

## **REMS At Home – Science in the Late 17<sup>th</sup> Century**

On 12 January 2012 77 Retired Members (REMS) of the Institute of Physics and their friends were educated and entertained by 6 distinguished and knowledgeable speakers on the exploits and achievements of a number of natural philosophers active at the time of the founding of the Royal Society and the Royal Observatory.

The day began before anyone arrived, because two of our speakers, Rita Greer and Allan Chapman, were interviewed on the BBC “Today” programme about Rita’s new portrait of Robert Hooke which was to be unveiled during our symposium and about Hooke himself. REMS Secretary, John Belling, shown in picture 1, chaired the event, which was organised by George Freeman.

### **Robert Hooke and the scientific environment**

Sir Arnold Wolfendale is shown in picture 2 speaking on Hooke’s career. He covered the early years on the Isle of Wight, being apprenticed to the painter Sir Peter Lely, and spending his inheritance on an education at Westminster School under the headmaster Dr Busby. At Christ Church College Oxford he was influenced by Christopher Wren, John Wilkins and Robert Boyle and later worked with them. The Civil War had been going on and the Cromwells, father and son, were in charge of England while he was working on clock escapement and spring controlled balance wheel mechanisms. At about the same time, in 1658, he perfected the air pump, a development which led to him and Boyle formulating Boyle’s Law. Later he was probably the first to describe Newton’s Rings of interference colours. He was annoyed by losing out on precedence claims, eg gravity, the earth’s oblate spheroidal shape and the precession of the earth’s axis, to Newton.

One thing he didn’t have was financial clout. He was earning £30 a year as the first paid scientific research worker. Sir Arnold sympathised over this small stipend, although the word “science” had yet to be devised. Even as Gresham Professor of Geometry and Curator of Experiments to the Royal Society he only earned £80 p.a.

### **A College for the Promoting of Physico-Mathematical Experimental Learning: Early days of the Royal Society**

Felicity Henderson in picture 3 spoke about the early days of the Royal Society, which was formed after a lecture by Christopher Wren at Gresham College to enable experimental philosophy to be carried out collectively by those interested. By witnessing the experiments and discussing the results on the spot, more weight could be given to the conclusions. Robert Hooke and Robert Boyle used the former’s air pump to see and demonstrate what happened when various substances and living creatures were subjected to a lack of air. Dissections were carried out. Also “curiosities” were examined and collected. Observations were written up and reported in Philosophical Transactions and in correspondence as before. This was all organised by Henry Oldenburg, the Society’s Secretary.

One of the most prolific correspondents was Antony van Leeuwenhoek who, although working alone in the Netherlands, obtained confirmation of his microscopical

observations from local people. All his letters were in Dutch and had to be translated. He was appointed Fellow of the Royal Society.

Among the curiosities was a collection of Chinese ear pickers and no doubt things like that led to lampooning of the Society in plays written by Thomas Shadwell. Felicity hinted that Gulliver's Travellers were partly based on the Society's research programme. Boyle's wish list looks very similar to one that might be written today. First on the list is the prolongation of life.

### **Hooke's Portrait**

Rita Greer (picture 4) explained how she was inspired by Rachel Chapman's drawing of Hooke and Allan Chapman's article in the Daily Telegraph of 24 February 2003 about Hooke to make good the lack of a contemporary portrait by painting one, guided by the written descriptions of Hooke by John Aubrey and Richard Waller. She explained that there were 14 portraits of Newton, but none of Hooke. She is well on the way to her goal of 20 portraits of Hooke and showed some of them in her talk.

### **Unveiling of Rita Greer's portrait of Robert Hooke**

The Institute of Physics commissioned the portrait for the Hooke Room, but Sir Arnold performed the unveiling in the Rutherford lecture room to save us all walking up 2 floors. We did that at the end of the day. Left to right in picture 5 are: Rebekah Higgitt, Felicity Henderson, Sir Arnold Wolfendale, Rita Greer, Robert Woodward, Allan Chapman and Michael Cooper. Picture 6 is the portrait in the Hooke Room.

Many discussions took place over lunch including the one between Sir Arnold and Allan Chapman shown in picture 7.

### **The role of the Astronomer Royal in the early days of the Royal Observatory, Greenwich**

Rebekah Higgitt shown, in picture 8, explained the circumstances of the setting up of the Observatory and the difficulties of the first Astronomer Royal, John Flamsteed. One problem was his title, Astronomical Observator. He preferred Regius Professor of Astronomy. Another was that he had to figure out what his job was. He corresponded with other astronomers like Hevelius, Mayor of Danzig, and was well aware of Kepler's work. The king provided no money, but he was sponsored by the Board of Ordnance through Jonas Moore, who provided Flamsteed personally with telescopes and chronometers. The second Astronomer Royal found that the observatory was bare, when he took over, because Flamsteed's widow had sold all the instruments. There was some animosity between the Royal Society and Flamsteed, who had the data that Newton wanted. Flamsteed was determined to insure that his star chart was accurate. It was far better than that of his hero Tycho Brahe, partly because he was able to use telescopic sights. Having determined the latitude of Greenwich, he set the longitude through his observatory, so that the coordinates of 3000 stars had absolute values. In answer to a question about the meridian for GPS, Sir Arnold mischievously informed us that Flamsteed's 0<sup>0</sup> longitude passes through an area now marked "rubbish", but then he was 14<sup>th</sup> Astronomer Royal and should know.

## **Scientific and Civic Measurements: Hooke, Boyle and the Citizens of London**

Michael Cooper is shown in picture 9. He described Hooke and Boyle's experiments on the "Spring of the Air" and their defence of their results, which led to Boyle's Law, following objections lodged by Francis Linus. Boyle and Hooke published their results in great detail, so that anyone could repeat them. They showed many measurements of the position of the meniscus of the mercury trapping the volume of air in question, from which we could see that standard deviation was +/-1.6mm.

Despite already being busy with Gresham College and the Royal Society, Hooke and Christopher Wren exercised their skills in sorting out London after the fire of 1666. While Wren working for the king, designed churches, Hooke, working for the City, formulated new building regulations, surveyed the damage, staked out plots for buildings, roads, some of which were widened, and spaces for markets, assessed compensation, sorted out disputes, ensuring his fellow surveyors followed his guidelines, and reporting on the suitability of various building materials. Every morning for years he was seen measuring, discussing with everyone from urchins to landlords, so that Londoners could see that something was being done and quickly. For compensation he gave generous assessments of area by assuming 2 sides of a plot were at right angles to the street and multiplying the mean by the distance along the street. He quoted the area in square feet and duodecimal fractions of a square foot so that it was easy to calculate the monetary compensation in pounds, shillings and pence. He wrote 2995 foundation certificates and 592 reports on land disputes – a busy man indeed.

Not only did he work with Wren on designing St Paul's and other churches, he designed and supervised the building of St Benet's, Paul's Wharf, now the Welsh Church, Bedlam Hospital, the Monument, including its zenith telescope and dropping tower, and the clearing and re-canalising of the Fleet River. One of the most important things he produced was a proper large scale (1/1200) map of London.

It was interesting to learn that, although Hooke failed to find evidence for the inverse square law of gravitational attraction that he was hoping for, the experiments by Speake et al in 1990 showed actual timings of bodies falling in a 300m dropping tower versus results expected from the inverse square law in exactly the same fashion as Hooke had done in verifying Boyle's Law..

Robert Hooke was buried in St Helen's, Bishopsgate, but along with many other remains was reinterred in the City of London Cemetery, Wanstead. In addition to the memorial next to Christopher Wren's in St Paul's seen by REMS on 8 December 2008, just before it was officially unveiled, there is now another in Westminster Abbey.

## **Artificial Organs that strengthen the natural (R Hooke) – the impact of instrumentation**

Andy our technician for the day helped several times during the day with microphones, projection of slides, spot lights and he is shown in picture 10 with Allan

Chapman. Allan in picture 11 talked about the historical setting in the world as well as Hooke's status in society and something about his biological studies.

There has been a suggestion that Hooke was a downtrodden artisan compared with Boyle the landed gentleman. Despite being poorly paid for his science, he was the son of a clergyman, went to Westminster School and Christ Church College, Oxford and at 27 was elected FRS. Moreover he did make money from his surveying and rebuilding London. He gave his brother £4000 in ready cash to buy a property on the Isle of Wight. He left £10000, although he didn't actually make a Will. So, in fact, he was a gentleman and the equal of Wren and Boyle.

Among the curiosities received by the Royal Society was a rattlesnake, provided by Richard Amerike of Bristol who supplied John Cabot with the means to get to the New World in 1497. Larger ships were among the scientific instruments to enable one to see new things. In 1453 Byzantium was overrun by the Ottoman Turks, who made Constantinople their capital, but this brought new ideas and translated (from Greek) older ideas to Europe in the form of documents, astronomical instruments and mathematics.

On 26 July 1609 Thomas Harriott turned his newly acquired telescope on the moon and made drawings of it some months before Galileo did. Telescopes improved from then on to show more and more.

In 1667 Hooke dissected a dog and showed red arterial blood contrasting with blue venous blood. He was interested in visualising the body as a machine with circulation, joints, lungs etc. He studied the flight of flies and compared the frequency of flapping wings with musical notes. He studied the weather too.

Question time brought about quite a bit of discussion with the audience (picture 12) and between speakers (picture 13).

Then, before members of the audience repaired to the Hooke Room to inspect the newly hung portrait, Andy played a recording of the Radio 4 interview about the portrait and about Robert Hooke the man. Thus ended a most informative and memorable day.

Mike Quinton, from notes taken by Kate Quinton

Photographs by Mike Quinton:

1. John Belling [Belling2]
2. Sir Arnold Wolfendale [Wolfendale2]
3. Felicity Henderson [Henderson]
4. Rita Greer [Greer]
5. Unveiling Hooke [Hooke12012012]
6. The Portrait [Hooke2]
7. Lunchtime discussion [Wolfendale and Chapman]
8. Rebekah Higgitt [Higgitt]
9. Michael Cooper [Cooper]
10. Technical help [Chapman and Andy]
11. Allan Chapman [Chapman]

12. Audience participation [Audience Participation]
13. Speaker participation [Speaker Participation]