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VIEWPOINT

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Spanish Influenza, 1918

How humour helped people cope during the spread of history's deadliest pandemic

BSHS

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Contents

Editorial

Does war always lead to scientific advancement? This issue features a selection of responses to this question.

Our cover feature, by Hannah Mawdsley, explores humorous interpretations of the difficulties faced by scientists and sufferers alike during the deadly Spanish Flu pandemic, which broke out in the final year of the First World War.

Then follows an article co-authored by Luisa Bonolis and Giulia Pancheri on the roles played by nuclear physicists Bruno Touschek and Rolf Widerøe in the development of particle colliders during World War II. And continuing with the theme of defence research, Sally Horrocks introduces three female engineers whose scientific contributions led to military advances.

Also this issue, Rose Roberto reports on the impact of a BSHS Special Projects Grant, while Dominic Berry tours the new 'FOLK' gallery at The Norwegian Museum of Science and Technology. Lastly, we interview doctoral researcher Sophie Almond from the University of Leicester.

We hope you enjoy the issue. Let us know what you think by email or on Twitter @BSHSViewpoint.

Contributions to the next issue should be emailed, by 15 April 2019, to viewpoint@bshs.org.uk.

Hazel Blair, Editor

Blue Plaque for Botanist

A Blue Plaque was unveiled in Primrose Hill on 1 November 2018 to celebrate the botanist, and philosopher and historian of botany Agnes Arber (1879-1960).

Arber, *née* Robertson, researched the physical forms and microscopic structures of living and fossil plants, publishing some 70 articles and eight books over a long career.

She investigated many plant families, including cereals and grasses, seed-producing and flowering plants, and their places within taxonomy and evolutionary history.

In her sixties, she was the first woman to win the medal of the Linnaean Society and the third to be a fellow of the Royal Society.

The unveiling event paid tribute to a pioneer who made a significant mark in her academic field.

This new plaque reflects the English Heritage scheme's ambition to increase the numbers of women and other under-represented groups commemorated by its plaques. To propose a new plaque, visit their website: *www.english-heritage.org.uk/visit/blue-plaques/propose-a-plaque*. •

Image: ©English Heritage. **Text:** Based on Rebekah Higgitt's blog *teleskopos.wordpress.com*.

Science, Maths & Religion in 17th-century England

The Royal Society has published a special issue of its journal *Notes and Records* in honour of the English mathematician John Wallis (1616-1703).

Wallis is best known for his role in the development of infinitisemal calculus, and he is credited as having been the first person to use the '∞' symbol to represent infinity.

The papers in the collection, titled *John Wallis at 400: Science, Mathematics, and Religion in 17th-century England,* reflect how Wallis himself sought to be remembered: as an accomplished mathematician, but also as a clergyman, a humanist, and a member of the Royal Society.

The editors – Adam D. Richter and Stephen D. Snobelen – hope that, through an in-depth look at Wallis,

readers will gain a deeper understanding of science, mathematics, and religion in his time.

All the articles are available online via the Society's website: *www.royalsocietypublishing.org/toc/rsnr/72/4*. •

BSHS Grant Report: International Summer School, Lille

The aim of the 2nd Inter-Divisional Teaching Comission (IDTC) 'International Summer School for Sciences, History, and Philosophy of Sciences, Technology, and Science Education' was once more to provide a platform for young researchers, postdocs, and PhD candidates, alongside teachers and practitioners from academia and schools, to meet and share cutting-edge developments in the field. The two-day event was hosted by the IDTC in collaboration with the *Maison Européenne des Sciences de l'Homme et de la Société (MESHS)* and the University of Lille's *École doctorale Sciences de l'Homme et de la Société*.

Our gathering in October 2017 aimed to investigate and improve how scientific, historical, and philosophical techniques could be used in science teaching to make education and foundational science more interesting. Science explains the material world and is an important part the EU cultural heritage and development, so fighting young people's disenchantment with it is a necessity.

Does the problem lie in wider socio-cultural changes, and the ways in which young people in EU countries now live and wish to shape their lives? Alternatively, is it due to failings within science education itself? The seminars and workshops were structured to delve into such questions in-depth, so we had a full day focusing on each subject rather than on a variety of subjects.

Our core program combined formal and methodological discussions: 'historical and philosophical sciences teaching' on the one hand, and 'science teaching' and 'science and the nature of science' on the other. We took a participative approach, which included participant problem-solving, round tables, panel discussions, and collaborative group work.

Generally speaking, current school science curricula are constructed in order to prepare students for scientific degrees at university and college. But such education does not meet the needs of the majority of students who will not pursue tertiary studies in science or even science-related fields.

Thanks to international committees (scientific and organising), as well as two honorary members, Joseph Agassi (Tel Aviv University, Israel/York University Canada) and Guy Brousseau (France), we hosted keynote speakers such as Laurence Viennot (France), Jean Dhombres (France), Laurence Maurines (France), Annibale Mottana (Italy), Moïra Anne Müller (The Netherlands), Raffaele Pisano (France) Patricia Radelet de-Grave (Belgium), Shahid Rahman (France), Michael Segre (Italy), Kostas Skordoulis (Greece), and Gérard Vergnaud (France). This multidisciplinary team of experts, in conjunction with the manifold experiences shared by the participants in history, epistemology, philosophy of sciences, and the nature of science, meant that our event easily cut across disciplinary boundaries.

This fertile environment provided insights and led to the answer of questions such as: how can history and philosophy of sciences assist in solving the crisis in science education and foundational science in Europe? How can a new scientific pedagogy produce reliable knowledge within the limits of certainty?

The questions covered were serious and complex, but all the sessions were conducted in a rigorous and friendly manner thanks to participants' goodwill and the organisers' hospitality. All of us are very grateful to the BSHS for supporting this initiative. •

Raffaele Pisano
University of Lille, Summer School Director & IDTC President

History of Mathematics Small Grant Scheme

The British Society for the History of Mathematics has introduced a small grants scheme to encourage the study of the history of mathematics. The scheme will provide grants (£100 to £500) for specific research purposes, such as archival visits, research trips, and copying costs. For eligibility criteria and application details, see: *www.bshm.ac.uk/bshm-small-grants-scheme*. •

Tensions of Europe

The latest in a series of workshops organised by the Tensions of Europe network was held at the KTH Royal Institute of Technology, Stockholm in June 2018. Historians from number of countries attended.

A series of papers dealing with the theme, 'Challenging Europe: Technology, Environment and the Quest for Resource Security' were circulated among the participants for discussion. Subjects included the supply of nuclear fuel to Sweden; oil exploration and exploitation in Nigeria; the use of technology as a political tool in Liberia; and the complex relationship between mining and the development of renewable energy. These papers will now be edited for publication.

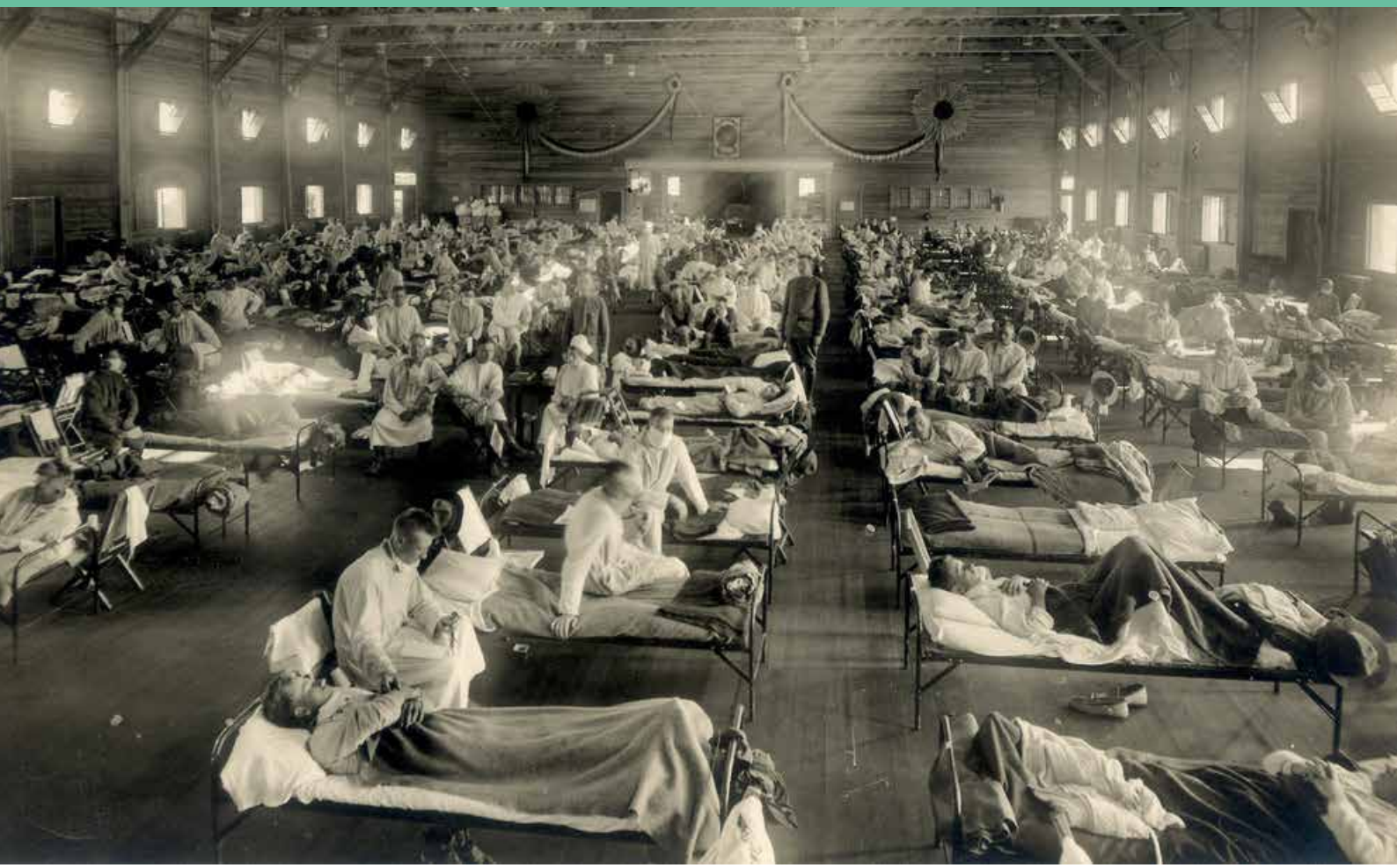
This year's ToE conference theme is 'Decoding Europe: Technological Pasts in the Digital Age.'

For more information about the network, visit: *www.tensionsofeurope.eu/technology-environment-and-resources*. •

Rosalind Franklin for the new £50 note?

The BSHS conducted a poll to decide which scientist it should nominate to be pictured on the new £50 note. The winner was chemist Rosalind Franklin (1920-58), who died of cancer aged 37 and so was ineligible to share the Nobel Prizes awarded to men working on the same projects. The Bank of England recieved 227,299 nominations and is considering a long-list of 989. •

Main Cover Image: Wellcome Collection / CC BY 4.0. 'A monster representing an influenza virus hitting a man over the head as he sits in his armchair. Pen and ink drawing by E. Noble, c. 1918.' Cropped.



‘Infectious’ Humour in the Face of History’s Deadliest Pandemic

Hannah Mawdsley explores contemporary light-hearted responses to the Spanish Flu pandemic, which broke out in the final year of the First World War.

In the final year of the First World War, a deadly pandemic swept around the globe. In a little over a year, the 1918-1919 ‘Spanish’ influenza pandemic had infected up to a third of the world’s population, and killed up to 100 million people. Its spread was aided by the mass movement of troops, and in a world already reeling from unprecedented amounts of death, the Spanish Flu heaped horror on horror.

The symptoms could be grotesque. Some victims suffered from heliotrope cyanosis, a result of an overactive immune response where victims turned completely blue or black as they drowned in their own fluids. Delirium was also a distressing hallmark symptom, leading in some cases to violence and self-harm. In her *Testament of Youth*, Vera Brittain recalled being ‘chased up and down the hut by a stark naked six-foot-four New Zealander in the fighting stages of delirium.’

In the peaks of the virus waves, services were overwhelmed. Hospital mortuaries stacked bodies in corridors, and grave-diggers had to use mass graves to keep up with demand. In the midst of such chaos, it is hard to imagine any joy or humour. And yet, despite such traumatic experiences, first-hand accounts illustrate how some survivors managed to find opportunities for light-hearted relief and mirth.

Barracks jokes

Unusually for an influenza virus, the ‘Spanish’ Flu strain was most deadly for young adults aged between 20 and 40, rather than the young and elderly that are most affected by seasonal flu strains. Young adults therefore bore the brunt of the pandemic, and yet still found opportunities for humour, even if it was of the morbid variety. For soldiers, many of whom fell within this age range, the pandemic was often considered simply as a new enemy in a long and drawn-out war.

As such, the Flu was subject to the same morbid humour as other aspects of the First World War. Private R. Dann was stationed in India during the conflict, and recalled how his friend Jim was advised by medical staff to ‘get a good sweat on’ in order to break the fever. Jim had struggled to manage this but recalled that ‘when the man in the bed to his right died, and then the one in the bed to his left…I soon got a sweat on then.’

In some countries, quarantine provided an opportunity for humour among adults in the face of this deadly pandemic. In Australia, for example, a policy of quarantine helped to further hinder the virus' progress. The temporary camps erected to house quarantined passengers were the perfect environment for humorous takes on the pandemic to emerge.

Most people in quarantine were healthy, and therefore had time and space for fun and mischief. Some created camp magazines which recorded these exploits. *The Yellow Rag* is one example of this, a magazine created by quarantined rail passengers in February 1919 while they were being held at Parkeston, Western Australia. Aside from daily health checks and inoculations, the magazine showed how quarantined passengers spent their time in social engagement as well as creative activity.

Many of the themes in the magazine are light-hearted and humorous. Some made light of the threat of influenza, as well as the efforts of medical staff and their attempted preventive treatments. One section read: 'Apart from the delay and resulting inconvenience, no one will suffer very much, while the experience will be looked back upon with pleasure, and considered a huge joke'. Some quarantined individuals composed pithy songs and poetry about the Spanish Flu and their quarantine experience. For others, the romantic possibilities created by the enforced quarantine were the perfect opportunity for mirth. One section read:

> *Cupid was terribly busy in camp, and a number of the inmates will perhaps, in after years, often recall the incidents of the camp life while sitting over the fire with their life partners, found in quarantine.*

All images: Public Domain

Above *Spanish Flu was nicknamed the 'Naples Soldier' after a song in the musical theatre production 'La canción del olvido' ('The Song of Forgetting'), the tune of which was considered just as 'catchy' as the Flu.* Opposite page *Soldiers with influenza in an emergency hospital at Camp Funston, Kansas, 1918.*

Children's experiences

It was children, however, that drew the most humour from the experience of the Flu. Children were particularly likely to enjoy the pandemic, because it gave them unexpectedly long holidays, as schools were closed to prevent further spread of the infection. George Arthur was aged eleven during the pandemic, and at school in Scotland. His teacher informed the class that they were now on holiday, but the pupils assumed he was joking. 'However, it was no joke,' Arthur recalled, 'and we were soon streaming home laughing and chattering over the fact that we had been given an unexpected holiday'.

That is not to say that children were unaware of the serious nature of this outbreak of infectious disease. Due to the unusual mortality profile of the virus, many children saw their parents directly affected. However, the effect on this demographic could lead to alterations in expected gender norms that were later recalled with humorous enjoyment.

Alexander Riddle lived with his parents in South Shields during the pandemic. He recalled how his father had taken over domestic duties during his mother's illness, and decided to bake some bread. Riddle recalled with amusement: 'He got a stone of flour and a pound of yeast. Imagine the result, it practically knocked the oven door off its hinges.' Riddle also recalled the humour that was evident between his parents and their neighbours during the pandemic. He recalled a local elderly lady being asked how her spouse was. Her reported reply; 'I've got rid of that old b ---, the flu got him, not the booze as I always said.'

> For soldiers, the pandemic was often considered simply as a new enemy in a long and drawn-out war.

Alcohol was in fact one of the most popular attempted cures for the infection. The Spanish Flu was a mystery killer, and doctors were largely powerless to help. In 1918 there were no antibiotics, and viruses had not yet been identified. As a result, ordinary people themselves attempted whatever treatments they could to tackle the infection including, unsurprisingly, copious consumption of alcohol. Schoolboy Eric Newell recalled:

> *The only other story I remember about the Spanish Flu was about two of our bachelor junior masters who had digs together. One was a teetotaler, and went to bed with a bottle of milk, the other was not and went to bed with a bottle of scotch. The one with the scotch lived.*

LA FIEBRE DE LOS TRES DÍAS

SE TRATA DE UNA EPIDEMIA DE "GRIPPE"

En el Instituto Nacional de Higiene se comprueba la existencia del bacilo de Pfeiffer entre los atacados

LOS BIÓLOGOS.—¡Anda, precioso!... ¡Dinos quién eres!

El doctor Ruiz Falcó, uno de los mejores bacteriólogos españoles, ha descubierto al germen de la epidemia ac- ría del Hospicio, previo permiso del señor presidente de la Diputación provincial, a quien agradecemos públicaza, pero rara vez puro, sino asociado a otros gérmenes, generalmente. El pneumococo y el estreptococo piógeno.

Top *A group of women wearing surgical masks during the influenza epidemic in Brisbane, Australia, 1919.*
Bottom *Biologists and the Spanish Flu microbe. Comedic cartoons show how both medical practitioners and the public sought to understand the unknown flu virus in 1918, and their powerlessness against it.*

For children, one of the most potent sources of humour during the pandemic involved the discomfiture of authority during a time of crisis. Philip Learoyd was at school near Blackpool, UK during the pandemic. He recalled a nurse entering the school dormitories where the pupils lay sick with the Flu on 11 November 1918. She 'announced that the Armistice had been signed and the war was over.'

To her surprise, the pupils received the news in dead silence. In contrast, when the same nurse later re-entered the dormitory to share some sad news, she found an altogether different response. 'Boys,' she said, 'I regret to inform you that your headmaster has succumbed to the prevailing epidemic.' Learoyd recalled: 'this time we really rocked her back on her heels. Our cheer nearly lifted the roof off.'

In the face of the horrifying headline figures associated with the Spanish Flu, therefore, it is perhaps easy to homogenise the pandemic experience. There is also a danger of assuming that this homogenised experience was always a negative one. These humorous accounts illustrate the breadth and complexity of responses to this pandemic. •

Hannah Mawdsley
Queen Mary University of London

Further Reading

The Collier Collection, Imperial War Museum Archive 63/5/1-18.

Vera Brittain, *Testament of Youth: An Autobiographical Study of the Years 1900-1925* (1933)

Richard Collier, *The Plague of the Spanish Lady* (Macmillan, 1974)

Mark Honigsbaum, *Living with Enza: The Forgotten Story of Britain and the Great Flu Pandemic of 1918* (Macmillan, 2009).

A Tale of Two Scientists and the Development of Particle Colliders

Luisa Bonolis and **Giulia Pancheri** travel through Europe, space, and time to highlight the scientific significance of Bruno Touschek's meeting with Rolf Widerøe in 1943.

This is the story of two scientists who came together during the Second World War and of how their shared ambition led to the development of particle colliders. The latest and best-known of these machines is the Large Hadron Collider at CERN in Geneva, but the roots of particle colliders stretch back to 1940s Germany. Indeed, the meeting between Bruno Touschek and Rolf Widerøe in Berlin in 1943 is a master example of how chance can lead to great advances in science.

Widerøe & Touschek

Our story begins in Vienna. In May 1940, a 19-year-old Bruno Touschek – banned from attending university because of the Nuremberg laws and his half-Jewish heritage – dreamed of becoming a theoretical physicist. He studied at home with books borrowed from the university library, but as the war proceeded life became more dangerous.

In early 1942, Bruno moved incognito to Germany, to pursue the studies in which he was already showing great proficiency. Unofficially, he attended classes in physics at the Universities of Hamburg and Berlin. In need of money, however, Bruno began working for Loewe-Opta, a furnisher of electronic equipment to the Reich's war ministries, including the ministry of aviation, the *Reichsluftfahrtministerium* (RLM). The firm was directed by Karl A. Egerer, also editor-in-chief of the scientific journal *Arkiv für Elektrotechnik*. And this is how, one day in February 1943, Touschek (now Egerer's assistant editor) came into contact with Rolf Widerøe, who had submitted an article to the *Arkiv* a few months earlier.

Widerøe's article had been prompted by the arrival in Trondheim of one of the last issues of the *Physical Review* to reach Norway before its occupation by the Nazis in 1941. This contained an article by Donald Kerst, reporting the successful operation of a new type of electron accelerator machine later called the 'betatron'. In his article, Kerst quoted an original idea proposed by Widerøe in his dissertation.

Several months later, in Oslo, the renowned Norwegian physicist Roald Tangen mentioned the unknown Widerøe in a talk on developments in particle accelerators, and it just so happened that Widerøe – who had left academic research after his doctorate – was in the audience. The lecture immediately re-connected Widerøe to his life-long dream of designing and building particle accelerators, and he quickly designed a more powerful machine than Kerst's and described his project in an article he submitted to the *Arkiv* in September 1942.

> "The German military was interested in the so-called 'death-ray', which could be directed at enemy airplanes to disable their engines.

Several months passed and Widerøe did not hear back from Egerer, the editor, but in the spring of 1943, he was approached in Oslo by Luftwaffe officers who asked him to fly with them to Berlin to discuss his proposal.

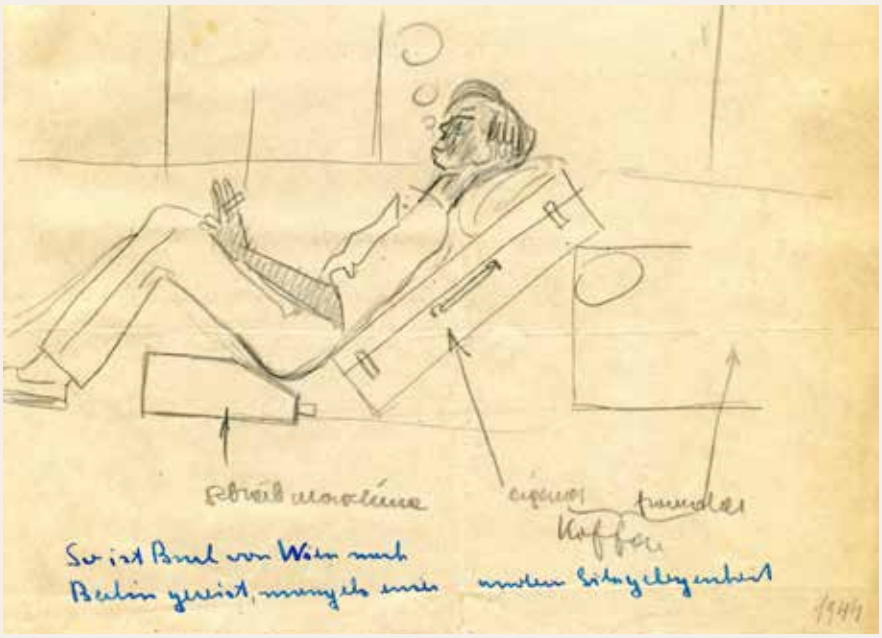
A cache of wartime letters

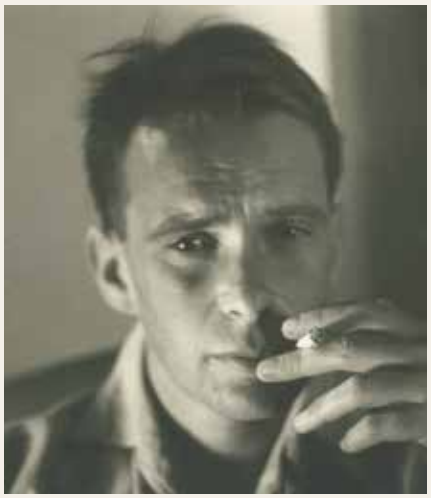
What prompted the German military to ask Widerøe to come to Germany and build his betatron is a hitherto unknown story, but we have unraveled it from a cache of wartime letters sent from Touschek to his family. Indeed, Widerøe's involvement with the German betatron projects can be traced via two letters Touschek sent to his family on 15 February and 17 June 1943, respectively.

In the first, Touschek writes of his realisation that relativistic effects should be considered when particles are accelerated at high energies. He recounts that he had recently read a 'silly article' in which such effects were neglected. Although Widerøe's name never appears in this letter, several elements suggest that Touschek was referring to Widerøe's recently-submitted research article on the betatron.

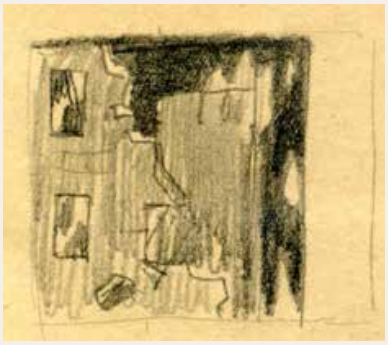
In the same letter, Touschek mentions Egerer's excitement about the possibility of the Wehrmacht's interest in funding an accelerator project, which Werner Heisenberg (leader of the Third Reich's secret nuclear project 'The Uranium Club' [the *Uranverein*] and the highest scientific authority in Nazi Germany) could have been interested in.

And so, a chain of events was set in motion, which included Egerer communicating with his contacts at the RLM. From here, it is likely that news of Widerøe's work reached Heisenberg. This would explain the despatch of Luftwaffe officers to Oslo to convince Widerøe to come to Berlin and collaborate in the war effort.





Above *Touschek in 1955.*
Left *His drawing of a journey from Vienna to Berlin, in a letter of 11 September 1944.*
Below *His drawing of bombing in Berlin, in a letter of 27 November 1943.*



All images: Courtesy of Mrs Elspeth Jonge Touschek, 2003.

> It was a disruptive idea, which had huge implications for the development of particle accelerators.

The German military was interested in betatrons as a war weapon, particularly the so called death–ray: the intense X-ray emitted by electron accelerators could be directed at the enemy's airplanes to disable their engines. For Widerøe's part, he hoped that collaboration with the German military would relieve the conditions of his brother Viggo, who had been in the Norwegian resistance and was being held prisoner in Germany. He accepted the officers' proposal, having learned from Kerst's success that his dream of building a betatron was possible and that the Germans were offering him the means to realise it.

In the following months, Widerøe refined his project and began corresponding with Touschek. Widerøe is mentioned more explicitly in Touschek's letter of 17 June, where the latter writes, 'I have beaten my Norwegian on all grounds,' referring – as we know from other sources – to Widerøe and his treatment of relativistic effects. This letter probably follows a meeting in Berlin that same month, in which Widerøe's project was approved by the German authorities and classified as secret. This explains why Widerøe's article, already in its proofs, was never published.

Disruptive science

Things moved rapidly after June, with Touschek joining a Hamburg-based group working on building the betatron. Widerøe went back to Norway for the summer, but he returned to Germany with an idea for another possible accelerator device, one in which positively and negatively charged particles would be accelerated in opposite directions to meet and, in the clash, release their energies in debris. It was a disruptive idea, which had huge implications for the development of accelerators in the second half of the 20th century. He shared this idea with Touschek, and on 8 September Widerøe submitted a patent for his new device. He then started, in earnest, on the betatron project, which he worked on for several months.

In October, referring to his contract with the German military, Touschek wrote to his family: 'Yesterday I signed my death sentence, with a very formal declaration of secrecy together with a hundred oaths…' November and December brought some of the heaviest bombing of Berlin. Touschek's descriptions shed a vivid light on those dramatic days during which his own house was hit by bombs; he says he wandered around, climbing on piles of rubble and shattered roofs.

In September 1944, the betatron began to work, but by 1945 the war was coming to its end. In March, following orders to keep the betatron away from the fast-ap-

Above Touschek's passport, c. 1939.

proaching Allied forces, Touschek helped Widerøe move it to the countryside. On his return to Hamburg, Touschek was arrested by the Gestapo and imprisoned in Fuhlsbüttel concentration camp. A few weeks later, in June, he wrote to his family:

> *[200 prisoners] had to set off on foot towards Kiel. There were SS soldiers behind us, in front, and on both sides. Near Hamburg [Langenhorn] I collapsed (I was no longer used to walking). They threw me into the ditch on the side of the road and then shot me. Without success. A bullet went glancing brushing close to my left ear, the other went through the padding of my coat.*

Narrowly escaping death, he was freed after the war.

After the war

Different destinies awaited the two friends after the war. Widerøe went back to Norway, where, a few days after his arrival, he was arrested on the charge of collaborationism. The investigation that followed cleared him of the accusation, but he had to pay a heavy fine. He turned his interest in accelerators to their medical applications, and eventually moved to Switzerland.

As for Touschek, he completed his studies first in Göttingen, and then in Glasgow, where he obtained his doctorate and worked on a synchrotron built under the direction of Philip Dee. But the northern climate did not suit him. In 1952, an opportunity arose for a position in Rome, which he accepted.

> 'Yesterday I signed my death sentence, with a very formal declaration of secrecy together with a hundred oaths...'
>
> — Bruno Touschek, 1944

In February 1960, his theoretical training, alongside his apprenticeship with Widerøe during the war, led him to propose 'AdA' (the first ever electron-positron collider), which was built in the Frascati National Laboratories, near Rome. The collider was later brought to the Laboratoire de l'Accélérateur Linéaire in Orsay, near Paris, and there, in 1963, it was successfully proved that head-on particle-antiparticle collisions had occurred.

The many paths that had been traced across Europe before, during, and after the war, thus came to their meeting point, ultimately paving the way to modern-day particle physics. •

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& Giulia Pancheri, *INFN National Laboratory of Frascati, Italy*

Acknowledgments

This article stems from a longer version included in the History of Physics Group newsletter in January 2018. For more information about this group, see: www.iop.org/activity/groups/subject/hp/newsletter/page_58992.html.

The authors are grateful to the late Elspeth Jonge Touschek who gave them access to the letters quoted here.

The authors and Editor also thank Jim Grozier for reading and commenting on this article prior to publication.

Further Reading

Edoardo Amaldi, *The Bruno Touschek legacy (Vienna, 1921 - Innsbruck, 1978)*, CERN Yellow Reports: Monographs No. 81-19 (CERN, Geneva, 1981).

Rolf Widerøe, *The Infancy of particle accelerators. Life and work of Rolf Widerøe*, edited by P. Waloschek (Vieweg + Teubner Verlag, Braunschweig, Germany, 1994).

Pedro Waloshek, *Death-Rays as Life-Savers in the Third Reich* (Desy Library, 2004).

Luisa Bonolis and Giulia Pancheri, 'Bruno Touschek: Particle physicist and father of the e^+e^- collider', *European Physical Journal H* 36.1 (2011), arXiv:1103.2727 [physics.histph].

In Defence of Britain: Women in 20th-century Military Engineering

Sally Horrocks introduces three women whose scientific contributions led to military advances.

Unlike front-line roles in the armed forces, where gendered restrictions have only recently been removed, women were permitted to work in military research alongside men over a century ago. Yet we know relatively little about these female researchers compared to their university-based counterparts and their wartime colleagues in caring professions. What kind of careers were open to women in defence research in the early 20th century? How did they secure their posts? And what work did they carry out on a day-to-day basis?

One of the first military establishments to offer women opportunities in engineering was the Royal Aircraft Establishment (RAE) in Farnborough. Formerly known as the Royal Aircraft Factory, and renamed in 1918 to recognise its transition from a production to a research facility, the RAE recruited several women to help set up its new research programmes.

This article explores the careers of three women who worked at RAE Farnborough: Frances Bradfield (1895-1967), Hilda Lyon (1896-1946), and Beatrice Shilling (1909-90). Although female scientists and engineers were only ever a small minority of the RAE's staff during its 70-year history, they were a constant presence, making pioneering contributions to aeronautical research as part of one of the UK's best-funded research organisations.

Women at Farnborough

Frances Bradfield had the most straightforward route into research at Farnborough. She read Mathematics at Newnham College Cambridge before also completing Part II Physics in 1918. She joined the RAE soon afterwards, probably benefiting from the superintendent's preference for Cambridge-educated staff. Initially classified as 'female draughtsman' until a vacancy appeared on the scientific staff, she eventually found work in the Aerodynamics Department headed by Hermann Glauert.

Hilda Lyon's path to Farnborough, by contrast, was more circuitous. She too studied Mathematics at Newnham, and upon graduating in 1918 she took an Air Ministry training course in stress analysis, which led to further employment in a succession of aircraft firms. Frustrated at her lack of opportunities to move into research, however, Lyon took a short career break before finding work at the Royal Airship Works in Cardington, Bedfordshire, where she worked on the R101 airship. In 1930, she was the first woman to be awarded the R38 Memorial Prize of the Royal Aeronautical Society, and she used this to secure a travelling scholarship to study for an MSc at Massachusetts Institute of Technology. Her research identified the optimum shape for an airship which became known as the 'Lyon' shape and was also applied to submarines.

> "It was standard practice for women to resign upon marriage."

A second travelling scholarship in 1932 took Lyon to Göttingen in Germany, to work with pioneering aerodynamicist Ludwig Prandtl. In 1933, she returned to the family home in Yorkshire to nurse her sick mother, and – unusually for a female scientist in this position – she was able to maintain contact with her field, collaborating with William Jolly Duncan, lecturer in Aeronautics at University College, Hull, just a short distance from Lyon's hometown of Market Weighton.

Although unpaid, this work enabled her to continue to publish and keep up to date in a fast-developing field. As Frances Bradfield noted in her obituary of Lyon, 'a four year break would have ended most women's work.' After her mother died in 1937, Lyon joined Bradfield in Aerodynamics Department at RAE Farnborough where she initially worked in the wind tunnels

Beatrice Shilling was a graduate engineer, awarded an MSc by the University of Manchester in 1933 for work on internal combustion engines. She described her childhood as one spent playing with Meccano, building wireless receiver sets and servicing her motorbike. Thanks to the activities of the Women's Engineering Society, her mother came to see that these enthusiasms might translate into a future career, and Shilling worked first as an apprentice with pioneering female electrical engineer Margaret Partridge. She then secured funding from the National Society for Women's Service to study at university, and in 1929 she joined the University of Manchester's Engineering Department.

Upon graduating, Shilling struggled to find employment, but reasoned that success racing her motorbike might help her to find a job that used her engineering skills. Her racing record was distinguished, and in August 1935 she was only the second woman to be awarded a Brooklands Gold Star for lapping at over 100mph. Suitable employment opportunities remained elusive, but in 1936 she started work writing handbooks in the Technical Publications Department of the RAE. This proved a stepping-stone to a research role in the Engine Department working on carburettors.

Once appointed, all three women were promoted, gradually taking on additional responsibilities and gaining the respect of those they worked with. Neither Bradfield nor Lyon served long enough to enjoy equal pay with men on the same grade, which was implemented in 1961. Both Bradfield and Shilling reached the rank of Senior Principal Scientific Officer

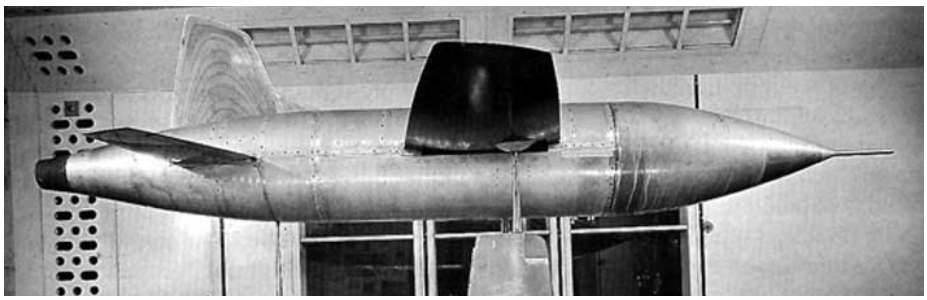
with an individual merit promotion, the highest grade that could be attained whilst remaining an active researcher. They also received external honours, including OBEs for their wartime work.

Further recognition

In 1948, Bradfield was the first woman to be awarded the Bronze Medal of the Royal Aeronautical Society while Shilling received an honorary degree from the University of Surrey in 1969. At a time when it was standard practice for women in the civil service to resign on marriage, Shilling managed to keep her post after her wedding in 1938 to George Naylor, a fellow motorcycle racing enthusiast who also worked at RAE. Lyon's external recognition came earlier in her career, and her untimely death in 1946 meant that her work at RAE was not recognised in this way. The esteem in which she was held, however, was reflected in the condolence letters sent to her family by such luminaries of aeronautical research as Ben Lockspeiser, Ernest Relf, and George Douglas.

But while Bradfield, Lyon, and Shilling received recognition for their scientific work, none of them made the transition from research to administration that was necessary to progress further up the hierarchy, something achieved by at least some of their male contemporaries. There is certainly evidence that Shilling sought to follow this route; her biographer suggests that she was unsuccessful because of both a reluctance to promote women and her readiness to criticise her superiors.

Their achievements are clear nevertheless. Bradfield's most significant work was on the use of wind tunnels as research tools. With George Douglas, she established techniques for using the tunnels that ensured the results they achieved would be of practical value. Bradfield is also remembered as a mentor, running a 'Kindergarten' where new recruits received the equivalent of a post-graduate education. This was particularly vital during the Second World War, when the RAE expanded rapidly. Sir John Charnley, who joined RAE during this period, noted with affection how Bradfield, had been willing to give her time in ways that senior male staff were reluctant to. Like Bradfield, Lyon started her Farnborough career in the wind tunnels, but she then moved to the Theoretical Stability Group, quickly becoming its lead researcher. Here she made pioneering contributions to the emerging field of aeroelasticity, and to longitudinal stability theory, while helping to solve critical wartime challenges.



Images: CC BY-SA 3.0 / Msemmett via Wikimedia Commons (top); Public domain (bottom).

Top *The control desk of the R52 transonic wind tunnel at Farnborough RAE.*
Bottom *A Vickers M.52 model undergoing supersonic wind tunnel testing, c. 1942.*

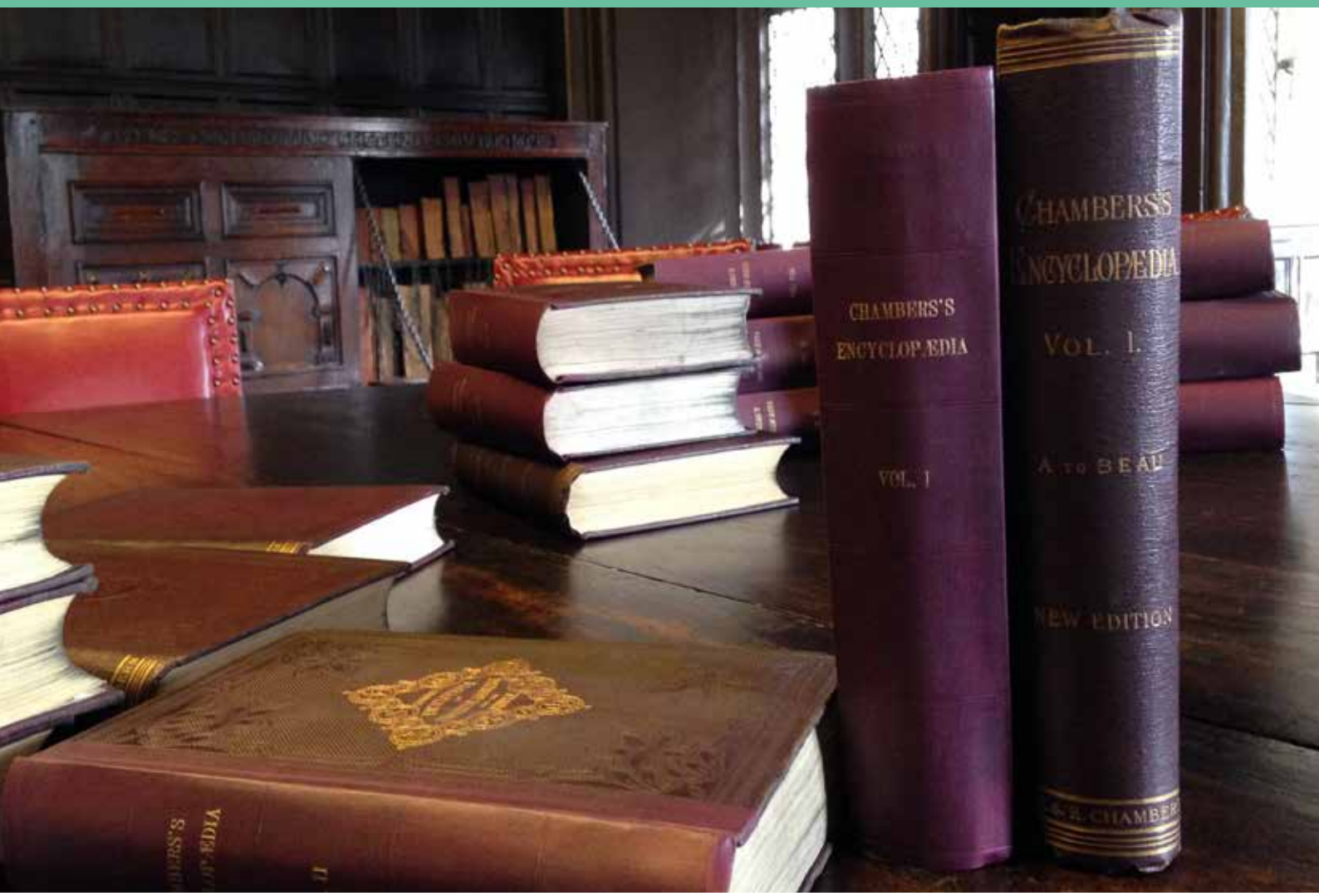
Spitfires & Hurricanes

Shilling is best known for resolving a problem with the Merlin engines that powered wartime fighters such as the Spitfire and Hurricane; these were prone to stall when they dived rapidly, allowing enemy aircraft to easily evade their pursuers by themselves diving steeply. The solution was a modification to the carburettor that could be fitted without taking the aircraft out of service. Known as 'Miss Shilling's orifice' this remained in use until an improved carburettor was ready for service in 1943.

The post-war shift in research away from piston engines forced Shilling to move fields, working first on ramjets, then on life support for crews at high-altitude, and later on the cooling of high-speed aircraft. She also advised on the design of bob-sleighs and Grand Prix car cooling systems.

Women such as Frances Bradfield, Hilda Lyon, and Beatrice Shilling are now to be found in lists of pioneering women in STEM. The striking image of Beatrice Shilling astride her 500cc Norton motorbike is regularly used to illustrate articles on 'forgotten' women in engineering – and yet Shilling is well known enough to have a public house named after her: The Tilly Shilling, in Farnborough. Such cartoonish presentation of these women flattens out the complexity starting to emerge from more detailed research on their lives and careers as integral members of Britain's defence research staff. •

Sally Horrocks
University of Leicester
With thanks to Liz Bruton, Laurie D Ferreiro, Graeme Gooday, Tom Lean, Emme Ledgerwood, and Paul Merchant.



Democratising 19th-century Science and Technology

Rose Roberto discusses the impact of a Special Projects Grant awarded by the BSHS.

While many people claim their work is interdisciplinary, I can claim my research, focused on 19th-century illustrations, is encyclopaedic, because it is focused on the first two editions of *Chambers's Encyclopaedia*.

The Scottish firm W. & R. Chambers published the first edition of their encyclopaedia between 1859 and 1868. The second edition, released between 1888 and 1892, was co-published simultaneously on two continents, in partnership with the American firm, J. B. Lippincott. The title of my thesis, 'Democratising Knowledge', refers to two ambitions fundamental to Chambers; first, it links to the Scottish firm's use of illustrations to convey complex information visually and succinctly to people with varying degrees of literacy. And, second, it reflects W. & R. Chambers's business philosophy of producing affordable, accessible publications, as described in the opening notice to volume I of their 1860 *Encyclopaedia*: 'The information may be characterised as non-professional, embracing those points of the several subjects which every intelligent man or woman may have occasion to speak or think about. At the same time every effort is made that the statements, so far as they go, shall be precise and scientifically accurate.'

Encyclopaedias are a snapshot of a particular time, place, and world view. Like museums, they have been curated, and the collections within them reflect particular narratives of history, science, and culture. Their construction and presentation of information, with the aim of increasing access to universal as well as practical scientific knowledge, is not only intriguing, but provides a key to understanding the flow of information in Victorian society.

The Chambers brothers

Readers of *Viewpoint* will know of Robert Chambers (1802–1871), who secretly authored *Vestiges Of The Natural History Of Creation*, a best-selling book which explained a Lamarckian view of evolution for a general audience. Between 1845 and 1854, a new edition of *Vestiges* was published every year. Chambers's scientific work was recognised by the Royal Society of Edinburgh and the Geological Society of London, and he attained Fellow status in both these societies.

Still, Chambers chose to release *Vestig-*

es anonymously, even going so far as to have it published in London with medical publisher John Spriggs Morss Churchill; evolution was a controversial subject in the 19th century, and Chambers did not want to endanger his own lucrative publishing business or mire his family with controversy.

Robert was the younger brother of William Chambers (1800-1883), and together the brothers co-founded W. & R. Chambers in the early 1830s. The firm grew out of the brothers' former experience in small-time bookselling and hand-press printing , and by the 1850s the Chambers firm was an established publisher with a global reputation and market for educational books, periodicals, dictionaries, and encyclopaedias. By the time W. & R. Chambers began taking subscriptions for the first edition of its illustrated encyclopaedias in 1859, the firm was a commercial success, having outlived several rival publishers of cheap instructive print.

Described by the Chambers brothers as their 'crowning effort in cheap and instructive literature,' the first edition of *Chambers's Encyclopaedia* was published in ten volumes between 1860 and 1868. The second edition, still in ten volumes, followed between 1888 and 1892, and subsequent editions were produced between 1923 and 1927, and in 1950 and 1966.

Edinburgh publishing

Edinburgh was one of the most prolific centres of publishing in the 19th century. Moreover, Chambers publications display a value for public education, a belief that knowledge and the opportunity to gain rewards for hard work should be available to all, and an admiration for new technology alongside encouragement of pragmatic solutions to problems. Professor Ian Campbell writes in the *History of Scottish Literature* that the democratisation of knowledge, typified by *Chambers's Encyclopaedia*, was a product of the period's education system in Scotland: 'non-specialism was a distinguished part of Scottish higher education, producing superb generalists, cross disciplinary teachers and researchers.'

Despite the non-specialism embraced by the Scottish education system, and by the Chambers firm, I have found through my research that the images in both editions of *Chambers's Encyclopaedia* favoured scientific topics. Grouping the images into categories, I found that 'vertebrates', 'botanical specimens', 'machines and vehicles', and 'medical or anatomical illustrations' were the most frequently produced images by the firm in its encyclopaedias. My research also found that towards the closing decades of 19th century, the style of illustrations were influenced by photography, and that there were editorial decisions to present more information in tabular and schematic forms. In other words, there was a decline in the use of decorative images in favour of more didactic ones.

A new e-resource

Thanks to the assistance of a BSHS Research Exhibition Grant, I was able to travel to Edinburgh in November 2017 to develop my research on Victorian book illustration into an online resource with National Museums Scotland (NMS), titled 'Democratising knowledge: *Chambers's Encyclopaedia*.'

The NMS holds 20,000 woodblocks formerly belonging to W. & R. Chambers, and more than 7,000 of those woodblocks were used in the production of the the first two editions of *Chambers's Encyclopaedia*. To complete this digital project, I spent time in Edinburgh sorting through the uncatalogued collections at NMS, selecting nearly 160 woodblocks for digitisation. My selection of specific blocks, showing how printing technology changed between the publication of various editions from the mid-to-late 19th century, provided criteria for curators to individually register blocks and have them professionally photographed. The online resource allows the woodblocks to be seen as high-resolution images, so that their high-quality design, functionality, and historical significance can be appreciated.

Some of the other behind-the-scenes tasks that I undertook in support of this online project included providing smaller images of the prints from the encyclopaedias that matched the woodblocks, since displaying prints next to their associated woodblocks gives audiences a better understanding of the woodblock as an object. I was also responsible for writing captions for each digital image, and cataloguing digital images: by subject category, by illustration style, and by type of material used in its creation.

This online resource would not have been possible without the assistance of regular museum staff, such as Alison Taubman, Principle Curator of Communications in the Science and Technology Department,

Photos: Rose Roberto

Above *W. & R. Chambers Collection woodblocks, National Museums Scotland.*
Opposite *The first two bound editions of* Chambers's Encyclopaedia, *in Chetham's Library, Manchester.*

as well as Elaine Macintyre from the Digital Media Team. They took my ideas, my research, and my textual and visual content, and with their high levels of skill and great amounts of patience, transformed what I gave them into an informative, coherent, beautiful, and approachable digital document suitable for general audiences as well as for scholars.

This online resource will appeal to researchers of the history of science and technology, but also to Scottish historians, information studies practitioners, and students of print and visual culture. In other words, its scope is broad, interdisciplinary, and encyclopaedic. •

Rose Roberto
Collaborative Doctoral Partnership student at the University of Reading & National Museums Scotland

Further Information

For the NMS e-resource, please visit www.nms.ac.uk/chambers.

The above-mentioned categories were grouped according to an international standard: CCO (Cataloguing Cultural Objects), developed by the Visual Resource Association (VRA) in collaboration with the Getty Research Institute. This standard allows for images to be categorised by features presented in the image itself, rather than on topical categories which are subject to different interpretations. See cco.vrafoundation.org for further details.

Review: FOLK Exhibition, Oslo

LSE's **Dominic Berry** tours a new gallery at The Norwegian Museum of Science and Technology.

I cannot cover everything significant about this important new gallery curated by Ageliki Lefkaditou and Jon Kyllingstad, and opened in 2018 at The Norwegian Museum of Science and Technology, Oslo. The exhibition directly addresses the long history and present status of research on human biological diversity in the hands of phrenologists, anthropologists, eugenists, and geneticists.

Understanding history's ongoing legacies in contemporary science and society, the exhibition creates an opportunity for visitors to challenge their assumptions about what race might mean, hear from the subjects of racial science themselves, learn the methods that have made up different sciences of human biological diversity, and connect these directly with the politics of their context in the past and present.

The full title of the exhibition is 'FOLK – From Racial Types to DNA Sequences'. Around the outer edge are various detailed panels addressing different periods, sciences, and significances, while at the centre there is an innovative circular perspex cabinet (photographed) that visitors can enter into, its shelves containing touchstone objects that link up the different questions and themes of the overall exhibition. The effect is that the visitor very naturally begins to 'look through' the object in their foreground, to see it in conjunction with the materials on the walls behind.

The middle of the perspex ring also contains a table full of books on the history of race science, and chairs for visitors to sit and talk through their experience. Visitor reflection on and discussion of the FOLK thesis is thus actively encouraged. And the FOLK thesis? That attention to the history of race science demonstrates over and over again that biological conceptions of race are untenable, based on flawed starting assumptions with disastrous and deleterious social and political ramifications. Whatever the biological differences between humans may be, a concept as ill-formed as race can play no part in its understanding.

To the left of the gallery's entrance are illuminated magic lantern slides showing the faces of people photographed by anthropologists in the 19th century, people who were taken to exemplify distinct 'race types'. As visitors enter the gallery, they will find infront of them a smaller ring-shaped wall containing examples of human face and skull-shape models once regularly produced by anthropologists for the purposes of demonstrating racial typologies.

One of the first exhibits visitors will come to explains the routine measurement of soldiers, who provided a ready supply of body shapes and sizes taken to represent the nation. Photographs of one particular cohort were taken as part of a national measuring project in 1920-21, where all young Norwegian men who did military service underwent physical-anthropological measurements of body type, head shape, eye colour, and hair colour. Indeed, this was an international phenomenon, recruits being used for these purposes in many countries largely because they could not refuse participation. Such photos and measurements were then used to divide the national population into racial types, coming to be published and circulated internationally.

Arguably the gallery's most significant exhibit is the one intended to give a voice to those who have been used as subjects in race science, where putative biological distinctions often reinforced their marginalisation. FOLK was completed in collaboration not only with university and museum researchers, but also with some of the Sami people, a group that has been central to physical-anthropological study of racial types in Europe. Working with the Árran Lule Sami Centre, the curators created an exhibit that directly addresses the power imbalances involved in biologically typologising the Sami — and making them into museum displays, for that matter — and the repercussions that typological thinking has had on their historical marginalisation and exoticisation.

Working with some of the Sami people, the curators have brought forth the biographies of some of those photographed for the purposes of anthropological measurement, who might otherwise have remained nameless. A video exhibit playing interviews with Sami people remembering the visits of anthropologists to their communities, and their measuring practices, plays alongside. Here, in particular, visitors are confronted with the implications of assigning specific values, features, and essences to people according to biological groups. FOLK thus directly examines how scientists may carry such views in their asymmetrical encounters with their subjects of study and, in turn, how scientific research has typically reinforced such views.

There is more in this exhibition than I can hope to cover in a single review, but elsewhere visitors are shown the role of race science in eugenics, the commercialisation of a genetics of race, and the making and remaking of national identities according to biology. Much of the exhibit also addresses genetic and anthropological research in the present.

The FOLK gallery demonstrates HPS museum practices at their very best, refusing to look away from uncomfortable subjects, and improving our understanding of what science is and how it works in an area that could not require it more urgently. In its displays and in its curators' practices of co-production, the gallery sets a new benchmark for museums dealing with history of the human sciences. •

Image: The Norwegian Museum of Science and Technology

Viewpoint Interviews...

Sophie Almond, an AHRC-funded Midlands4Cities Doctoral Training Partnership student at the University of Leicester.

Who or what first turned you towards the history of science?

I first fell in love with the history of science whilst studying for my MA in English Studies at the University of Leicester. I knew that I wanted to write my dissertation on something related to medicine in the 19th century, and with the help of my amazing supervisor Dr Claire Brock, I decided on the topic of menstruation in Victorian culture and society. Tracing how medical perceptions of the female body changed as women broke down the barriers that confined them to the domestic sphere was truly fascinating. I haven't looked back since.

What has been your best career moment?

I think my best career moment to date has to be presenting three papers at three different conferences in the first month of my PhD. Sharing my research with others was an amazing feeling, and I really enjoyed answering questions from people who were genuinely interested in what I'm doing. It was certainly a baptism of fire, but I loved every minute.

Which historical person would you most like to meet?

I would relish the opportunity to sit down and have a conversation with Dr Annie Reay Barker (1851-1945). She was one of the first women to qualify to practice medicine in the late 19th century, but hardly anyone has heard of her. I've spent the last six months piecing together her life and medical career, and having the opportunity to get to know her on a personal level would be fantastic.

If you did not work in HSTM, what other career might you choose?

From a very young age, I've always wanted to be a teacher. If I wasn't currently doing my PhD, I would probably be teaching English in a secondary school. Whilst my current research is history-based, I did my undergraduate and postgraduate degrees in English and I have a real passion for reading and writing.

> "It was certainly a baptism of fire, but I loved every minute.

What are your favourite history of science books?

I always find myself returning to Ornella Moscucci's *The Science of Woman: Gynaecology and Gender in England, 1800-1929*. It gives a fascinating insight into the history of the female patient and cultural definitions of femininity. I would thoroughly recommend it to anyone wanting to find out more about the development of gynaecological practice.

What would you do to strengthen the history of science as an academic discipline?

I think encouraging diversity within the field is crucial. I would focus on different forms of community engagement to inspire the next generation of researchers. Establishing a mentoring programme could be a good way of supporting and encouraging people from all walks of life to participate in the history of science.

How do you see the future shape of the history of science?

I would love to see the history of science featuring more prominently in non-specialist degrees at universities. As an English student, I was fortunate enough to be able to take modules on the history of medicine. I hope that in the future, interdisciplinary modules become more widely available, so that everyone has the opportunity to be inspired by something outside of their usual subject area. •

The British Journal for the History of Science

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- Xiaoxing Jin, 'Translation and Transmutation: the Origin of Species in China'
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- Sophie Weeks, 'Francis Bacon's Doctrine of Idols: A Diagnosis of "Universal Madness"'
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Viewpoint: the Magazine of the BSHS

Contributions

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