assess the working of wind and water mills, and steam engines. In addition, they worked on schemes to improve 'inland navigation' as it was termed, from canals to harbours. The infrastructure that supported spread of markets, nationally and internationally.

For me, I see the history of scientific instruments being a part of the development of an overall history of the development of industrial society, a defining feature of our lives today – and important determinants of the future for humanity. While I hope the field will continue to grow and develop because I see it as essential for any adequate account of modern industrial society, I am not well-placed, however, to assess how it is changing or needs to change. It is up to current and future practitioners to fashion the subject as they think fit.

2000 Richard J. Sorrenson, then Bloomington, IN, USA; now Devonport, New Zealand

Bunge Prize awarded for: "George Graham, visible technician", *British Journal of the History of Science* 32 (1999), 203–222; and: "The ship as a scientific instrument in the 18th century", *Osiris* 11 (1996), 221–236

Richard Sorrenson was General Manager of the University of Auckland Foundation and its endowment fund from 2004 until recently. His MSc from the University of Auckland was awarded for his thesis on a topic in computational quantum chemistry and his PhD from Princeton University was for his work on 18th-century instrument makers at the Royal Society of London. In 1993 he became Assistant Professor at the Department of History and Philosophy of Science of Indiana University in Bloomington. In 2002 he moved to New Zealand, first as Director of Development at Auckland Grammar School and, from 2004, to the University of Auckland Foundation.

His publications in the history of science deal with scientific voyages and eighteenth-century English mathematical and optical instruments makers.

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2001 Jim A. Bennett, Oxford, UK

Bunge Prize awarded for: *Lifetime achievement*

Jim Bennett is Keeper Emeritus at the Science Museum, London, and Fellow of Linacre College, Oxford. He grew up in Belfast, Northern Ireland, before going to Cambridge for a first degree and a PhD in History and Philosophy of Science. He has spent almost his entire career in curatorial roles in national and university museums: at the National Maritime Museum (Greenwich), the Whipple Museum of the History of Science (Cambridge), the Museum of the History of Science (Oxford), where he was Director from 1994 to 2012, and the Science Museum (London). He has been President of the Scientific Instrument Commission, of the British Society for the History of Science and of the Hakluyt Society. In 2010, he was awarded the title Professor of the History of Science by the University of Oxford.

His research focuses on the role of instruments in the physical and mathematical sciences, in particular astronomy, navigation and practical mathematics in general, from the sixteenth to the nineteenth century. Working in museums allowed him to indulge a penchant for practical work through collections management and exhibitions.

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I was awarded the Paul Bunge Prize in 2001, at a time where we were reopening the Museum of the History of Science in Oxford, following a comprehensive redisplay throughout the building. Part of the new provision was a gallery for special exhibitions, which reflected an enthusiasm for such thematic exhibitions in the world of science museums. The new facilities also enabled and encouraged an expansion of programmes for public access, again part of a broader movement, which found common ground with the growth of education services in museums. Only rarely could this extend to university teaching, depending as it did on the existence of a willing museum and a sufficiently flexible curriculum. We were fortunate in these respects in Oxford and were running an independent master's course in the Museum. What was the culture of this expansion?

I think it is fair to say that it was broadening out beyond the worthy but limited agenda of the 'public understanding of science' and into a wider engagement with public culture. What was called 'sci-art', for example, brought together the work of scientists and artists, most commonly by encouraging visual artists to show work inspired by science or by inviting artists to curate exhibitions using material from our collections. Rarely did the links work in the opposite direction, where scientists might engage in art curation.

Other sensibilities offered further alternative settings for presenting scientific instruments before museum visitors. A broader engagement with history is an obvious instance, which reflected a powerful movement in history of science to embed scientific themes in political, social and cultural contexts. The role of faith also found echoes in exhibition topics. Visitors were given pathways to encounter and appreciation other than, though often alongside, technical understanding.

The broadening of cultural and historical perspectives within the history of science had the important advantage of bringing instruments within the domain of historians, where previously they had played only a small and incidental part in the narrative. Star examples could be emblematic but the generality of the work instruments performed in research, education and professional practice had held little interest. A broadening engagement with scientific practice in all its dimensions meant that historians encountered instruments at almost every turn. Books and articles were appearing with instruments as a major theme.

While museum curators might say that this interest in instruments did not increase engagement with collections, and the same remark can still be heard today, I think the overall effect has been positive. It has fostered a growing esteem for museums and collections and much goodwill towards their curators, which has recognised their activities in conferences and edited volumes.

One particular development in 2001 was the beginning of an annual section in the journal *Nuncius* devoted to papers given at meetings of the Scientific Instrument Commission. After a few years this was transformed into a dedicated book series published by Brill, which now numbers nine volumes. This has been a very significant development for scholarship in the field.

The award of the Paul Bunge Prize was immensely encouraging to me. It was a great honour, not least on account of its international standing. I felt this both personally and also because I was joining such a distinguished group of recipients. The prize has done a great deal to recognise and encourage the discipline as well as the individual awardees.

I do not think that the field of research has changed in its core character since 2001, but it has certainly been enhanced and enriched in its scholarship. The standard of published work and of papers presented at meetings has gone from strength to strength. Two notable developments are a broader geographical distribution of practitioners and, most notably, an extension of interest into much more recent science and instrumentation.

2002 Paolo Brenni, Florence, Italy, and Mendrisio, Switzerland (1954–2021)

Bunge Prize awarded for: *Lifetime achievement* and in particular the catalogues of the *Museo Galileo* and the *Istituto Tecnico Toscano*

Born in in Switzerland in 1954, Paolo Brenni studied experimental physics at the University of Zurich, graduating in 1981. Soon after, he specialized in the history of scientific instruments. He began working in Italy, first for the University of Pavia, where he restored and catalogued the physics collection, and later at the Museo Galileo and the Fondazione Scienza e Tecnica, both in Florence. He was associate researcher at the Centre de Recherche en Histoire des Sciences et des Techniques in Paris, president of the Scientific Instrument Commission of the International Union of History and Philosophy of Science, and president of the Scientific Instrument Society.

Brenni collaborated with various European and American museums, astronomical observatories, and scientific institutions for the preservation and study of historical scientific instrument heritage. He catalogued, reorganized, and restored several collections of instruments in Italy and internationally. In a famous series of YouTube video clips he re-enacted historical physical experiments.

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Obituaries: Marco Beretta, "Paolo Brenni, 1954–2021", *Nuncius* 37 (2022), 175–206; "Remembering Paolo Brenni", *Bulletin of the Scientific Instrument Society* 152 (2022), 2–14

2003 Sean F. Johnston, Glasgow, UK

Bunge Prize awarded for: *A History of Light and Colour Measurement: Science in the Shadows* (Bristol: Institute of Physics, 2001)

Sean F. Johnston is emeritus professor of science and technology studies at the University of Glasgow. He graduated with a BSc and MSc in physics from Simon Fraser University in Burnaby, Canada, and holds a PhD in History and Philosophy of Science from the University of Leeds.

His research has focused on social, cultural and philosophical aspects of scientific knowledge, design and ethics from the 19th to 21st centuries, and how new kinds of practitioner and audience have evolved alongside new sciences and technologies. His books include histories of the distinctive scientific cultures that emerged with holography, nuclear engineering, colour measurement and technological faith.

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I would like to thank the Gesellschaft Deutscher Chemiker and the Hans R. Jenemann Foundation again, twenty years later, for awarding me the Paul Bunge Prize. The Prize was deeply appreciated and valuable for the progression of my career. It gave external recognition for my early work, and provided monetary resources that were helpful for progressing two of my ongoing historical case studies.

These concerned how scientific and popular cultures developed around new technologies – namely holography and nuclear engineering – and became emblematic of my later work. This heightened attention to wider social and cultural contexts of scientific technologies appears to have been an expanding theme of historical research over the past two decades.

2004 Carsten Reinhardt, then Regensburg; now Bielefeld, Germany

Bunge Prize awarded for: *Shifting and rearranging: Physical methods and the transformation of modern chemistry* (Sagamore Beach: Science History Publ., 2006)

Carsten Reinhardt is full Professor for Historical Studies of Science at the University of Bielefeld since 2007. In 1997 he earned his PhD in history of science and technology at the Technical University of Berlin, was Assistant Professor at the University of Regensburg from 1997 to 2005. Following positions at Jena University and at the Max Planck Institute for the History of Science in Berlin, he was, from 2013 to 2016, President and CEO of the Chemical Heritage Foundation in Philadelphia.

His research interests include the history of nineteenth- and twentieth-century science and technology, the methodology of science, expert knowledge, industrial research, and scientific institutions.

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When I received the Bunge Prize in 2004, the history of scientific instruments, in my perception, was a large field with many different flavors. Next to the history of instruments proper (that is, the hardware of science, the objects and collections), works such as Nick Rasmussen's *Picture Control* and Peter Galison's *Image and Logic* had shifted the focus toward scientific practice in all the richness of its epistemic and social contextualization. So understood, the history of scientific instrumentation represented the history of science at large. (I am not sure if this could be said of today's situation as well.)

My own work was on the shifts and rearrangements of chemical practice and conceptualization through the inroads of what chemists called "physical methods": electronic (mostly spectroscopic) instrumentation that deeply impacted the chemical sciences and technologies during the mid-twentieth century. The Bunge Prize helped to put this history of chemical practice on the international map, arguably strengthening the trend toward studying scientific practice already underway. In the long run, it led me to see chemistry as an interdisciplinary tool-box, providing many other scientific and technical fields (molecular biology, the materials sciences, and nanotechnology among the biggest) with the scientific gear necessary to do their jobs.

Today, I'd argue that the circle of scientific instrumentation reaches beyond disciplines and their interactions into technical, medical and increasingly environmental and social fields. The impact of science in society is influenced to a very large extent by the capabilities of instrumental infrastructure. This trend, which can be traced back to Terry Shinn's *Research Technologies*, has gained a lot of momentum. Arguably, it has been expedited by the onset of computation and Artificial Intelligence (which can be traced back to the 1960s), that has contributed to recognize software as key part of the scientific instrumentation boom. Understanding scientific hard- and software as being a crucial driving force not just of the scientific enterprise itself, but of modern polity, politics and policy seems to me the single most important development in the present and near future.

2004 Jobst Broelmann, Munich, Germany

Bunge Prize awarded for: *Intuition und Wissenschaft in der Kreiseltechnik, 1750–1930 (*Munich: Deutsches Museum, 2003)

Jobst Broelmann is a Senior Research Fellow at the Deutsches Museum in Munich. He was trained as a naval engineer in Hanover and Hamburg and did research in this field before he worked for MAN New Technologies, Munich, from 1979 to 1981. Since then he served as Curator at the Deutsches Museum and was responsible for the aerospace and later the navigation collections and galleries.

He has published on navigation and naval architecture, and on the gyro compass and its history in particular. His research interests include the material culture of technology, the role of tacit knowledge, and popular presentations of technology.

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The Historical Encyclopedia *Instruments of Science*, edited by Robert Bud and Deborah Warner and published in 1998, provided a good overview of the actual field of scientific instruments. Because of the size of the area covered, it becomes necessary here, to focus on the direction indicators, especially the gyro-instruments. While the relatively long, initially nameless history of the magnetic compass was dealt with mostly by historians and curators who had to analyze and study such artefacts in museum collections, the comparatively young phase of the gyroscopes can in some cases still be traced back to their initiators and originators. Among these, a notable figure who combined the qualities of a scientist and an instrument maker was William Thomson, who developed magnetic compasses for seafaring as well as taking the first steps in gyroscope technology. The work of such pioneers was mostly researched in a biographical approach, while the presentation of the first manufactured devices in company publications, on the other hand, had to fulfill the task of advertising and were hardly suitable for the historical and scientific analysis. Examples of this were subsequently the cases of the American inventor and entrepreneur Elmer Sperry (Thomas Hughes 1993) and the German Hermann Anschütz-Kaempfe, who was chosen as the first target of my investigation. While Sperry took a rather common practical engineering approach to the needs of more or less unskilled users, Anschütz-Kaempfe explored the still largely uncertain and unexplained technical solutions as a welcome opportunity for demanding, unconventional research, as a result of which he knew how to win over the most renowned scientists for his purposes. One of the greatest difficulties of my work was the initially very sparse source situation. This was partly due to losses of documents and artefacts in two lost wars, but also the reluctance of companies to provide closer insight into documents from the Nazi era. Similarly, the accidental rediscovery of documents of Albert Einstein's contributions led to a significant expansion of the investigations. Since the educational background and the spontaneous way of working of Anschütz-Kaempfe was scarcely documented in written sources, the research had to be based on patent specifications, most of which turned out to be detailed descriptions of individual prototypes. The very effective collection activity of the Deutsches Museum since its foundation had also secured a considerable basis of rare prototypes and laboratory models from the initial phase of other makers like Siemens, without however being able to ensure adequate documentation.

As a museum curator and naval architect, familiar with a technology that in centuries before, and partly still today, had to proceed without sophisticated and articulated science, I was curious to find out whether intuitive, non-written methods could also lead to reproducible results in this theoretically very demanding area of gyro technology, free of a theoretical basis or professorial standard processes. The Bunge Prize reassured me that the results of my similarly unpre-

dictable lengthy work could be considered more than a private venture but as a contribution to the history of technology in general.

The handling and research of gyroscope technology has changed significantly with the shift from technical-historical museums with considerable collections of artefacts to science centers. This change to science centers scarcely supports the presence of artefacts in museums or public displays. Two contrary developments can be observed: on the one hand, the disappearance of entire museum departments including the navigation instruments they contain, such as the shipping department of the Science Museum in London, closed in 2012. Similarly, numerous aeronautical gyroscopes were removed from museum display, for example from the aviation department of the Deutsches Museum which opened in 2022, where they have been replaced by demonstrations. On the other hand, efforts are being made to make large collections of gyro-instruments, previously stored in university domains, accessible to a wide public through digitization, 'from the basement to the shelf', e.g. in the Gyrolog project. This research project deals with the digitization of the collection of gyroscopes at the University of Stuttgart. It is intended to provide access to the mode of operation of gyroinstruments, usually considered to be physically and mathematically demanding, and to provide an overview of the history of navigation devices, which this collection represents as a whole. Gyroscopes nowadays are usually not visible to everyday users, although modern forms are built into every smartphone and navigation system. In the Gyrolog project, these technical cultural assets are made visible and their functionalities clarified by offering a look inside the objects and thus freeing them from their 'black box' image. This opens up avenues for museums or science and technology education as well as for research questions in a wide variety of fields, such as the history of technology. Using the latest and combined methods of 3D object digitization, such as computer tomography scan and photogrammetry, construction principles and functionalities of gyroscopes are visualized that would otherwise have to remain invisible.

2005 Myles W. Jackson, then Salem, OR; now Princeton, NJ, USA

Bunge Prize awarded for: *Spectrum of Belief: Joseph von Fraunhofer and the Craft of Precision Optics* (Cambridge, MA: MIT-Press, 2000)

Myles Jackson is Albers-Schönberg Professor in the History of Science at the Institute for Advanced Study, Princeton, since 2018. He received his academic education at the University of Cambridge and at Cornell, and held appointments in Harvard, at the University of Pennsylvania, the University of Chicago, Willamette University in Salem, OR, the Polytechnic Institute in New York and, from 2008 to 2018 at New York University.

His research explores the intersections between science, technology, aesthetics, history, and society. This extends from the artisanal production of scientific knowledge in nineteenth-century Germany to molecular biology and physics, intellectual property and privacy issues, knowledge sharing, race and genomics, bioengineering, and the interactions between musicians, natural scientists, and radio engineers.

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When I received the Bunge Prize back in 2005, the history of scientific instruments was beginning to blossom. Historians of science were shifting their attention away from theory-driven science toward understanding experiments and the instruments used in them. Many – although certainly not all – of those early works also examined the bodies, skills and practices of those

building the instruments. Those social histories were often dedicated to uncovering those artisans who had been historically marginalized or indeed totally forgotten.

The prize certainly resulted in German scientists and historians of science reading and engaging with my work. The prize is always mentioned when I am introduced to give talks in Europe, Israel, and the United States. And it encouraged me to continue to research the field. I have authored a book on the topic of the importance of scientific and musical instruments to the development of the natural sciences (*Harmonious Triads: Physicists, Musicians, and Instrument Makers in Nineteenth-Century Germany*, Cambridge MA 2006) and co-edited one with Alexandra Hui and Julia Kursell on that topic as well (*Music, Sound, and the Laboratory from 1750–1980*, Chicago 2013). I continue to write on the relationship between scientific and musical instruments and the rise of radio engineering and electroacoustics having just finished a book manuscript entitled *Engineering Aesthetics: Early German Radio, the Trautonium, and the Rise of Electronic Music*.

I think it is fair to say that the field of the history of science in general has become much more popular with other fields than was the case back when I won the prize. And this holds true for the history of scientific instruments as well. Cultural history and cultural studies, museum studies, and musicology have all taken an interest in the history of scientific instruments. And this is, of course, a very good thing.

2006 Davis Baird, then Columbia, SC, now Worcester, MA, USA

Bunge Prize awarded for: *Thing Knowledge: A Philosophy of Scientific Instruments* (Berkeley: Univ. of California Press, 2004)

Davis Baird is Professor of Philosophy at Clark University, Worcester. In 2010 he moved to Clark University where he served as the Provost and Chief of Academic Affairs from 2010 until 2021. He served on the faculty at the University of South Carolina for 28 years (1982–2010). From 2004 until his departure to Clark he was the Louise Fry Scudder Professor of Philosophy. From 1981 to 1982 he was Visiting Assistant Professor at the University of Arizona, where he taught after receiving his 1981 PhD in philosophy of science, language and logic from Stanford University. He also holds a master's degree in philosophy of science from Stanford, and a 1976 bachelor's degree in mathematics and philosophy from Brandeis University.

His research has focused on the history and philosophy of science and technology. From 2000 until 2010 he worked on the societal implications of emerging nanotechnologies and on the function of images of nanoscale objects. He also conducted research on the commercialization of scientific knowledge. This work connected with earlier research focused on the epistemology of scientific instruments, that is, how the things that we make express our knowledge. He has also worked on the philosophy of statistics. His current work focuses on the philosophy of religion and Unitarianism.

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In the years after the writing and publication of my book, *Thing Knowledge: A Philosophy of Scientific Instruments* (Berkeley 2004) – and after receiving the 2006 Bunge Prize for this book – there have been a couple of important developments. First has been a prominent focus on nanoscale science and technology. Second has been a significant change in the role of computers in developing and expressing models of scientific and technological – or perhaps better

techno-scientific – phenomena and processes. Broadly speaking both of these developments have confirmed the theses of my book.

Nanotechnology is made possible by new and improved instruments. The scanning-tunnelling microscope is a prominent example. Instruments led the way. This was foreseen in a widely quoted and prophetic 1959 article by Richard Feynman, "There Is Plenty of Room at the Bottom." There Feynman wrote what could be a manifesto for *Thing Knowledge*: "We have friends in other fields – in biology, for instance. We physicists often look at them and say, 'You know the reason you fellows are making so little progress?' … 'You should use more mathematics, like we do.' They could answer us – but they're polite, so I'll answer for them: 'What you should do in order for us to make more rapid progress is to make the electron microscope 100 times better.'" Feynman also foresaw another shift accelerated by nanotechnology, a shift towards the creation of new phenomena, and away from theoretical representation. Instead of "Publish or perish," the catch-phrase became "Demo or die." This shift, in turn, has promoted the promise of new technological opportunities, new ways to do things of value to humanity. This again was a central theme of *Thing Knowledge*.

Interestingly – and perhaps somewhat ironically – modelling has largely gone digital, losing its materiality. Instead of DNA models made of "balls and sticks," as I discussed in *Thing Knowledge*, we now have increasingly sophisticated computer representations, computer models that include dynamic elements showing how complicated molecules behave. Think of models of protein folding, for example. While strictly speaking, this has been a move away from material culture, it continues the focus on developing and controlling new phenomena, for the computer models guide material interventions. The goal is material control, or what I called "working knowledge." The phenomenally fast development of Covid-19 vaccines is a recent striking example.

These changes have all made the material nature of techno-science more prominent, and this of course feeds the importance of the history of the material culture of science and technology – techno-science – and of scientific instruments in particular.

2006 Inge Keil, Augsburg, Germany (1929–2010)

Bunge Prize awarded for: *Augustanus Opticus: Johann Wiesel (1583–1662) und 200 Jahre optisches Handwerk in Augsburg* (Berlin: Akademie-Verlag, 2000)

Inge Keil was an historian of Early Modern astronomy who had trained as a mathematician at the Ludwig-Maximilians-Universität in Munich. For several years she was employed by local high schools as a part-time teacher of mathematics and worked on the development of teaching materials.

From 1981 she published her research on the history of astronomy and on Augsburg as an early centre for the production of optical instruments.

Obituary and bibliography in: *Seeing further: Essays on the early history of the telescope and the history of science in Augsburg – in memory of Inge Keil*, Acta Historica Astronomiae 45 (2012).

2007 Charlotte Bigg, then Berlin, Germany; now Paris, France

Bunge Prize awarded for: "Behind the lines: Spectroscopic enterprises in early twentieth-century Europe", PhD diss., Univ. of Cambridge 2002

Charlotte Bigg is currently a permanent research fellow at the CNRS Centre Alexandre Koyré and she teaches at the École des Hautes Études en Sciences Sociales (EHESS) in Paris. She was educated in history at the university of Oxford (BA Hons. 1996) and in history and philosophy of science at the University of Cambridge (MPhil 1998, PhD 2002). From 2002 to 2009 she worked at the Max Planck Institute for the History of Science in Berlin and at ETH Zurich. Since 2021 she chairs the Board of the Hans R. Jenemann Foundation.

She has published widely on the social and cultural history of the chemical, physical and astronomical sciences in the 19th and 20th centuries in a transnational perspective. Her work focuses especially on the elaboration of instruments and visual cultures in scientific practice and their circulation among a range of audiences. She is currently working on an entangled history of photography and astronomy and on the public display of the physical sciences in twentieth-century France.

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The history of scientific instruments was in a very good place when I was awarded the Paul Bunge Prize – at least considered from the perspective of someone like me who had the privilege to discover it in the company of many eminent and inspiring teachers, most of whom were, or were to become Bunge prize holders. It began with Jim Bennett, whom I met as an undergraduate when he arrived to head the Museum for the History of Science in Oxford and began offering fascinating museum visits, talks and classes. He surely played a part in my decision to study the history of science. In Munich I followed the classes of Matthias Dörries at the Deutsches Museum and enjoyed the proximity on the Museumsinsel of scholarship, collections and their display. At Cambridge when I came up for a prospective visit to learn about the MPhil programme in the history and philosophy of science, Simon Schaffer received me with characteristic generosity. He insisted I sat in on the most curious lecture, the replication of an experiment by a teacher dressed in old-fashioned clothes who turned out to be Otto Sibum, in whose 'Experimental history of science' department at the Max Planck Institute I later had the pleasure to work. When I began studying at Cambridge, almost on the first day, Simon Schaffer brought me to Liba Taub and the Whipple collection where I became fascinated with the beautiful Rowland gratings and spectroscopes that became the subject of my PhD. dissertation. In the course of this work I was lucky to meet and learn from other distinguished Bunge prize holders such as Robert Bud, Davis Baird, Klaus Hentschel (who invited me to my very first conference and published my very first article!), Paolo Brenni and many others featured in this volume, including several of my age peers such as Simon Werrett, Matteo Valleriani, Hennig Schmidgen or Carsten Reinhardt and Jutta Schickore whose work is a continuing source of inspiration.

What this trajectory reveals is not only how lucky I have been but also the extent to which in many places the history of science and the history of scientific instruments were 'inextricably entwined' (to use one of Simon Schaffer's favourite expressions), how fluidly curators and historians could work together collaborating on the common goal of writing a history of science as a history of practices and material cultures, of makers and users, circulations within and beyond scientific and technical worlds. This was not always easy institutionally, and this was by no means everywhere the case, but it seemed like an irreversible trend. Growing up then, it could seem completely obvious that objects were as legitimate objects of inquiry as papers, that cura-

tors could be excellent historians, and that historians could be involved in exhibitions and museums, that makers and collectors possessed knowledge and skills that were important for a proper historical understanding of instruments.

I was delighted to be invited to join the eminent, international Bunge family. It was also an encouragement to continue working in integrated ways across fields, specialties and national boundaries. It certainly resonated with the exhibition that Jochen Hennig and I curated that same year at the Deutsches Museum, "Atombilder, Strategien der Sichtbarmachung im 20. Jahrhundert" ("Images of the atom. Strategies of visualization in the twentieth century"). It may well have played a role in my recruitment as permanent researcher at the French Centre National de la Recherche Scientifique the following year.

When I entered the history of science, research was still largely focused on the experimental sciences, which made a study of scientific instruments evident if one was to care at all about practices. Increasingly since, the field has diversified and opened new horizons to look at many other forms of knowledge, and has begun asking questions that are not primarily focused on the making and circulation of knowledge made in laboratories. The history of scientific instruments has benefitted from perspectives from the history of art, of material cultures, of technology, and of materials, not to speak of colonial and environmental history. What an instrument is and how it can be studied has taken on new meanings, without necessarily rendering older approaches superfluous. Writing as the marvellous and diverse proposals for the upcoming Bunge Jubilee conference are coming in, I am more than confident that it has a bright future – though perhaps not quite the one imagined by Hans Jenemann when he set up his foundation, but who knows? As the foundation's board looks to the next thirty years of awarding the Paul Bunge Prize, it will be its duty to continue helping the history of scientific instruments thrive and take on new challenges, and to continue highlighting the important contributions it can make towards a better understanding of past and present worlds.

2008 **Alison D. Morrison-Low**, Edinburgh, UK

Bunge Prize awarded for: *Making Scientific Instruments in the Industrial Revolution* (Aldershot: Ashgate, 2007)

Alison Morrison-Low is Research Associate at the Collections Department of the National Museums of Scotland. After a first degree in English history at the University of East Anglia, a further qualification in Museum Studies at Leicester University, and a part time doctorate at the University of York, she joined the National Museums Scotland in 1980, with responsibility for the history of science and history of photography collections. Since her retirement in 2015, she has continued to research, publish and lecture in these subjects.

Much of her research focusses on the historic scientific instrument trade in Scotland and Ireland. More recently, in November 2021, she became General Editor of the Scientific Instrument Commission's Editorial Board.

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I received the Paul Bunge Prize in 2008, for a book published in the previous year, entitled *Making Scientific Instruments in the Industrial Revolution*. It was based on my D. Phil. thesis, undertaken part time between 1992 and 2000 at the University of York. In 1992, the UK na-

tional inventory had just been published, and this helped me to think about where in these islands instruments might be made outside the global centre of London, which had been for so long been taken by instrument historians as the sole manufacturing centre. My work had followed on from that of Gloria Clifton's *Directory of British Scientific Instrument makers 1550–1850*, published in 1995, and other works about the British and Irish scientific instrument trade. In a way, my book was a continuation of the mapping exercise to work out the names of those involved in the trade, in particular those of provincial England.

Richard L. Kremer gave a paper at the XXVI Scientific Instrument Conference at Cambridge, Massachusetts, in 2007, he said inspired by the listings of English provincial instrument makers and sellers in my book that was awarded the 2008 Bunge Prize. His paper was subsequently published in "How Scientific Instruments Have Changed Hands" (2017). The prize enabled me to go to conferences abroad, such as that at Harvard and MIT, and over the following years in Lisbon, Budapest, Kassel, Manchester, Turin; and to buy books on historic scientific instruments while on visits to these places, as well as relatively expensive catalogues such as those produced by the National Maritime Museum from 1999 onwards. Winning the prize has certainly helped me in my career, and I have been extremely grateful for the prestige that it has awarded me. After retirement from National Museums Scotland, I have been asked to join a number of advisory boards for exhibitions and editing, and continue to work in the field.

Attention has moved away from the mapping out of individuals involved in the instrument trade towards a more holistic appreciation that if all of this (British) information were held online in a publicly accessible format, then it would be easier to find out or add to the total. There is a grant-funded British universities project – to which I act in an advisory capacity – which is attempting to this, and I see it as an exciting step into the future. The project, entitled 'Tools of Knowledge', aims to produce a semantically modelled database that will allow investigation into the British and Irish scientific instrument trade.

2009 Jutta Schickore, Bloomington, IN, USA

Bunge Prize awarded for: *The Microscope and the Eye: A History of Reflections, 1740–1870* (Chicago, Univ. of Chicago Press, 2007)

Jutta Schickore is Ruth N. Halls Professor for History and Philosophy of Science and Medicine at Indiana University Bloomington. She received her PhD from the University of Hamburg in 1996. Before coming to Indiana, she held a Wellcome Research Fellowship at the Department of History and Philosophy of Science in Cambridge, UK, as well as postdoctoral fellowships at the Dibner Institute for the History of Science and Technology at M.I.T. and the Max Planck Institute for the History of Science in Berlin. She was a member of the Institute for Advanced Study in Princeton 2007–2008 and 2017–2018.

Her research interests include philosophical and scientific debates about scientific methods in the past and present, particularly debates about (non)replicability, error, and negative results; science and public engagement; historical and philosophical aspects of microscopy; and the relation between history and philosophy of science. Her current research focuses on causation and control in the life sciences in the late eighteenth and nineteenth centuries.

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My background and training are in philosophy of science (PhD) and history of science (postdoc), and I have always been interested in the question of how these two disciplines relate to

each other. My book *The Microscope and the Eye: A History of Reflections, 1740–1870* was published in 2007. During the years I was working on the book, that question had opened once again as disciplinary perspectives were shifting. At the time, several philosophers of science oriented themselves more towards actual scientific practice, examined the historical context of past philosophers or philosophies, or studied the long-term history of epistemic and methodological terms. In history of science, the turn to experimental knowledge generation and to the objects, tools, and places of scientific experimentation had already been going on for some time. New communities of HPS researchers were forming, with specialized conferences and societies dedicated to the History of Philosophy of Science (HOPOS), Philosophy of Science in Practice (SPSP) and integrated History and Philosophy of Science (or, in Europe, "historical epistemology"). These shifts and developments in science studies scholarship had significant impact on my work.

The Microscope and the Eye charts the entwined history of the eye and the microscope, but methodological and epistemological reflections are always at the forefront. The microscope appeared as an extension and perfection of the senses, and the eye, in turn, served as a model to elucidate the microscope's function. The eye has also been a reference point for debates about the legitimacy of man's invasion in the microcosm; and the limits of the microscope, problems of illumination, and the destructive effects of preparation procedures became objects of fierce debate. My account of the history of the microscope is embedded in a study of the practitioners' concerns with the possibilities and limits of their instruments, their "second-order concerns", as I called them then. Practitioners of microscopy not only used microscopes but meticulously investigated the nature of light and the effects of chemical agents, pressure, cutting, and tearing on organic tissues. Novel devices such as test objects and testing procedures were developed to ensure that instruments and observers were in good working order. The reflection on the methodological and epistemic issues raised by microscopic investigations was a major driving force for the microscope's establishment as a research tool.

Since 2008, the history of scientific instruments has become even more diverse, with scholars studying research infrastructures and networks of researchers surrounding them, the inscriptions and data generated by scientific instrumentation, or entire collections of objects and materials as instruments for research. Scholarly attention to scientists' second-order concerns has also been increasing, not least due to growing concerns about when to trust science, when to rely on scientific information, and how best to respond to the worries surrounding the so-called "replication crisis" in the sciences. The reliability of instruments has thus become a topic of close scrutiny for scientists and historians and philosophers of science alike.

2010 Henning Schmidgen, then Berlin; now Weimar, Germany

Bunge Prize awarded for: *Die Helmholtz-Kurven: Auf der Spur der verlorenen Zeit* (Berlin: Merve, 2009)

Henning Schmidgen has been Professor for Media Theory and History of Science at the Bauhaus University Weimar since 2014. From 2011 to 2014 he held a professorship for Media Aesthetics at the University of Regensburg. Previously, he worked at the Max Planck Institute for the History of Science, Berlin, after earning degrees at Free University Berlin and Paris-VII. He has been a visiting scholar at the École des Hautes Etudes en Sciences Sociales, Paris, the Department of the History of Science at Harvard University, and the Program for History and Philosophy of Science, Stanford University.

His research interests include the theory, culture and history of media, historical epistemology, philosophy of technology, and machine aesthetics. He co-founded *The Virtual Laboratory: Essays and Resources on the Experimentalization of Life*, one of the core platforms for the history of experimental physiology and psychology in the nineteenth and early twentieth centuries.

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In 2010, the history of scientific instruments did not play a central role in the history of science. Many historians of science were aware of the programmatic and theoretical importance of the history of instruments. This had been ensured by prominent contributions to the history of the "material culture" of science and to the history of scientific 'things' since the early 1990s – from Peter Galison to Bruno Latour to Hans-Jörg Rheinberger.

However, these contributions have only in some cases led to a closer engagement with the history of scientific instruments. Despite some exceptions, the history of science community remained separated from the communities seriously interested in the history of scientific instruments. E.g., there was little overlap between the annual meetings of the History of Science Society and the meetings of the Scientific Instrument Commission. Accordingly, the number of historians who actually went to the archives and museums to explore the details of instrument history was rather small. When, in the late 1990s, I went to the Deutsches Museum for doing research on the history of chronoscopes, the responsible curator, Hartmut Petzold, was more or less baffled: "You're the first historian of science coming here."

The awarding of the Paul Bunge Prize has drawn additional attention to my research work. I was very grateful for this, especially as a junior scholar. I was also pleased that I could use some of the prize money to advance my publication projects.

I received the prize for my work on the experiments Hermann von Helmholtz conducted around 1850 on the psychophysiology of time. My focus was on the instruments for electromagnetic and graphic measurement of short time intervals in the range of hundredths and thousandths of a second. As far as I can see, there have been no new findings on these instruments in the meantime. The major Helmholtz studies by Norton Wise (*Aesthetics, Industry and Science, Hermann von Helmholtz and the Berlin Physical Society*, 2018) and David Cahan (*Helmholtz: A Life in Science*, 2018) do mention and discuss Helmholtz's experiments, which remain important milestones in the modern history of psychophysiological research. But the question of instruments does not play an overriding role. My own attempt to anchor the history of these instruments and experiments more generally in a history of modernity (*Hirn und Zeit*, 2014) has not been widely received.

However, this attempt did allow me to open up and expand the field of history of science by bridging into the field of media studies. Indeed, in the wake of the work of media scholars such as Marshall McLuhan and Friedrich Kittler, but also in light of current problems (climate change, Big Data, the Corona crisis, etc.), there is a lot of interest in the role that media play in the process of producing, representing, and making available scientific knowledge. In this context, the question of scientific instruments proves to be an extremely productive link between the history of science, media studies, and related fields.

Be that as it may, there are always concrete inquiries and requests. Stimulated by the recent anniversary (Helmholtz's 200th birthday in 2021), for example, there has been interest in an edition of the corresponding writings (Helmholtz, *Versuche zur Fortpflanzungsgeschwindigkeit*

der Reizung in den Nerven, 2021). In this context, I could also reiterate the importance of the history of instruments for the history of scientific knowledge.

2011 Matteo Valleriani, Berlin, Germany

Bunge Prize awarded for: *Galileo Engineer* (Dordrecht: Springer, 2010)

Matteo Valleriani is a research group leader in the Department I of the Max Planck Institute for the History of Science in Berlin, honorary professor at the Technische Universität of Berlin, and professor by Special Appointments at the University of Tel Aviv. He received his academic education in physics and philosophy in Bologna, joining the Max Planck Institute in 1998.

He investigates the relation between diffusion processes of scientific, practical, and technological knowledge and their economic and political preconditions. His research focuses on the Hellenistic period, the late Middle Ages, and the Early Modern Period. Among his principal research endeavors, he leads the project "The Sphere: Knowledge System Evolution and the Shared Scientific Identity of Europe," which investigates the evolution of the cosmological knowledge system and the establishment of a shared scientific identity in Europe between the thirteenth and the seventeenth centuries. A further focus of his research is the epistemic function of visual material in the framework of knowledge transformation. His current projects embed approaches and techniques of Complex System Theory as well as Machine Learning and Artificial Intelligence technology within historical studies.

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In terms of my scientific interests at the time, I believe that the history of scientific instruments was demarcated by two streams of research that were almost completely separate and that today, although not yet well integrated, have managed to come closer together. The first stream concerned textual studies of scientific instruments. Since I was mainly concerned with Renaissance studies, I was constantly busy with reading works that analyzed texts (and images) of instruments. Usually, these texts contain one or both of the chapters devoted, the first, to the use of the instrument and, the second, to the procedure of its construction. This kind of historical works deals mainly with mathematical and instrument-related culture in a fairly general way. It also deals with social aspects related to the instrument. However, they often tend to ignore the more purely technological aspects.

While this tendency in certain cases (of technical 'simplicity') might not really represent a great loss, in others the lack of attention to the material dimension leads to historians ignoring essential aspects of the history of scientific knowledge. These kinds of studies, often conducted by museum curators or collection managers, turned out to be virtually unrelated to the studies conducted by historians of science and sometimes even historians of technology. Nowadays, this situation has changed mainly thanks to work and research that has led to outstanding results and made Renaissance historians of science realize that scientific knowledge was often directly integrated into the materiality of technology.

The award has had a very positive effect on my career. In particular, it helped me to disseminate my research results to German academia. Since I am employed at an independent research institute and not at the university, it has always been complex to remain in a stable intellectual exchange relationship with academia. The award and the prestige it brought me greatly helped to improve this situation.

Speaking of the changes in the field of research and, going beyond what has already been mentioned above, I believe that for Renaissance studies the fundamental difference now lies in the use of digital and computational techniques. On the one hand, twenty years of digitization of textual and visual sources as well as the preparation of institutional databases have provided the historian with the opportunity to accrue a more comprehensive view regarding the actual dissemination of knowledge concerning mathematical instruments. On the other, photography and non-invasive techniques of scanning material artifacts have enabled the dissemination of this knowledge and these findings to a wider audience. In particular, it is now possible to reconcile on a grand scale textual sources with material sources pertaining to them, in order to arrive at a deeper understanding of the knowledge and imagery of the historical actors involved.

Finally, this kind of material and these results offer the possibility of moving to a further level of research, that aims at the development of analysis techniques based on the use of computers and in the field of machine-learning and artificial intelligence.

2012 David Pantalony, Ottawa, Canada

Bunge Prize awarded for: *Altered Sensations: Rudolph Koenig's Acoustical Workshop in 19th-Century Paris* (Dordrecht: Springer, 2009)

David Pantalony is Curator of Science and Medicine at Ingenium: Canada's Museums of Science and Innovation and Adjunct Professor at the University of Ottawa, Ontario. He received his academic education at Queen's University and the University of Toronto and received a PhD from the latter in 2002. David has been a pre-doctoral fellow at the Smithsonian Institution, and a post-doctoral fellow at the Dibner Institute, MIT. He has held curating positions at Dartmouth College (NH) as well as the Bakken Library and Museum in Minneapolis.

His research is focused on the history of scientific instruments, on nineteenth-century science in general, and on medicine and technology during the Cold War. At Ingenium, he developed the Reading Artifacts Summer Institute that brings together students artists and scholars from an array of the sciences and humanities who deal with the material culture of science in their work. The new Ingenium collection and research facility has been developed to build on these programs for people throughout Canada and the world, and to enhance access for diverse perspectives on science, collections and museums. In the past five years, David has worked with Indigenous partners to develop an exhibition on Indigenous star knowledge and an international symposium on this topic.

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I will begin with a specific story that speaks to innovations in accessing historic instrument collections at that time, and why these developments mattered. I was awarded the Bunge prize in 2012 at the University of Leipzig. While at the conference, I used the opportunity to visit two collections at the University – the geometric model collection of Felix Klein in the Mathematics Department, and the Wilhelm Wundt collection within the Psychology Department. As is always the case, there were surprises within both collections, surprises in terms of knowledge not found in textual records. The mathematics collection, stored at that time in a series of cupboards in a departmental seminar room, had quantity, depth and variety I had not seen before, as well as very local markings of use that distinguish these models from similar ones found Europe and North America. The psychology collection had very early versions of classic psychology instruments, and early instrument makers that spoke to the material origins of experimental psychology.

I knew about these collections through the national inventory of German university science collections <https://portal.wissenschaftliche-sammlungen.de/>, essentially a national finding aid. Each university has a list of their collections, a basic description of their holdings (sometimes links to much more), and a contact for requests or visits. This is an incredibly useful tool that I have come to use often for research in Germany,[70] and I hope to build a similar database in Canada.

By the 2010s, this German collection portal had grown into a welcoming scholarly context. In 2012, our field had certainly become more visible within the larger history of science, medicine and technology, STS, and philosophy of science. In the wake of the 'material turn' in the history and philosophy of science, and attention towards experiment and instruments, by the 2010s curators started to see an increase in attention to actual artifacts and collections by these communities. Instrument scholars had long worked closely with collections, but other researchers were starting to take objects more seriously as a resource, and subsequently the work we did in this field.

One dimension of this broader shift related to access. Collections had long been accessible through exhibits, appointments with curators, catalogues, and since the late 1990s online platforms. But many valuable collections remained inaccessible. In 2005, Marta Lourenço famously compared them to the "dark matter" of universities – they are everywhere, shaping our history and present, but still quite invisible.[71] By the 2010s, this was changing. As a curator, I have seen many of these collections being uncovered and used in Canada, as well as a large increase in research visits to my own collections in Ottawa.

It is miracle that any collections survive in Leipzig, and this kind of collection history was becoming important by the 2010s. So much of our heritage and history depends on the selection of what we preserve, and what miraculously survives. We have to be critically aware of this. Around the time of my Bunge Award, scholars were paying increasing attention to provenance of scientific instruments and collection histories. This has become a rich field of study. The objects are no longer seen as just types, but as something once owned, something that has travelled, something with a biography.

The actual conference setting for the Prize had a positive impact on me. I loved how the award was situated squarely, and on equal terms within a scientific meeting of the German Chemical Society and the Deutsche Bunsen-Gesellschaft für Physikalische Chemie. I have long been involved in historical branches of scientific societies – this is a great way bring history and the humanities into a scientific conference, to enhance collecting activities, and explore the larger themes related to scientific instrument studies in real time. The Bunge Prize is rare in that it truly elevates our field within this context.

The award also elevates our work in the history of science and technology, and the museum world. Similar to other Bunge Prize recipients who have a curatorial approach, the Bunge award demonstrates that collection work has a valuable role to play in academic scholarship and has unique contributions to the broader fields.

[70] David Pantalony, "What Remains: The Enduring Value of Museum Collections in the Digital Age" *HoST – Journal of History of Science and Technology* 14 (2020), 160–182.

[71] Marta C. Lourenço, *Between two worlds: The distinct nature and contemporary significance of university museums and collections in Europe,* (Paris 2005), p. 23.

Many of the previous Bunge Prize winners are from Europe and the United States, so my receipt of the award was also a recognition of the good work done by Canadians in this field. Trevor Levere, my supervisor at the University of Toronto, had enormous respect for instrument studies and sparked my life-long interest through his writings and a seminar on this topic. I have benefitted from instrument studies done by fellow Canadians Jean-François Gauvin, Randall Brooks, Robert Smith and Marv Bolt, as well as several scholarly collectors in Canada. Victoria Fisher's recent PhD (U of Toronto) on the history of physics in Canada represents the future in our field through her seamless blend of collection work and traditional archival approaches.

There is no doubt that instrument studies have entered a new phase in terms of the kinds of questions being asked, and the diverse kinds of scholars taking instruments and collections seriously. For example, scholars are showing this through their exploration of innovative, interdisciplinary themes in exhibits and research projects in our field.[72] In the field of instrument studies, we are now seeing a blending of the older connoisseur approaches (forensic examination of the instruments) with newer methods and questions. The digital realm has created novel connections and networks of primary resources that have the potential to expand our conception of scientific instruments and their history.

Access to collections has improved, but it is still not enough. This is the biggest challenge facing our field. The digitization of collections has grown exponentially in the 2010s. In my book on the instrument maker Rudolph Koenig, I created a fairly extensive catalogue raisonné of his instruments found around the world. (Paolo Brenni helped me enormously with this endeavor). I am still fielding updates to this catalogue through random Google searches, and the old-fashioned way – people who have read the book and write to me about their collections. Last year, I learned of previously unknown Koenig instruments in Tokyo, Istanbul and Athens. However, this shows that much more needs to be done to preserve and share these hidden collections.

Physical access, representing another dimension of hands-on scholarship, is an even bigger challenge. At my museums (Ingenium), for years we hosted a "Reading Artifacts" Summer Institute for scholars and students that became a model for classes and collection engagement. At our new storage and research facility, we have built these lessons into the design of the building. However, we can't take any of this for granted and need to rebuild a culture of access that coordinates conservation, collection services, curatorial work, digital teams, our administrative services and our fellowship program. Collection work is complex, takes up enormous resources and staff coordination. Instrument studies depend on making this system work. It also needs robust financial resources to make it work, and encourage access in all its forms.

In Canada, access is also about reconciliation with our Indigenous peoples. This represents a significant opportunity for instruments studies. Through several collaborations with Indigenous partners in the past seven years, I have learned much about the larger context of scientific instruments, ways of knowing, museum practices, science and society.

[72] The "Science and the City" research project and exhibition is a great example; see Alexandra Rose's introduction in the *Science Museum Group Journal* 15 (Spring 2021) <http://journal.sciencemuseum.ac.uk/browse/issue-15/science-city-intro/>.

2013 Marco Beretta, Bologna, Italy

Bunge Prize awarded for: *The Alchemy of Glass: Counterfeit, Imitation and Transmutation in Ancient Glassmaking* (Sagamore Beach: Science History Publications, 2009) and for his research on Lavoisier's instruments

Marco Beretta has been full Professor of History of Science at the University of Bologna since 2005. He received his academic education at the universities of Milan and Uppsala, and held research fellowships at the Office for History of Science in Uppsala in 1994 and at the Institute and Museum of History of Science in Florence from 1995 to 2000, when he became Associate Professor at the University of Bologna. From 2004 to 2012 he served as Vice Director of the Museo Galileo.

His areas of specialisation are the history of chemistry from Antiquity to Early Modern time, Antoine-Laurent Lavoisier and the Chemical Revolution, Lucretius and Roman science, the material and visual cultures of science, and historiography. More recently he published, with the late Paolo Brenni, a major study of Lavoisier's laboratories, and is currently preparing an edition of early biographies and autobiographies of Lavoisier between 1780 and 1836.

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By 2013 the history of scientific instruments was a well developed research field and thanks to the contributions by many distinguished historians such as Jim Bennett, Paolo Brenni, Mara Miniati and Gerard L. E. Turner, its integration with the general history of science became apparent. However, within the history of chemistry which is my main research field, the pioneering study by Robert G.W. Anderson, *The Playfair Collection and the Teaching of Chemistry in the University of Edinburgh 1713–1858* (1978) remained an unsurpassed but rather isolated example of scholarship for decades. Following the dominant view on the scientific revolution, historians of scientific instruments focused on collections of mathematical, astronomical, optical, meteorological, electrical instruments, precision apparatus and machines; you find surprisingly few studies regarding chemistry and chemical apparatus in the index of the *Bulletin of the Scientific Instrument Society*. In passing, it is worth to mention that the Museo Galileo in Florence, an institution where I worked for almost 20 years, has published several scientific catalogues of its special collections of instruments (astrolabes, electrical machines, clocks, astronomical and mathematical instruments), but the chemistry collection, which is one of the largest, has not yet been the object of a systematic research.

In addition to the limited view of traditional historiography of science, two more reasons for this neglect are that chemical apparatus appears to be very simple, and that most of the chemical instruments used in laboratory practice seemed to have remained the same from Antiquity to Early Modern time. At a closer examination, however, both impressions are ungrounded as it is difficult to find a science with a larger variety of instruments.

A notable work bringing a renewed attention to chemical apparatus was the collective volume *Instruments and Experimentation in the History of Chemistry* (2000), edited by Frederic L. Holmes and Trevor Levere. However, despite the historiographical importance of this book, references to chemical instruments and apparatus instruments were mostly drawn from texts rather than from the direct examination of actual artifacts.

This unsatisfactory state of the art led me to consider chemical heritage from a different point of view, and my studies on the history of glass helped to enhance the historical relevance of chemical knowledge in the manufacture of instruments and, more generally, to reassess the role of materials in the progress of scientific apparatus and machines. The book awarded the prize,

The Alchemy of Glass, was the most important result of a research I began around the year 2000 in Ravenna in collaboration with archaeologists, historians and chemists.

The most important effect of this prize was certainly that of boosting my confidence and of inspiring me to direct my focus on this research field more systematically. After I was awarded the prize, I began in fact to work on a project devoted to Antoine-Laurent Lavoisier's laboratories and experimental practice and in 2015, thanks to the scientific partnership with Paolo Brenni, I submitted a proposal to the Musée des arts et métiers (Paris) for a scientific catalogue of Lavoisier's collection of instruments and apparatus. The proposal was approved in 2016 and in 2022 Paolo and I published *The Arsenal of Eighteenth-Century Chemistry: The Laboratories of Antoine Laurent Lavoisier, 1743–1794* (Leiden 2022).

I was awarded the prize only ten years ago and it is therefore difficult to assess with precision the changes that have occurred in the field since then. However, it seems to me that the attention paid by historians of science to scientific instruments and museum collections has grown both in quality and in quantity. In the history of scientific glass, which is a topic that I have followed since the early 2000s, many important studies have been published after 2013. Let me just mention the following: Catherine M. Jackson, "Wonderful Properties of Glass: Liebig's Kaliapparat and the Practice of Chemistry in Glass", *Isis* 106 (2015), 43-69, and Umberto Veronesi, Marco Martinón-Torres, "Glass and Alchemy in Early Modern Europe: An Analytical Study of Glassware from the Oberstockstall Laboratory in Austria", *Angewandte Chemie International Edition* 57 (2018), 7346-7350; Pascal Richet (ed.), *Encyclopedia of Glass Science, Technology, History, and Culture*, 2 vols. (Hoboken, NJ 2021). These studies will hopefully inspire museum curators and historians to work on the numerous collections of scientific glassware enriching most of the world's science museums.

2014 Cyrus C.M. Mody, then Houston, TX, USA; now Maastricht, The Netherlands

Bunge Prize awarded for: *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (Cambridge, MA: MIT Press, 2011)

Cyrus Mody is full Professor of History of Science, Technology and Innovation, and is heading the STS programme at Maastricht University. He received an undergraduate degree in mechanical and materials engineering from Harvard and a PhD in Science and Technology Studies from Cornell University in 2004. From 2005 to 2007 he was Program Manager in the Center for Contemporary History and Policy of the Chemical Heritage Foundation, Philadelphia. In 2007 he became an assistant professor and, from 2014, an Associate Professor in the History Department of Rice University, Houston, before moving to Maastricht in 2015.

His research focuses on recent science and technology, specifically the applied physical sciences in the United States since 1965. He studies the commercialization of academic research, university-industry-government partnerships, the longue durée of responsible research and innovation, and the technopolitics of scarcity in the long 1970s. At present, he is the principal investigator in a major project on the oil industry, environmentalism, and alternative energies, and co-PI of an interdisciplinary project on error correction in science.

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The history of scientific instruments was in excellent shape when I was awarded the Bunge Prize, and I sincerely hope my work has done nothing to undermine that reputation. I was thrilled to accept the prize in part because the list of previous winners contained many names of

people I'd read, cited, and been inspired by; and the list of awardees since 2014 is, if anything, even more inspiring. One especially nice feature of that list is that its membership illustrates both the strong connection between histories of scientific instruments and museum work (collecting, preservation, and understanding of the material heritage of science) and the ways that histories of instruments can open onto aspects of science that seemingly (but only seemingly) aren't closely related to material heritage.

All that said, my sense when I was awarded the Bunge Prize was that many colleagues in broader history of science and technology considered histories of scientific instruments to be a niche subfield with, well, not the most stellar career prospects. Of the roughly three dozen PhD candidates who overlapped with me in the Cornell STS program, I think only one other was working on a topic in which scientific instruments figured prominently. Possibly the proportion would have been slightly higher in history of science and technology PhD programs of the late 1990s and early 2000s, but it can't have been much higher.

Why? My guess is that this partly has to do with the disfavor that internalist histories of science have fallen into and the unmerited but widely shared sense that histories of scientific instruments just are, by definition, internalist. True, many instruments are used in laboratories, the exemplary 'internal' spaces of science. But even for such tools there is much to say about how they got there, how they became icons of scientific expertise, etc. – topics that (as the awardees of the Bunge Prize have shown) undermine any internal external distinction. Moreover, many instruments are used in the field, the hospital, the home, even in outer space – instruments travel much more widely than, perhaps, many of the 20somethings embarking on a PhD in history of science (myself included!) might guess. Our subfield could perhaps do more to broadcast that.

We could also do more to broaden the chronological and spatial scope of our subfield. General history of science and technology have globalized significantly in the past decade, both in topic and membership, yet the Bunge awardees don't reflect that turn well. General history of science has also moved into the 1990s and even the 2000s, yet 1970 is still roughly the limes for studies of instruments. This may be a pet peeve, but as an historian of probe microscopy I flinch when I see (for instance in the Wiley *Companion to the History of Science*) 'microscopy' equated to "optical microscopy". Non-optical microscopes have been around since at least the 1930s, and the family of new microscopes continues to grow right to the present – as evidenced, for instance, by the 2014 Nobel Prize in Chemistry. In other words, without being overly presentist, our subfield could better reflect the present state of science, history, and the world.

The trip to collect the Bunge Prize was also the trip where I decided to move from Houston to Maastricht, so – if not an 'effect' – the prize certainly coincided with a major change in my life and career. And one happy consequence of moving to Maastricht has been unexpected opportunities to revisit the history of scientific instruments. Three examples stand out: first, Joe Martin and I co-edited *Between Making and Knowing: Tools in the History of Materials Research* (New Jersey/London 2020), which features essays by around forty authors on a variety of instruments and other scientific equipment. Second, I've had the pleasure to supervise Lea Beiermann's PhD dissertation, *'A Co-operation of Observers': Crafting Knowledge Infrastructures for Microscopy* on 19th-century microscopy clubs. And third, I'm now part of the ERC Synergy project NANOBUBBLES, which looks at difficulties in correcting scientific errors in nanobiology. As I showed in *Instrumental Community*, scientists sometimes use innovation in instrumentation as a way to move past errors without ever stopping to publicly correct them! So NANOBUBBLES has been a wonderful opportunity to get back to some of the same topics and themes and extend my thinking about instruments.

I've outlined a few changes in general history of science and technology above. Here I'll just add that the work for which I was awarded the Bunge Prize, *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (Cambridge, MA 2011) was associated with a field of social studies of nanotechnology that was emerging at the time (another Bunge awardee, Davis Baird, was one of the people who helped push that field into being and who enrolled me into it). I received the Bunge Prize toward the end of a ten-year run in which I assisted Patrick McCray in building a research group on the history of nanotechnology – a group that included a number of people interested in instrumentation, broadly construed, such as Amy Slaton, David Brock, and the late great Ann Johnson (who no doubt would have been awarded the Bunge prize eventually had she lived). Since 2014, though, social studies of nanotechnology has more or less dissipated, with the bulk of its members moving into "Responsible Research and Innovation", while the historians moved onto more topics beyond nano, such as Patrick's work on 'visioneers' or my current project on the oil industry and alternative energy. What I hope to show in my presentation for the Bunge Prize jubilee, though, is that one never really moves 'beyond' instrumentation – that instruments constantly crop up everywhere and that they offer one of the brighter red threads running through the history of science in/and society.

2015 Brian Gee, Chelsea, UK (1939–2009)

Bunge Prize awarded for: *Francis Watkins and the Dollond Telescope Patent Controversy*, ed. by Anita McConnell und Alison D. Morrison-Low (Farnham: Ashgate, 2014; London: Routledge, 2016)

Brian Gee was an independent historian of scientific instruments and the instrument trade. He took a degree in physics and mathematics and became a physics teacher in London schools and at the International School in Geneva before becoming Senior Lecturer in Science Education at the College of St Mark & St John (Marjon) in Chelsea, the oldest teacher training college in Britain. Simultaneously, he studied history of science at University College London and wrote a PhD thesis on philosophical instrument makers from 1750 to 1900, defended at the University of Leicester in 1988. After taking early retirement from Marjon in 1993, he worked as a free-lance historian and tutored for the Open University, while caring for his elderly, invalid parents.

His research focused on British instrument makers and the instrument market, in particular 18th-century electrical and optical apparatus. The Handlist of scientific instrument-makers' trade catalogues, 1600–1914 co-edited with Robert Anderson and John Burnett remains to this day a valuable reference work. Brian Gee's archival study of the long-running dispute about John Dollond's achromatic telescope was published only after his death and the prize money for his posthumous Bunge prize was given to the Grants programme of the Scientific Instrument Society.

Obituary: W.H. Brock, "Brian Gee", in *University of Leicester E-Bulletin*, 9 March 2010, quoted in: A.D. Morrison-Low, "Francis Watkins and the Dollond telescope patent dispute: Dr. Brian Gee's take on the subject", *Bulletin of the Scientific Instrument Society* 122 (2014), 4–9

2016 Robert G. W. Anderson, Cambridge, UK

Bunge Prize awarded for: *Lifetime achievement*

Robert Anderson is a museum curator, an historian of chemistry and an Emeritus Fellow (also former Vice-President) of Clare Hall in the University of Cambridge. He was educated at St

John's College in the University of Oxford and completed his doctorate in physical chemistry in 1972. He joined the Royal Scottish Museum with responsibilities in chemistry and physics and in 1975 moved to the Science Museum in London, becoming Keeper (head) of the Chemistry Department in 1980. Four years later he returned to Edinburgh as Director of the National Museums of Scotland. In 1992 he moved back to London as Director of the British Museum, overseeing the creation of the Great Court, designed by Norman (Lord) Foster, which the Queen opened in the year 2000. Latterly he held visiting positions at the Institute for Advanced Study at Princeton, was an Emeritus Leverhulme Fellow, an Honorary Professor at the University of the Arts, and served as President and CEO of the Science History Institute in Philadelphia between 2016 and 2020.

His research is largely focused on chemistry during the Scottish Enlightenment and he has published the complete correspondence of Joseph Black (1728–1799) and also papers on the teaching of chemistry at Edinburgh University. He has written on the history of collections and has interests in how the working class learnt science in nineteenth-century mechanics institutes through lecture demonstrations assisted by subscription libraries. He encouraged instrument studies as President of the Scientific Instrument Commission of IUHPS from 1981 to 1994.

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First, a bit of autobiographical commentary is needed: I won the Bunge Prize in 2016, late in my career, as a lifetime award. Museums and collections (of all kinds) have intrigued me from my earliest memories. Perhaps the first historically significant scientific instrument to fascinate me was when in 1966 I noticed stored above the door of my laboratory a crude infra-red spectrometer (the 'biscuit tin'). It had been made in the 1930s by my tutor at Oxford University, Professor Sir Harold Thompson (after much nagging by me, he presented it to the Science Museum in 1976).

I had been appointed a curator of the history of chemistry and physics at the Royal Scottish Museum in 1970. I worked there until 1975, then at the Science Museum in London until 1984. I returned to Edinburgh to direct what became the National Museums of Scotland till 1992, and then became director of the British Museum until I retired in 2002. I spent a year in the Institute for Advanced Study at Princeton and then with fellowships for research at Cambridge University until 2016 when I became director of the Chemical Heritage Foundation in Philadelphia, later named the Science History Institute, until Covid came along, and I returned to the UK in 2020, retiring again. In all the jobs mentioned I had responsibilities for historical scientific instruments.

I gained the Bunge Prize in 2016, some 46 years after I had first been employed as a science curator. Over my experience of more than half a century the study of instruments did change somewhat, probably to a greater extent over the period 1970 to 2016 than in the seven years since then. My answers to the questions are obviously affected by my pre-Bunge Prize experiences.

History of scientific instruments was a relatively flourishing subject by 2016, and the subject had been accelerating since its modest position in the 1960s. But it was never particularly well-integrated with other history of science studies, not enjoying the fashionability of the changing world of HPS. It could be regarded by some, when regarded at all, as being conservative in nature, even unexciting. This was not a particularly unusual situation when compared to other areas of material culture studies, such as art history or archaeology (though in both of these fields, scholars studying objects are very much greater in number, so that they form a more

significant sub-culture within their fields than do scientific instrument historians). Collections of any kind need nurturing and interpreting, and they absorb resources of time and money.

Historical studies of scientific instruments have a longer background than might at first be thought (though overall coverage of the field when I started was very patchy). As an example, in 1970 I wanted to know more about the identity of an early 18th century air pump. I found that an excellent paper on the evolution of air pumps had been published by George Wilson in 1849. Those conducting research like to feel that their work is groundbreaking, but if I had not traced Wilson's work I could later have been accused of 'reinventing the wheel'. I realised that our studies needed to be useful to understanding science culture and not be simply antiquarian. My earliest monograph attempted to show how a group of chemical apparatus could be closely linked with teaching practices at Edinburgh University.

In the four decades before and after my winning the Bunge Prize, many changes in museums have taken place. At the beginning of my period, science museum galleries were drier but more serious, some taking an almost taxonomic approach. They have become more populist and less systematic in recent years. Only a very few exhibitions have been inspirational. Some efforts have been made to integrate instruments into cultural history displays with, I suggest, limited success. In the 1970s the Science Museum in London had three (or four, if Wellcome is included) independent departments which dealt with instruments. These were gradually whittled down to only one. Layers of administrative posts were introduced between subject specialists and the director. Curatorial posts were downgraded, lost or merged. On the brighter side, active groupings of instrument historians, including serious amateurs, were set up. In the 1970s in Britain, the Group for Science, Technology and Medical Collections was established. Then in 1978, Gerard Turner started his private Equinoctial Club which met twice a year to dine and have lively discussions on the state of the art. The Scientific Instrument Society, for professionals and amateurs, was established in 1983, publishing its *Bulletin*, which continues today. Its American equivalent, *Rittenhouse*, the Journal of the American Scientific Instrument Enterprise, was started in 1986, though it stopped being issued in hard copy in 2009. General history of science periodicals publish papers today dealing with instruments when editors judge them to be of sufficiently high standard and fit into the ethos of the publication.

I was truly delighted to win the prize, my name then being associated with other Bunge prize-winners whom I admire. But as I was antiquated when I received it, it did not have an effect on my career in the UK. Americans like prizes, and perhaps it persuaded the Chemical Heritage Foundation board that I should be asked to take on its Presidency in that same year (2016), though there's doubt about this as the Prize was announced after the job had initially became vacant. One effect that it did have was to galvanise me into writing my Bunge acceptance speech, and then adapting it for publication ("Where has all the Chemistry Gone?", *Fachgruppe Geschichte der Chemie: Mitteilungen* 25 (2017), 329–346). I make no apologies for it being a downbeat paper: I think that chemistry is a subject of great specialist and public importance which is rarely to be found in science museums today. I am not aware that my lecture and paper have led to any discussion, let alone changes of attitude.

My field has evolved rather than has become revolutionised so that change has been gradual in museums and universities, and in any case, non-uniform. In recent history of chemistry there has been a great deal of attention paid to alchemy, though it was developing well before my 2016 prize. There is some interest in alchemical processes involving apparatus, and attempts are made to reproduce experiments. Occasionally archaeologists find fragments of vessels. Discoveries, virtual or real, have sometimes been incorporated in papers which deal largely with concepts and theories of the practice. Laboratories are receiving more attention than before, and

Peter Morris's important book *The Matter Factory* (2015) should be mentioned. The Science History Institute has developed themes which involve substances and instrumentation and it acquired some important objects when it was under my direction from 2016 to 2020. It is necessary to add that the Science History Institute collects printed books, manuscripts, archives and graphic materials, and I promoted collecting of instruments in relation to these other forms of evidence so that research can benefit by considering these materials together. From 2006 to 2017 I was chairman of the Society for the History of Chemistry and Alchemy and there are now more young historians on its Council than before; some of these have taken an interest in material culture. However, things have not changed dramatically over the past seven years.

The key question is one to which I have alluded before: how can the various approaches to history increasingly incorporate instrument studies, to its benefit?

2017 Simon Schaffer, Cambridge, UK

Bunge Prize awarded for: *Lifetime achievement*

Simon Schaffer was Professor of History and Philosophy of Science at the Department of History and Philosophy of Science at the University of Cambridge until his retirement in 2022 and has been a Fellow of Darwin College since 1985. He was trained in natural sciences and history and philosophy of science at Trinity College Cambridge and Harvard University, and gained his PhD in 1980 from Cambridge with a thesis on Newtonian cosmology. He has taught at Imperial College London, at UCLA and at the École des Hautes Études en Sciences Sociales, Paris.

His research addresses the practices, materials and organisation of scientific inquiry between the seventeenth and nineteenth centuries, including studies of astronomy, natural philosophy, technology and the physical sciences. Schaffer has collaborated with several museum and gallery projects. He is currently a co-investigator on the Project "Making Climate History".

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I was delighted and extremely grateful to my close friends and to my professional colleagues for the decision to award me the Bunge Prize in 2017. At that period, certainly, the significance of scientific instruments in history, however that very difficult and exceptionally fluid category might be defined, was very widely proclaimed and honoured. It was often said by science historians that a former highly idealist and theory-driven story about the sciences had somehow been displaced by proper insistence on the roles of instruments, tools and material labour. A key site where this development was apparently in evidence was around museum curatorship and the use of instrument collections. During that same year, for example, preparations were in progress at the Science Museum in London, where I had served as Trustee, for a major exhibition on The Sun, with Harry Cliff as lead curator, in which the salience of the tools and apparatus on which solar sciences and technologies relied was extremely evident. Indeed, it was striking that the periodisation of solar experience as the object of a set of expository displays were in many ways arranged according to the appearance and development of different ranges of instruments and devices, whether objects that used apparent solar movement to determine time or position, apparatus to capture and analyse the properties of sunlight through spectroscopy and photography, and equipment to use solar rays as power sources.

It seemed clear, on the whole, that museum collections offered something like the principal concern of historians of scientific instruments, and that inquiry into the long and complex ca-

reers of apparatus used within the sciences should apparently engage with, and document, the provenance and the subsequent use of these materials. Scholars working on the composition, design and properties of instruments' materials held in collections, including several eminent Bunge Prize winners, as well as some strong prospective candidates for the award, showed how such analyses could change and challenge orthodox histories of the character of the sciences, of their labour force, and of their relation with technology and economy. Over the four decades before 2017, furthermore, linkages between instruments as display objects and as working tools of scientific labour had been strikingly reinforced – and in fascinating ways challenged – by important projects to rebuild and rework past scientific experimental equipment, especially in the enterprises launched from the Carl von Ossietzky Universität Oldenburg by an impressive group of physicist-historians, concerned with making sense of the practices and materials of lived sciences, and of recovering the meanings of instruments in use.

The uneven relation, therefore, between use and show in the sciences' material culture remained a major theme of inquiry. It is noteworthy that in some influential versions of scientific authority, it is held that to draw attention to the labour and materials of a scientific project might undermine the authority of that project's claims – on this account, it seemed, only those results achieved somehow without troublesome mediation should be credited. On others, however, it has been precisely the impressive, compelling and, in some cases, sublime material technologies of working sciences that have seemed to grant them their persuasive status, quite evident in cases such as the Large Hadron Collider at CERN (launched in 2008) or the detection of gravitational radiation by the Laser Interferometer Gravitational-Wave Observatory (LIGO) announced in 2015, both of which were also accompanied by major displays, exhibits and publicity campaigns.

My own local experiences around the middle of the last decade seemed to confirm association between instrument histories, curatorship and wider analysis of the practice of the sciences. Between 2010 and 2015 I joined a project funded by the Arts and Humanities Research Council on the archives of the Board of Longitude, to produce historical accounts of the materials and documents of the initiatives launched with the passage of the Longitude Act in Britain in 1715 and enduring for just over a century under the administration of the Board. A central aim of the collective work was to link together official and informal records of patronage, controversy and management with extant instruments preserved at the National Maritime Museum in Greenwich. A major exhibition, curated by Richard Dunn and Rebekah Higgitt, who helped lead the Board of Longitude project, was held at the Museum in 2015 to display the remarkable histories and lives of devices ranging from timepieces and sextants to more visionary and speculative objects related to the determination of longitude at sea; and the project also included a complementary exhibition involving modern commissions from artists and designers who had been invited to use the Board of Longitude archives to devise their own fanciful, witty or puzzling instrumentation. In such examples, past instruments seemed to nourish a range of historical and inventive responses; and it appeared indispensable to ground any historical account in the experience of practitioners and of audiences in interacting with such material tools.

Reflection on these apparently evident features of the relationship between instrument history, the institution of the collection and the museum, and the means through which tales were to be told about the career of the sciences and of their objects, were certainly reaffirmed through the Bunge Prize. The generous award of 2017 was then devoted to supporting museum internships at the Whipple Museum for the History of Science in Cambridge, to aid effective interaction between the study of the collections by students and practitioners, and the accounts of their histories. Histories of material instrumentation were entangled with a wide range of themes in public science and its many different constituencies. As a complementary example, the follow-

ing year it was formally announced that the official definition of the kilogram would be changed in May 2019 from reference to the celebrated platinum-iridium bar held at the Pavillon de Bréteuil west of Paris, to dependence on the value of the Planck constant. As an apparent example of dematerialisation – or, rather, a switch from embodiment to a form of procedural metrology – this seemingly minor but eloquent change provided the occasion for a major and genuinely brilliant exhibition, "Sur mesure", with Bruno Jacomy as commissaire, at the Conservatoire National des Arts et Métiers in Paris. In a brief talk I gave in spring 2019 in the series to accompany these displays, it was possible to discuss with visitors and curators the range of understandings of the work of measuring, the authority of material devices as standards, and the manufacture of the sciences' world. Themes ranged from religion and credibility to consumption and controversy. It was obvious these were neither minor nor marginal concerns.

No doubt the crises of the pandemic and especially of the new climate regime have brought into relentlessly sharper focus the meanings of the instrumental and material practices of the sciences and their presences within everyday social and economic lives across the globe. Organised inquiry into the histories of scientific instrumentation will be markedly focused and reoriented by these developments, and by the remarkably significant relations between the apparently esoteric world of instrument design, production and use and the conduct of citizens and activists. The politically uneven and fraught production of test equipment, of its relation with end users, of the meanings of the results it generates and the confidence to be vested in its measures, are at the very centre of public politics. In the case of the climate crisis, the seemingly self-evident identification of climate with temperature, and thus with the work of thermometry, demands a fascinating and decidedly complex re-examination of the genealogy of instruments of measure and record. During the early invention of climatology as a discipline in central Europe in the early nineteenth century, it was already importantly argued by German and Danish scholars that the very history of climate must be divided between what was called the meteorological period, when reliable thermometers were available, and previous epochs, when antiquarian, conjectural and proxy methods must be used. Climate history in this sense is always also the history of its equipment. This has become a significant research concern for a project on "Making Climate History", under the leadership of Richard Staley and supported by the Leverhulme Foundation, which I was able to join in 2019. The fraught relationship, therefore, between the authority invested in sciences' accounts and work with past and contemporary instrumentation plays a central role in the most important political and social issues of our time. It is evident that completely different and revisionist accounts of instrument history are needed as a resource in these concerns, and that the continuing support of public institutions and citizens' organisations is required to make these projects more effective.

2018 Anthony J. Turner, Le Mesnil-le-Roi, France

Bunge Prize awarded for: *Lifetime achievement* since *Early Scientific Instruments, Europe, 1400–1800* (London: Sotheby, 1987)

Anthony Turner is an independent historian of scientific instruments, clocks and watches, and the social history of science. For most of his professional life, he has operated without being formally attached to any institution, university or museum. Educated at Wadham College, Oxford, he graduated in history in1968, followed by a Diploma in History and Philosophy of Science in 1969. For two years he worked at the National Maritime Museum, Greenwich, but since 1972, works as a freelance scholar and consultant, preparing exhibitions and auction catalogues in parallel with running an antiquarian book business centred on the history of science and technology.

Already one of his first articles on mathematical instruments and the education of gentlemen, published in 1973, addressed questions beyond the traditional and sometimes antiquarian interest in scientific instruments. His 1987 *Early Scientific Instruments, Europe, 1400–1800* is almost a classic, although his book on the French naturalist and philosopher Pierre Gassendi, prepared to accompany the quater-centenary exhibition in Digne-les-Bain, is less well known. He catalogued the mathematical instruments held in the Bibliothèque Nationale de France, and is currently working on an online bio-bibliography of French and Swiss scientific instruments makers from the mid–15th to the mid–20th century.

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When I began work in this field in the early 1970s, the second volume of E.G.R. Taylor's survey of English mathematical practitioners had only recently been published, so too had the meticulous studies of meteorological instruments by W.E. Knowles Middleton. A useful popularising general survey was that by Henri Michel (1965), but the only authoritative work on early instruments, surveying the whole field of their development during the Ancien Régime, was that of Maurice Daumas (1953) – a work it should be noted still to be replaced. Such works were indispensable as were others that need not be detailed here such as R.T. Gunther's survey of astrolabes (1932), the Supplement to the Billmeier Collection in Oxford (1957), and the detailed works by Salvador Garcia Franco on astrolabes and nautical instruments in Spain (1945 and 1959). The period was primarily one of 'tunnel' histories of individual instruments such as Henry C. King's *History of the Telescope* (1955), and an increasing number of national inventories and individual museum catalogues fed into these.

Despite considerable progress since then, many instruments remain to be studied in their long term evolution, and many museums and collections still lack detailed comparative catalogues. That such work continue is essential because it supplies the narrative basis for a more subtle, more truly historical, analysis of the development of instruments set in the economic, scientific, technical, and social context of their production and use, and of the roles and importance that they held in the societies that gave rise to them. The history of scientific instruments is but a sub-section of the history of science and technology, itself only a sub-section of the history of culture and learning. Understanding of this has, and should, lead historians of instruments to develop contextual accounts of them and to do so by exploiting the wide range of sources such as newspaper advertisements, bankruptcy and insurance records that are now routinely examined but were not in the 1970s.

The audience for the investigation of instruments is twofold: historians and scientists primarily interested in their development and uses, collectors and curators primarily concerned with the objects in and for themselves and with their preservation. Clearly the two groups overlap, intermingle, but there is a tension between their aims which can crudely be summarised as understanding for the first group, preservation and perhaps profit for the second. As antiquities, mathematical and scientific instruments partake of the art market – dealers specialised in them seek them out, striking auctions of them irregularly occur in Europe and North America. Although a trade in second-hand instruments can be traced back to at least the mid-18th century and perhaps earlier (the subject is one that awaits detailed investigation), and the collecting of instruments with its own associated trade to the mid-19th century, the latter is a phenomenon that has vastly developed in the past half century. It is therefore an element that needs to be studied and absorbed into any general history of instruments. At the same time, even if the art market is parasitic on the work of historians, it is an important resource for research bringing to public notice, and so to investigation, numbers of instruments, some of considerable historical significance, hitherto unknown.

And the unknown is unfathomable. If the effect of the Bunge prize for me was that it enabled the acquisition of a fundamental research tool – a nearly complete run of the *Mémoires de l'Académie Royale des Sciences*, using this underlined for me the quantity of materials available that we have yet to exploit. More, with its world-wide survey of phenomena, it provoked the reflection that our history of instruments is parochial, compartmentalized. The development of instruments in Antiquity, in Islam, in China, Japan and Korea is only partially integrated into the history of instruments in general – normally such stories are recounted by highly skilled specialists – while the history of balances or medical and surgical instruments have no place in such general histories as we have, i.e. Daumas or the geographically more limited but splendid contextual study by Alison Morrison-Low of instrument-making in the Industrial Revolution (2007). But we lack a broad, comparative, survey similar perhaps, but more extensive, to the ambitious work of Toby Huff, *Intellectual Curiosity and the Scientific Revolution: A Global Perspective* (2011), through which the reasons why the historiography of instruments fails to offer a global account, and even why general histories of western instruments exclude certain classes, can be examined. If the explanation probably has something to do with the disciplinary boundaries of the sciences in the post–1700 world, and may also have much to do with the organization of manufacturing in Early Modern Europe, the structural imperatives of the different societies concerned need also to be brought to bear on the development of scientific instruments that we seek to recount. The current historiography of instruments is rich in precise, detailed, studies of particular devices and some of their makers, but to understand them fully a wider, and a global, context is requisite. From this perspective instrument history seems not to have developed very much in the past five years.

2019 Sara J. Schechner, Cambridge, MA, USA

Bunge Prize awarded for: *Lifetime achievement*

Sara Schechner has been the David P. Wheatland Curator of the Collection of Historical Scientific Instruments at Harvard University since 2000, and a Lecturer in the History of Science, Museum Studies, and other Harvard programs since 2004. She graduated in physics and history of science from Harvard, then earned an MPhil from the University of Cambridge in England and PhD from Harvard (1988) in history and philosophy of science. From 1983 to 1990 she was curator of the History of Astronomy Collection of the Adler Planetarium in Chicago, and then curated exhibits for the Smithsonian Institution, the American Astronomical Society, and the American Physical Society in the 1990s. She was Secretary of the Scientific Instrument Commission from 2003 to 2013.

Her research focuses on the history of astronomy and early scientific instruments. Publications and ongoing projects have been on comets and Early Modern cosmology, sundials, colonial astronomy, scientific instruments of glass, especially telescopes and optical glass produced or sold in American instrument-making workshop practices, and on the representation and iconography of astronomers and their instruments in works of art. She has been deeply engaged in museum education through curated exhibitions and object-based teaching for diverse Harvard courses and programs, including "Tangible Things" and "Prediction", which are online.

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I was awarded the Bunge Prize in 2019, which was not that long ago. At the time, many scholars in the history of scientific instruments were focusing on instruments at the crossroads of local and global practices, politics, disciplines, and networks. They were also interested in the movement of instruments and related knowledge across spatial and cultural boundaries, and

how the scale of analysis (from micro / localized to macro / universal) influenced what we could learn from and about instruments. These themes were strongly represented at the meetings of the Scientific Instrument Commission in Rio de Janeiro (2017), Leiden and Haarlem (2018), and Havana (2019). In Havana, for example, art historian Susanna Berger and I gave a joint paper on the meaning of astronomical instruments in an Italian 17th century painting by Niccolò Tornioli, thereby working together at the intersection of art history and history of scientific instruments.

Another theme from this period concerned scientific instruments that failed, became obsolete, or led to dead ends. What do we define as a failure? What factors lead to it, and how does context affect it? What role do failed instruments have in museum exhibitions and collections? What do we learn from them about knowledge production and instrument making and marketing? A prompt for 'pitches' (spirited 10-minute papers) to explore the theme of failure first appeared at the Scientific Instrument Commission meeting in Leiden (2018), and was carried forward in sessions in Havanna (2019) and London (2020). A volume on *Failed Scientific Instruments*, edited by Sofia Talas and myself, is forthcoming in the series *Scientific Instruments and Collections*.

In 2019 the generosity of the Hans R. Jenemann Foundation enabled me to come to Germany not only to accept the prize in person at a meeting of the History of Chemistry section of the Gesellschaft Deutscher Chemiker in Halle (Saale), but also to extend my visit into a study tour that took me to collections in Dresden, Berlin, and Göttingen. I was able to meet with colleagues and make new friendships and working relationships. The prize also helped me politically in gaining more recognition at my university and in my department.

Little did I know that one year later the world would be plunged into the Covid–19 pandemic. This event sent everyone into isolation at home. Time away from our office distractions and exhibition installations offered many scholars, including me, the opportunity to catch up on curatorial tasks such as object cataloguing, and perhaps more significantly to reflect on the collections, to think more critically, and to write.

Although only three years have passed since I received the prize, the pandemic and sociopolitical movements highlighting racism and decolonization have altered some practices in the field of scientific instrument studies. The pandemic has introduced us to new video-conferencing tools, which have enabled greater access to conferences, workshops, lectures, and site visits for individuals dispersed geographically and with lesser economic resources. This has enriched our community with new voices and ideas. Political movements seeking to teach awareness of the history of slave labor, colonial powers, and Indigenous cultures, have encouraged some scholars, including myself, to consider the roles played by scientific instruments in colonial exploration, land management, commerce, and social control. Historians also now have a greater awareness of the labor and ecological costs of materials used to produce the instruments.

2020 Simon Werrett, London, UK

Bunge Prize awarded for: *Thrifty Science: Making the Most of Materials in the History of Experiment* (Chicago: Univ. of Chicago Press, 2019)

Simon Werrett is Professor of the History of Science in the Department of Science and Technology Studies of University College London. He received his academic education from the University of Leeds and in the Department of History and Philosophy of Science, and in the University

of Cambridge and obtained a PhD there in 2000. From 2002 he was Assistant and then Associate Professor at the Department of History at the University of Washington, Seattle, before joining University College London in 2012, first as a Senior Lecturer, then full Professor. He has been a visiting scholar at the Max Planck Institute for History of Science in Berlin and the Getty Research Center in Los Angeles.

His work explores the history of science through novel perspectives on material culture and practice in the sixteenth to nineteenth centuries. His most recent book is a new approach to natural inquiry, foregrounding re-use, adaptation, repair and exchange. It examines Britain and North America from the seventeenth century onward, and combines history of science, material culture studies, and environmental history. He also has a longstanding interest in Russian science, and has published on science, technology, and empire, including articles on British and Russian voyages of exploration. His current project 'The Sporadic Table' rethinks our understanding of the chemical elements from the perspective of thrifty science.

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The history of scientific instruments has been steadily growing in recent decades particularly as there is much more attention paid to the material culture of science by academics today then there was in the past. There have been very interesting debates about the nature of scientific instruments following Deborah Jean Warner's famous 1990 article "What is a scientific instrument?" During my time in the History Department at the University of Washington I was fortunate to have many conversations with Thomas Hankins who together with his graduate student Robert Silverman produced the influential book *Instruments and the Imagination* (Princeton 1995). For me this book opened up many new vistas on the history of scientific instruments and broadened the definition of what scientific instruments could be by showing how they moved back and forth between scientific and other uses. In retrospect I think this was a key step towards my book *Thrifty Science* (Chicago 2020), in which I argued that such movements were not accidental but actually part of a whole philosophy of everyday life in which "making use of things" or turning objects to new ends was highly valued. Historians had been thinking about the home as a site of scientific inquiry and experimentation for some time when I wrote this book but I don't think they appreciated the particular approach to materials that Early Modern domestic life entailed. It was still the case that the home was seen as a place for the consumption of scientific instruments rather than as a site where instruments were being produced and reworked continuously as people "made use" of furnishings, decorations, utensils and architecture to learn about nature. In the eighteenth century as we know from the brilliant work of scholars such as Jessica Riskin, Simon Schaffer, Alan Morton and Sara Schechner, there was a growing market in Europe (and beyond) for the domestic consumption of optical and philosophical instruments made by expert makers. But this ran alongside, I wanted to argue, a continuing thrifty improvisation of instruments and experimental apparatus in the home. I would also say that environmental history and the history of scientific instruments had not really come into contact much when I was writing *Thrifty Science*. The core goal of the book was to show how studying the history of instruments and experiment could contribute to new ways of thinking about the current environmental crisis. Today there is now a deeper crossover between environmental history and the history of science but I still think much remains to be done to bring them together around the history of scientific instruments.

When people say it's an honour to receive an award I always took it as something of a formality – until I actually received one and realised that it's a quite humbling experience and I am indeed very honoured to have received the Bunge Prize! The best thing about receiving the prize was that it gave me more confidence and conviction in my own ideas and that has been a

real boost to thinking creatively since I received the award. It means that as I work on new material I have the confidence to explore paths that I might have held back from or been more cautious about in the past and while this doesn't mean throwing caution to the wind it has given me many opportunities to be bolder and I hope more interesting in the kinds of arguments that I am pursuing. I'm also sure that the prize helped to raise the profile of my work in the past two years leading to interest from scholars and creators within and outside the history of science (see below). For this I am very grateful.

The history of science and experimentation in domestic context has continued to grow since 2020, and Donald Opitz recently published an excellent review of recent work in this area. One hopes that or understanding of the domestic context of science will endure and become as widespread as the historical focus on artisans and craft practises has become in recent decades. There is also much to do to combine these two areas of study since there was so much overlap between domestic and artisanal work in the Early Modern era. One way this can be done is through more recreations and restagings of past practises and experiments. Marieke Hendriksen, for instance, has been doing this very successfully in the past few years. We do not yet have the funding to establish workshops and laboratories in history of science programmes and department to really enable this practise to come to full fruition but as Pamela Smith has shown at Columbia with her 'Making and Knowing' project this can be an incredible resource for both teaching and research <https://www.makingandknowing.org/>.

There is still a great deal that could be done to expand the history of scientific instruments by exploring the history of materials and material culture in greater depth. My current project ("The Sporadic Table") seeks to do this by exploring the different ways that cultures around the world have made sense of material things in the past in order to enrich how we might think about instruments and their environments in the present.

I am pleased to report that *Thrifty Science* has continued to build some momentum since I received the Bunge Prize in 2020. The book has been taken up in disciplines within and outside the history of science. In 2021 I was invited to give a keynote on thrifty science for a project on the history of museum conservation organized by the Ashmolean Museum in Oxford and in 2022 I gave the keynote at an artist's workshop exploring the re-use of old materials in contemporary video art held in Babelsberg, Berlin. In February 2023 an international conference organized by the Institut d'Història de la Ciència, Universitat Autònoma de Barcelona, will survey the history of thrifty techniques and 'Small Science'. Another conference on "Wastework" organized by a group studying "Decay, Loss, and Conservation in Art History" will take place at the Bibliotheca Hertziana in Rome in March 2023. I was also fortunate to receive the Turner Medal of the Scientific Instrument Society for *Thrifty Science* in 2021. The work was always intended to give history of science an environmental impact, and I hope that as more people make use of its ideas in different disciplines and practices, this will be the case.

2021 Liba Taub, Cambridge, UK

Bunge Prize awarded for: *Lifetime achievement*

Liba Taub is currently Director of Research, Whipple Museum of the History of Science, University of Cambridge; Professor Emerita, Department of History and Philosophy of Science; and Fellow Emerita of Newnham College, Cambridge. She received her PhD in 1987 from the University of Oklahoma and was Curator and Head of the History of Astronomy Department at the Adler Planetarium. She came to Cambridge in 1995, as Curator (later, Director and Curator) of

the Whipple Museum of the History of Science, part of the Department of History and Philosophy of Science, and became a Fellow of Newnham College in 1996. She was an Einstein Visiting Fellow at the Excellence Cluster Topoi in Berlin 2010 - 2014.

Liba Taub's research interests include the history of scientific instruments and the preservation of material relating to scientific heritage, as well as the history of early science, particularly ancient Greek and Roman astronomy, physics and meteorology.

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I was thrilled to be awarded the Paul Bunge Prize in 2021. The history of scientific instruments, as a subject of study, was in a very different place in 2021 from where it had been when I first became a curator of scientific instruments in 1990. Thirty years ago, there was tendency to focus on individuals: specific, individual instruments held in a collection; instruments made by an individual maker; instruments used by a particular individual.

In 1990, the year I began working with the historical astronomical instrument collection at the Adler Planetarium in Chicago, Deborah Jean Warner, a curator at the Smithsonian Institution, published her now-classic article "What is a scientific instrument, when did it become one, and why?" *British Journal for the History of Science* 23 (1990), 83–93. These questions were prompted by practical curatorial considerations: what was she supposed to collect for her museum? Warner's questions have elicited some new and perhaps surprising answers since the publication of her article, sometimes – but not only – as a reflection of changing technologies and laboratory practices, and also as a result of changes in the disciplines that study science, including history of science and philosophy of science.

Warner's questions were still relevant at the April 2018 Cain conference "Shaping Scientific Instrument Collections", organised at the Science History Institute by Carin Berkowitz and Sam Alberti. My talk, "What is a scientific instrument, now?" was published in the special issue that resulted, in the *Journal of the History of Collections* 31 (2019), 453–467. In focusing attention on meanings associated with scientific instrument collections and thinking about which objects are identified as scientific instruments, I examined how definitions of instruments actually influence what is collected and preserved. In 2021, we were still asking questions about what we should collect for the future, why, and how, perhaps a bit more self-consciously than sometimes previously was the case. I hope that that is still true in 2023. There is not always unanimity about what counts as a 'scientific instrument', and why.

As Director and Curator of the Whipple Museum of the History of Science in the Department of the History and Philosophy of Science at the University of Cambridge, the award of the Bunge Prize for work on scientific instruments usefully reminded – and even alerted – some of my colleagues, especially around the University (including my college, Newnham), that scientific instruments have been at the heart of my work – and that of the Whipple Museum. The phrase 'history of science' (as in 'the Whipple Museum of the History of Science') sometimes suggests to people a focus on intellectual or even social history, but the award of the Bunge prize newly highlighted in the minds of others the importance of scientific instruments not only to my own work, but to the work of the Whipple, and to history of science more generally. A very important reminder, in my view.

In the relatively short period of time since my receipt of the Bunge Prize in 2021, I don't believe that research on scientific instruments has changed greatly. However, I have been pleased to have the opportunity to be involved in a new effort to support the study of scientific instru-

ment makers (particularly British) through the "Tools of Knowledge" project, funded since 2021 by the United Kingdom's Arts and Humanities Research Council.

Working with an interdisciplinary team, "Tools of Knowledge" is applying cutting-edge methods of digital analysis to data on almost four centuries of the scientific instrument trade in Britain. The project aims to provide highly accessible information on the history of scientific instruments, specifically as it relates to commerce, industry, teaching, and questions of local, national and international geography. The project is grounded in the *Scientific Instrument Makers, Observations and Notes* (SIMON) dataset due to Dr. Gloria Clifton and held by the National Maritime Museum, comprising more than 10,000 records on individual instrument makers and firms from Great Britain and Ireland. To this we are adding data from existing legacy databases, collections catalogues and new metallurgical research, as well as material newly extracted from historical texts and generated using advanced digital methods. The aggregated data is being added and remodelled using semantic knowledge representation, to encode expert understanding of the meaning of this data in a machine-readable form and enable linking across datasets.

The project is a partnership between the Whipple Museum, the National Museums of Scotland, the University of Sussex, the Science Museum and the National Maritime Museum. Members of the entire project team are in continual discussion with colleagues around the world; we hope that the project will add new capabilities to our studies of scientific instruments more generally.

2022 Matthew L. Jones, New York, NY, USA

Bunge Prize awarded for: *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago: Univ. of Chicago Press, 2016)

Matthew L. Jones is James R. Barker Professor of Contemporary Civilization in the Department of History, Columbia University, New York, and will be moving to Princeton University in 2023. He was educated at Harvard and Cambridge University, and received a PhD from Harvard University in 2000.

He studies the history of science and technology, focused on Early Modern Europe and on recent information technologies. A Guggenheim Fellow and a Mellon New Directions fellow, he is completing a book on state surveillance of communications and, with Chris Wiggins, has just published a history of the science, politics, and power of data, statistics, and machine learning from the 1800s to the present.

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The scholarship inspiring my work – much of it written by Bunge Prize winners – connects careful technical and indeed curatorial insight to more contextual forms of historical thinking without reducing or neglecting one or the other; it connects histories of technology with histories of the science, both more theoretical and practical; it connects skilled craftsmanship with accounts of meaning and the organization of credit and property; and it eschews anachronistic dichotomies between elite theoreticians and more mechanical practitioners; it challenges facile divisions among ostensible pre-modern, modern, and information orders; it makes thinkable the richness needed to explain both small and large scale socio-technical change.

News of winning the Paul Bunge Prize came at just as I was completing my jointly authored history of machine learning, artificial intelligence, and data science, just published by Norton. Throughout the book, we try to remind readers that the expansion of data collection and its analysis, from the enlightenment to the present, always requires the creation of instrumental infrastructures, the labor necessary to maintain and inform them, and the financial resources needed to produce initial forms and then produced them in standardized ways. Understanding all these phenomena demands just the approaches central to historians of instruments, needed to grasp, for example, how to move from a delicate prototype to mass produced devices that can be deployed at scale and at relatively low cost. Our book deliberately draws upon key themes omnipresent and pioneered in the professional history of scientific instrumentation and puts in them into a narrative written to be accessible to working data scientists as much as to other scholars. Models built on trillions of data points demand massive infrastructure, massive energy consumption, and engineering skills aplenty, from data engineers to hydraulic cooling.

2023 Robert W. Smith, Edmonton, Canada

Bunge Prize awarded for: *Lifetime achievement*

Robert Smith received his PhD in the History and Philosophy of Science at the University of Cambridge in 1979. He is currently a Professor of History at the University of Alberta. He joined the University in 1998, and before that he was Chair of the Space History Department of the Smithsonian Institution's National Air and Space Museum in Washington DC. He has been the Lindbergh Chair of Aerospace History at the Smithsonian Institution and a Fellow of the National Humanities Centre, as well as a McCalla Professor and Killam Annual Professor at the University of Alberta.

His main scholarly interests are in the history of science and technology from the late eighteenth century to today. He has particular interests in the history of astronomy. At present, he is, among other projects, working on a monograph on the history of the $11 Billion James Webb Space Telescope.

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When I first began to pay close attention to scientific instruments in the early 1980s, relatively few scholars outside of the museum world regarded them as major subjects for research. I am delighted this situation has been transformed and that the analysis of the history of scientific instruments has advanced enormously. It is exciting that many historians of science now put scientific instruments at the heart of their research and that the various approaches taken to these studies have produced such innovative and outstanding scholarship.

The Paul Bunge Prize underlines that it is now fully accepted that the study of recently built or planned scientific instruments is a worthwhile area of scholarly endeavour.

How has the field of research for which I received the prize changed since I started research on scientific instruments? This question brings to mind a quotation from Arthur Berry's *A Short History of Astronomy*. He argued that "Here, as elsewhere, I have given no detailed account of astronomical instruments, believing such descriptions to be in general neither interesting nor intelligible to those to those who have the actual instruments before them, and to be of little use to those who have not." Berry was writing in 1898, but when I began working on the history of

astronomical instruments about eight decades later, my sense was that some historians of science took a similar position to Berry.

Nevertheless, with hindsight, the years around 1980 appear as a period of transition. Two developments at this time now seem to me to have been particularly significant. First, a small but increasing number of historians, philosophers, and others interested in the sociology of scientific knowledge since the seventeenth century turned to the scrutiny of the experimental process. They examined the day-to-day activities and working practices of scientists, rather than what scientists implied or claimed they had done in scientific papers and monographs. Others then followed the turn to the history of practice, with its natural focus on instruments, often with concerns far from the sociology of scientific knowledge. Second, contemporary debates in the U.S. and in Europe on whether or not to proceed with the construction of very large-scale instruments drew attention to the history of scientific instruments more generally. The steeply rising cost of these sorts of instruments largely fueled this growing interest. For example, the Hubble Space Telescope was launched into orbit in 1990 at a cost of approximately $4.7 billion in 2023 dollars. When the mega sized particle collider, the Superconducting Supercollider, was cancelled before it was completed in 1993, over $4 Billion had been spent on it, and if it had been completed its final price tag was reckoned to be of the order of $25 billion in 2023 dollars.

At the same time, I was fortunate to work in a general area, the history of astronomy, in which its practitioners often saw instruments as crucial. To pick a few examples of publications from the 1960s and 1970s that I recall being influential for me: Victor Thoren's reconstruction of the development of Tycho Brahe's instrument-building program, Albert Van Helden's investigation of the invention of the telescope, and Deborah Jean Warner's monograph on the Clark family of telescope builders. In addition, given the centrality of the telescope to astronomy since the seventeenth century, it is hard to imagine how historians of modern astronomy could have shied away from instruments.

However, until the last twenty or thirty years, twentieth-century astronomical instrumentation did not prompt much interest among historians, an attitude that I think was part of a wider lack of engagement with the history of twentieth century astronomy. In 1976, Owen Gingerich, for instance, welcomed the tercentenary of the Royal Observatory at Greenwich as a chance to "focus our attention on more recent astronomy", and complained of "the paucity of studies of 19th- and 20th-century astronomy." I found a good way to produce puzzled looks well into the 2000s was to explain I worked on twentieth century topics to do with astronomical instruments.

The above points do not mean, of course, that there were no writings on twentieth century astronomical instrumentation until after the 1980s, but, rather, that they were often the products of people who had been directly involved in the design and building of the instruments they were describing. For example, Bernard Lovell's writings on the foundation and operation of the radio astronomy observatory at Jodrell Bank in Britain, as well as his more general essays on the development of radio astronomy, provide significant source material as well as analytical insights. Participant histories, then, can be extremely valuable, but they often raise a variety of methodological and interpretive issues, one being the subscription to a narrative of ever-increasing accuracy along with corresponding progress in theory and methods of calculation. But talk of 'continual progress' obliterates the contingencies involved in the histories of even successful instruments and ignores the outright failures, as well as the shifts that astronomers came to decide were misguided and instruments that were made obsolete by, say, other technologies or changed demands of theory. In terms of the development of my own interests in astronomical instruments, a 1976 book on radio astronomy was pivotal. This volume by the sociologists of science David Edge and Michael Mulkay tackled the emergence of radio astro-

nomy. Here, among other things, they claimed that radio astronomy became a new scientific discipline with the introduction of a new instrument. For me, the message was that the study of astronomical instruments in the twentieth century could *really* matter!

Paul Bunge Prize winners (year of award), page number of biography and statement

WRITING THE HISTORY OF SCIENTIFIC INSTRUMENTS
STATE OF THE ART AND FUTURE PERSPECTIVES

A conference celebrating 30 years of the Paul Bunge Prize of the Hans R. Jenemann Foundation, 31 May – 2 June 2023, Deutsches Museum, Munich

This conference, bringing together almost all Bunge prize holders and special guests, aims to take stock of the recent development and current state of the history of scientific instruments and to reflect on nascent and future trends. This might include for instance intersections with studies of material culture, environmental history, art history, global history and other areas of investigation that have recently renewed or promise to produce fresh insights into the history of scientific instruments. This will also be a forum to collectively reflect on the efforts of the past decades to encourage conversations and collaborations between historians, curators and museum professionals and how these have or may in the future productively irrigate historical understandings of scientific instrumentation. The Deutsches Museum constitutes an ideal setting for holding these discussions while offering the opportunity to visit the newly renovated and opened galleries of the museum and exchange with its curators.

31 May, 2:00–2:15 p.m.
Welcome and opening by Helmuth Trischler and Christoph Meinel

2:15–4:15 p.m.
Session 1: Innovating modes of studying early modern instrument cultures
chaired by Richard Sorrenson
Simon Werrett, "The sporadic table"
Liba Taub, "Studying 'lost' scientific instruments"
Matteo Valleriani, "What does Artificial Intelligence think about mathematical instruments?"

4:45–6:45 p.m.
Session 2: Beyond makers and users. Scientific instruments and social worlds
chaired by Carsten Reinhardt
Simon Schaffer, "Off Balance – scientific instruments in social encounters"
Nic Rasmussen, "The germ-free mouse: A cyborg instrument and its evolving uses"
Sara Schechner, "The world in a box"

7:00 p.m.
Award of the Bunge prize 2023 and Awardee Lecture by Robert Smith,
chaired by Robert Anderson

1st June, 9:30–11:30 a.m.
Session 3: Transformative dimensions
chaired by Kärin Nickelsen
Matthias Dörries, "The Earth as instrument"
Henning Schmidgen, "Instruments as media?"
Cyrus Mody, "Scientific instruments and/as oil spillovers"

1:00–3:00 p.m.
Session 4: Coping with materiality
chaired by Alan Morton
Mara Miniati, "Thirty years of research on scientific instruments in Italy: A brief reflection"
Marco Beretta, "Which kind of source is a museum for the history of science? An Italian perspective"
David Pantalony, "Relational objects: What we learn about scientific instruments in a museum context"

3:30–5:00 p.m.
Guided tours of the Deutsches Museum galleries
by Johannes Hagmann

6:00 p.m.
Keynote lecture,
chaired by Helmuth Trischer
Sam Alberti, "The endurance of scientific instrument studies"

2nd June, 9:00–11:00 a.m.
Session 5: Scientific instruments as a challenge to history
chaired by Klaus Hentschel
Jutta Schickore, "The history of instruments and the history of control practices"
Elena Canadelli, "Writing the history of scientific instruments: The viewpoint of *Nuncius: Journal of the Material and Visual History of Science*"
Jim Bennett, "Is there a legitimate narrative or a historical specialism of the history of scientific instruments? Should there be?"

11:30–12:30 a.m.
Round table: Foci, blind spots and future perspectives
chaired by Charlotte Bigg
Matthew Jones, Carsten Reinhardt, Robert Smith, Davis Baird

12:30–13:00 a.m.
General discussion and farewell by Charlotte Bigg

ABSTRACTS

Session 1: Innovating modes of studying early modern instrument cultures

Simon Werrett, University College London, "The Sporadic Table"

In Thrifty Science I sought to open up the study of scientific instruments by adopting an early modern perspective on material culture that emphasized "making use" of diverse household goods to do experiments. If one pushes this perspective further it invites us to question the material definitions of substances currently held in the sciences. Elements and compounds became more precisely defined in the eighteenth and nineteenth century partly as a result of rising industrial and legal stakes in their identities. The periodic table (itself an instrument) then appears as another nineteenth-century attempt to classify and order the world for the purposes of controlling it, a kind of chemical racism. What would a more open, social, emotional and material version of this instrument look like? In this talk I propose the sporadic table as an alternative, in which the incomplete and shifting sociomaterial world is explored through new categories that might offer novel persectives on scientific instruments and material culture as a whole.

Liba Taub, Whipple Museum of the History of Science, University of Cambridge, "Studying 'lost' scientific instruments"

Historians of scientific instruments have understandably focused on objects that they can see and hold. It is deeply satisfying to work with tangible things, especially when the things in question were actively used. However, there are many scientific instruments that no longer exist and about which we would like to know more. For some of these, we have written descriptions and, occasionally, visual depictions.

For example, in the second-century CE Almagest, Ptolemy provided detailed descriptions of various astronomical instruments; he gave instructions for their construction as well as their use. Ancient examples of his instruments do not survive, but his descriptions provided the basis for others to (re-)construct their own. In a late fourteenth-century manuscript owned by Peterhouse College, Cambridge, John Westwyk described an equatorium (for computing planetary positions) and gives instructions for its construction and use. While his equatorium does not survive, Derek de Solla Price and Seb Falk have each produced important work to understand it, including the creation of physical and digital versions. Tycho Brahe provided elaborate descriptions and visual illustrations of his astronomical instruments in the Astronomiae instauratae mechanica (1598). He described their use as well as his transversal method for creating subdivisions of scales. Tycho's instruments do not survive but were the basis for observatory instruments later installed by missionary-astronomers in China. In 1715, William Whiston had printed in London The Copernicus explain'd: or a brief account of the nature and use of an universal astronomical instrument, for the calculation and exhibition of new and full moons, and of eclipses, both Solar and Lunar; with the Places Heliocentrical and Geocentrical of All the Planets, Primary and Secondary, &c. Whiston apparently sold instruments, especially the Copernicus, at his home. The Whipple Museum has an example of his chart for calculating the 1715 eclipse (drawn

by him and engraved by John Senex; Wh. 1589). The chart advertises that Whiston's creations were 'Engraved and sold by Iohn Senex at ye Globe in Salisbury Court near Fleet Street. And Will: Taylor at ye Ship in Paternoster Row. Where are sold Mr Whiston's Astronomical Lectures, his Taquet's Euclid, and ye Scheme of ye Solar System', but examples of Whiston's 'Copernicus' do not appear to survive.

Thinking about how we have gained and tested our knowledge of these and other 'lost' instruments, I will provide a case study of the aeolipile described in the first century BCE by Vitruvius in his On Architecture, and will also consider how the aeolipile was used and understood in the early modern and later periods. I will contrast that method of study with the ways in which Tools of Knowledge (an AHRC-funded interdisciplinary research project based at the University of Cambridge, University of Sussex and National Museums Scotland, in partnership with Royal Museums Greenwich and the Science Museum) may also help us identify and better comprehend other 'lost' scientific instruments.

Matteo Valleriani, Max Planck Institute for the History of Science, Berlin, Germany / Technische Universität Berlin / Tel Aviv University, "What does artificial intelligence think about 'mathematical instruments'?"

While investigating the process of homogenization of scientific knowledge in Europe during the early modern time and with a specific focus on astronomy, a corpus of about 80,000 pages of historical sources has been created. Such corpus is representative for the textbooks used all over Europe for the introductory class in astronomy from the end of the 15th century to 1650. The historical sources contain quite a number of descriptions of mathematical instruments, both concerning their assemblage and their use. The evident increasing attention for instruments in the frame of teaching caused increasing efforts to illustrate them and therefore the corpus displays an important collection of images of mathematical instruments.

The size of the achieved dataset finally allows for the use of such historical material to train machine-learning models that can 'find' and classify such illustrations and, thus, greatly ease the work of the historian while analyzing the sources. If the historian is dealing with a great number of sources, however, it is impossible to control whether all relevant materials have been recognized and correctly so. Such feature, which is due to the statistical nature of machine-learning, is the cause of the slow acceptance of machine-learning approaches in the humanities in general.

The problem acquires a new perspective when current methods of Explainable Artificial Intelligence (XAI) are applied. Based on this approach, historians can now learn back from the model how and why it took a decision while classifying the material extracted from the sources. In such a way, the historian can both qualitatively evaluate the work of the model without controlling all the decisions taken and, more relevantly, use AI itself to gain new insights on the sources analyzed.

The lecture will show how XAI can be applied to illustrations of mathematical instruments in order to enrich their current definition – a conceptual enrichment autonomously produced by the machine.

Session 2: Beyond makers and users. Scientific instruments and social worlds

Simon Schaffer, University of Cambridge, "Off Balance – scientific instruments in social encounters"

Scientific instruments have often played significant and complex roles in encounters across social boundaries between very different groups. No doubt this is partly because such devices are simultaneously supposed to be able more easily to communicate between users and subjects as well as to offer reliable information about how that relation functions. The figure of the balance, of such significance for the career of Paul Bunge, nicely evokes this principle: the analytical balance with its twin pans and crossbeam was a device explicitly designed to make two very different kinds of entity exactly commensurable. Yet it has also been shown by impressive historical studies of instrument making and instrument use how dependent instruments are on the specific practices and assumptions of the local society in which they are put to work. A few stories about past instrument use in such fraught cross-cultural encounters can show the rich possibilities and important implications of studies of scientific instruments where contrasting and indeed conflicting social purposes and practices are in play.

Nic Rasmussen, University of New South Wales, "The Germ-Free Mouse: A cyborg instrument and its evolving uses"

In my research on the history of the microbiome, I have been exploring the development of the germ-free lab animal and the isolator technology that enables it. The animal-isolator pair together constitute a cyborg instrument – but an instrument for what?Here I retrace the story of this instrument, and show how, in its different phases, it was conceived as a means of addressing a series of dramatically changing problems. This changing user intent reciprocally informed and was shaped by the instrument's design over time, a dimension of history we might easily miss by attending only to hardware. This then is the promising avenue I have found, although stated abstractly not terribly original: we should study the history of instruments not with a narrow focus on hardware, but simultaneously consider the evolving 'software' side, including the changing questions scientist users wanted to answer, and the various way scientists designed experiments around the instrument to answer them.

Sara J. Schechner, Harvard University, "The world in a box"

Most of us are familiar with thinking about scientific instruments in terms of their functions, makers, sellers, users, and designs over time. In this talk, I would like to explore what might be learned from a critical examination of the materials used in an instrument's fabrication and the different artisans who came together in its production. Take for instance a late 18th century octant made in London. Its production involved a wood worker, brass smith, mirror and glass makers, and a scale divider. It is a tool of navigation likely deployed on a merchant or naval vessel. We call it "English," but the components of the ebony frame, the ivory divided limb, and mahogany case did not originate in England. They were commodities brought from Africa and the Caribbean; the wood was harvested by enslaved people. Thus, the octant is not just an in-

strument that enables this trans-Atlantic trade by a colonial power, but also a consequence of that commercial and political infrastructure. It could be said that the octant is a microcosm of the social and economic relationships of its time. Is this a fruitful line for thinking about scientific instruments? As part of an answer, I will analyze a grand orrery made in Boston at the time of the American Revolution.

Session 3: Transformative dimensions

Matthias Dörries, University of Strasburg, "The Earth as Instrument"

In 2002 the Deutsches Museum in Munich organized an exhibition with the title Klima – das Experiment mit der Erde. What had transformed the Earth into an experimental setting or system? Part of the answer, I suggest, lies in a major technological shift over the last few decades: the Earth has been covered in millions of sensors, whose data have turned it into one big locus of scientific investigation. What was once our natural habitat has become an artificially modified environment, whose study has led us to realize that we are carrying out an ongoing experiment with the Earth. Our Earth has become instrumentalized for better or worse. On the one hand, our newly acquired knowledge warns us about the long-term consequences of political and economic actions; on the other, it opens the door to further instrumentalization of the Earth: climate engineering, for example. Historians of scientific instruments have paid little or no attention to this transformation: for example, the historical encyclopedia Instruments of Science has no entry for "sensors," nor does the term appear in definitions of scientific instruments, and in museums, the focus unsurprisingly is rather on individual instruments of size that can be touched and seen. The omnipresence of sensors entails three consequences: First is the emergence of a class of new instruments, living things ("living instruments?") and natural objects ("natural instruments?") linked to sensors ranging in size from bacteria to volcanoes, to the whole Earth. Second is a shift from quick, repeated, and often interventionist experiments to passive, slow, detection and monitoring of complex organisms and environments at distance. Third is a change in focus from the singular instrument to networks of instruments.

Henning Schmidgen, Bauhaus-University Weimar, "Instruments as Media?"

Over the past ten or fifteen years, the history of scientific instruments has attracted considerable interest in the burgeoning field of media studies. In the wake of Walter Benjamin, Marshall McLuhan, and Friedrich Kittler, a considerable number of recent media scholars have explored, from theoretical and historical perspectives, the role of imaging techniques, chronometric instruments, and the computer in the scientific process. Against the background of this development, this paper discusses the concept that media are "extensions" of the human body and bends it back to the history of scientific instruments.

Cyrus Mody, Maastricht University, “Scientific Instruments and/as Oil Spillovers”

Historians of scientific instruments (and fellow travelers such as the philosopher Davis Baird or the economist Eric von Hippel) have, to their credit, been at the forefront in highlighting the commercial and industrial dimensions of scientific knowledge and practice. Whether instruments are built, bought, or sold, and whether they are one-off masterpieces or mass-produced commodities, they are usually entangled in commercial relationships. Various industries – brewing, communications, healthcare – have figured prominently in histories of instruments. I will argue for the outsize importance of an industry that has appeared in passing in several studies but has not been a focus of our subfield's attention: the oil industry. This giant and diverse industry has been a site for the invention, development, and commercialization of scientific instrumentation for more than a century and for multiple uses: exploration, extraction, refining, and transformation of petroleum and its affines and derivatives. Moreover, oil firms have provided the initial markets that have enabled some instruments and instrument-makers to leap into other domains for which they have become more famous. A promising avenue of research would therefore be to look at scientific instruments as an example of a more general "oil spillover" by which resources from the oil industry have (mostly) productively flowed into fields and industries seemingly unrelated to oil.

Session 4: Coping with materiality

Marco Beretta, University of Bologna, “Which kind of source is a Museum for the history of science? An Italian perspective”

The university training of Italian historians of science has been, until recently, provided by philosophical faculties and departments. The most authoritative figures of post war Italy, Ludovico Geymonat, Eugenio Garin and Paolo Rossi, were all philosophers and the connection between history of science, history of philosophy and philosophy of science circumscribed the epistemological boundaries of our discipline for several decades. Although science and history of science museums such as those in Florence and in Milano became very important cultural venues, the mainstream Italian historiography has revolved around textual analysis. In my presentation I will talk about my personal experience at the Museo Galileo and how it contributed to change my perspectives in many ways.

Mara Miniati, Museo Galileo, Florence, Thirty years of research on scientific instruments in Italy: a brief reflection

In these thirty years, many things have changed in Italy. Museums of scientific instruments and technical devices were born. The professionalism addressed to these studies has grown. This short paper aims to summarize the path followed in this kind of studies, both from a museological and theoretical point of view.

David Pantalony, Ingenium – Canada's Museums of Science and Innovation, Ottawa, "Relational Objects: What we learn about scientific instruments in a museum context"

Over decade ago, I collected a coincidence mixer from a 1960s cosmic ray observatory in the Arctic – Aurora College, Inuvik, Northwest Territories. Since that time, this object's research file has continued to grow through diversifying documentation, collection practices and connections. As a museum artifact, the mixer reveals an evolving approach to scientific instruments as part of, and gaining new meaning and value within complex material, archival, digital, geographic, and social relations – including in the present – and not simply as end products of history on a storage shelf. This electronic instrument – basically a sophisticated processor of particle detection events – was at first a migrant object in Inuvik, bringing with it knowledge from cyclotrons, reactors, detection, cosmic rays, and electronics in post-Second World War Canada. However, the mixer was also located on Indigenous Gwich'in and Inuvialuit territory, an understudied and increasingly relevant part of its biography. In addition, recently the unique electronics within this particular mixer has emerged as historically significant with a surprising connection to the origins of experimental techniques in quantum physics. In this paper, I explore these dynamic connections through the mixer's material culture and biographical journey. I will draw on other case studies in our collection to illustrate a changing conception of scientific instruments as points in a sea of relations, and what this means for instrument studies, collection databases, the history of science and museums of science.

Keynote lecture

Sam Alberti, National Museums Scotland / University of Stirling, "The endurance of scientific instrument studies"

The Paul Bunge prize-winners embody the thriving field of historic scientific instrument studies. These thirty years of scholarship represent a sub-discipline that is not only innovative but also dynamic. This calls into question the notion of a 'material turn' in late twentieth-century historiography of science, showing rather that instruments and other artefacts have been long been and continue to be the objects of study of a range of researchers. Where can one find such 'instrument people', the Bunge winners and their kith? How do they interact with things, and where do they communicate their work? In universities, museums and other heritage bodies, for thirty years they have reflected and contributed to material culture studies, museology, history of science and other disciplines. They have stretched their study to new places, eras, people and things. Where might they go next?

Session 5: Scientific instruments as a challenge to history

Jutta Schickore, Indiana University, "The history of instruments and the history of control practices"

The history of instruments is inextricably intertwined with the history of scientific control practices. The paper illustrates this by discussing the ways in which advance-

ments in scientific instrumentation has stimulated and enabled increased control of experimental settings and targets as well as the ways in which an increased emphasis on experimental control has stimulated innovation in instrumentation. I will also consider whether the advancement of instrumentation can sometimes lead to an overemphasis on experimental control, which may impede the gathering of useful empirical data.

Elena Canadelli, University of Padua, "Writing the history of scientific instruments: the viewpoint of *Nuncius: Journal of the Material and Visual History of Science*"

Nuncius has been founded as Annali dell'Istituto e Museo di storia della scienza di Firenze in 1976 in the Florentine milieu of historians of science interested in collections and museums, thanks to the initiative of Maria Luisa Righini Bonelli, at the time director of the Museum of History of Science, now the Museo Galileo. In 1986, under the direction of Paolo Galluzzi, the journal was continued as Nuncius. Annali di storia della scienza. In 2011, the focus on the material and visual history of science was enhanced thanks to the new subtitle decided by the editor-in-chief Marco Beretta. Since its inception as Annali, Nuncius has always sought to foster dialogue across disciplines and areas of expertise, and encourage the exchange of ideas between university scholars and museum-library-archive-based researchers engaged in the history of instrument making, the historical-scientific heritage, museum collections, and the study of the arts and sciences. Still today, Nuncius' main objective is precisely to explore the historical importance of material and visual culture in science, mixing and updating in a fruitful way Andrea Corsini and Righini Bonelli's traditional approach with the current trends in historiography of science, the Italian tradition of studying and preserving scientific heritage with the international approaches on these subjects, offering an ample set of examples and case studies in different times and contexts. As current editor-in-chief of the journal, I will focus on what is happening in the field of the history of scientific instruments and the material and visual culture in science, as seen from the viewpoint of Nuncius.

Jim Bennett, Museum of the History of Science, Oxford, "Is there a legitimate narrative or a historical specialism of the history of scientific instruments? Should there be?"

It is difficult to write an abstract for a short talk without giving away all your principal thoughts and leaving little more to say. Many of us think of ourselves as historians of instrumentation but what can that mean for a subject so rooted in the wider discipline of the history of science? What might be the negative – and the positive – aspects of such an identity? Thoughts on this will be disclosed in my talk.