Digging deeper – issue 5, March 2025

A quarterly newsletter highlighting how the ICE archive helps deepen understanding of our heritage for the engineers and researchers of today.

Contents

Welcome

By Carol Morgan and Mike Chrimes

Last year was busy with visitors back to pre-Covid numbers and commemorations for the 300th anniversary of John Smeaton and this year looks to be just as busy. We carried out a lot of research relating to Smeaton last year and this is a bit of a bumper Smeaton issue with a piece by one of our archive volunteers on what we've learnt from Smeaton's machine letters or copy correspondence. Also a piece on how the drawings held by the Royal Society complement our records.

It is always interesting to find out more about our past members and this is certainly the case with Aeneas Coffey, a name which might not be familiar. Certainly, we didn't know much about him other than he was elected ICE Associate on 6 February 1844 as `from his general knowledge of mechanics and his scientific knowledge as a chemist he has introduced great improvements in the art of distillation'. Luckily, we can rely on our researchers to fill in the blanks and Donard and Dominic De Cogan have written a piece on Coffey.

We like to support and collaborate with our colleagues and in this issue Hannah Little gives us a view of the Clifton suspension bridge museum and archive.

This year we will be preparing to celebrate Rail200, commemorating the bicentenary of the opening of the Stockton and Darlington railway, so expect to see interest in early railways as well as preparation for the Menai Suspension bridge anniversary early next year.

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Learning about John Smeaton from his correspondence

By Mervyn Carter, ICE volunteer

Introduction
During a 12-month period largely in 2024 (to coincide with the tri-centenary of his birth) I had the privilege of studying the four volumes of John Smeaton's machine (copy) letters held in the ICE archives. For information regarding the copying process, see ICE blog: A peep into Smeaton's world: the invention of the copying press. The purpose of my work under the guidance of the ICE Archivist, Carol Morgan, was to update the ICE records and produce a digital record summarizing these letters which could be accessed by Members and researchers on-line. This is now attached to the catalogue record

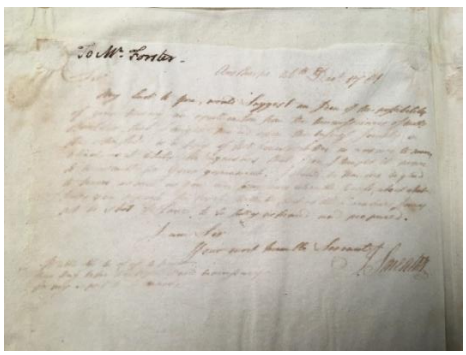
It was also one way of marking the 300th anniversary of John Smeaton's birth.

This work has given me an insight into John Smeaton's activities and character, which I am happy to share here. I have tried to understand the Professional Man. I have left technical study of his work to others. In my view he remains a worthy role model for the professional Civil Engineer in the 21st century seeking excellence and integrity.

The letters, reports and accounts in the ICE archives total nearly 500 items and cover the period December 1781 to January 1790. They were acquired by the ICE in 1886 and rebound in 1902. Sadly, the volumes are not in strict chronological order and there is considerable evidence that a number of letters have been removed and lost at some time, possibly during rebinding.

Full transcripts of some letters were carried out by a previous researcher, Stephen Buckland, in the early 1960s, and these are held by The Mills Archive Trust at Watlington House, Reading, RG1 4RJ. (Their ref: JSP-1125 733 for Vols 1 & 2, and JSP-1125 734 for Vols 3 & 4). These were consulted during our current research and copies have been acquired by the ICE. These will eventually be transcribed again to create a digital transcript of many of the letters. **If you would like to help with this, please contact the archivist.**

It should be noted that the ICE machine letters are of widely varying quality partly due to the copying process, the skill of the copier, and of course the passage of time. The copying process of the 18th century could be rather hit and miss. Consequently, many letters are partially or completely illegible and therefore it may be that I misunderstood the content of a particular letter. These errors are mine. Reading John Smeaton's handwriting was certainly an acquired art. That of his assistant, Henry Eastburn, who wrote some letters on John Smeaton's behalf, was certainly much better!



An example of a very faded letter

Overview
To modern eyes his letters may seem particularly verbose and repetitive. Sometimes the first third is spent detailing the chain of correspondence leading to the current reply. Often this is made worse as letters chased JS around the country on his many travels. On one occasion there were significant forwarding charges which JS sought to recover from his client!

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However, the technical content was always firm, consistent and accurate. Where letters were to friends or regular correspondents, they often started with thanks for recent hospitality and concluded by best wishes for the recipient's Wife and family. Health and ailments also often merited a sentence or two. JS was often in poor health and was reluctant to take journeys in the winter when he was susceptible to colds and flu (e.g. letter to Mr Henn 30 December 1782 [1]). Taken all round, however, his letters exhibit a good Work/Life Balance with family life remaining very important.

The breadth of knowledge and depth of expertise illustrated in his letters is remarkable from mills, both wind and water, to steam (''Fire'') engines, pumps, bridges, docks and harbours and of course lighthouses. Even beer cellars get a mention at Whitbread's brewery in Chiswell St (this venue still exists). (see letter to Mr Whitbread 28 August 1782[2]). And his interest and practical involvement in the field of astronomy should not be forgotten.

Expert and direct involvement in the Theory and Practice of Engineering
Design: John Smeaton was at the forefront of design knowledge in many areas as his presentations to the Royal Society would demonstrate. In addition, in the ICE letter books there are detailed papers on the design of steam engines clearly offering performance improvements. There is evidence of a dialogue with Boulton and Watt with a view to using their patents, which, although rejected, remained an amicable dialogue. His experiments with wind and waterpower advanced current knowledge and his letters reflect detailed comments on sizes and types of timber and iron components and pipe and pump requirements. He thought from first principles the best solutions, for example in pile and cofferdam design. And for something completely different 'Fine tuning a Gregorian Reflecting telescope' (Letter to Rev'd Milluhell 21 September 1785 [3])

Experiments (workshop): JS built a workshop at his home in Austhorpe where he was able to carry out a variety of tests and build models for his projects and verify his theories.

Material Science and selection of materials: There are several examples in correspondence of JS taking a direct interest in the selection of appropriate materials. On the Eddystone light for example the need for a mortar which would set underwater involved not only selection of aggregates but also which quarry to use to supply limestone and the appropriate mix to use. In another area he advised on the best oil ('oyl') to use to protect iron from the Carron Works from corrosion in transit to site.

Construction Supervision: JS's involvement with his projects did not stop with design and he took a direct interest in construction matters often working closely with the workmen on site. Both the Eddystone Light and Ramsgate Harbour provide good examples of this.

Delegation: Although it is clear from his letters that JS worked largely in sole practice, as his workload and geographical spread of his projects increased JS clearly understood and made great use of delegation to worthy assistants. This became an essential feature during construction ensuring that the quality of his designs was maintained in practice.

Fees, payments and charges
John Smeaton's charges remained remarkably consistent throughout his working life with fixed prices for each type of mill, wind, water and for what purpose. Such fees included a set of drawings. For some reason windmills were 5 guineas more than water at 30 and 25 respectively.

He had also had standard daily rates of 2 ½ guineas with discounts by the week and so on. London fees at 5 Guineas, (e.g. Letter to Mr Meredith 16 September 1782 [4]). Expenses were generally included but some travel costs by coach and chaise were extra. Daily and weekly charges quoted to Jersey Harbour seem particularly high, perhaps he didn't want the work. Some other daily charges were much higher, possibly for parliamentary work, for example letter to Mr John Smith 5 June 1782[5] gives £10 a day or £15 for 2 days all expenses included.

Two significant points emerge from his letters on payments. Firstly, he had few disputes about payment and appeared to be promptly paid in the main. Although where a client was late JS was not averse to writing a stiff 'final demand'. There was an amusing dispute where only £30 was paid instead of 30 guineas. JS did not let it go! (Letter to Mr Smith 15 January 1783 [6]).

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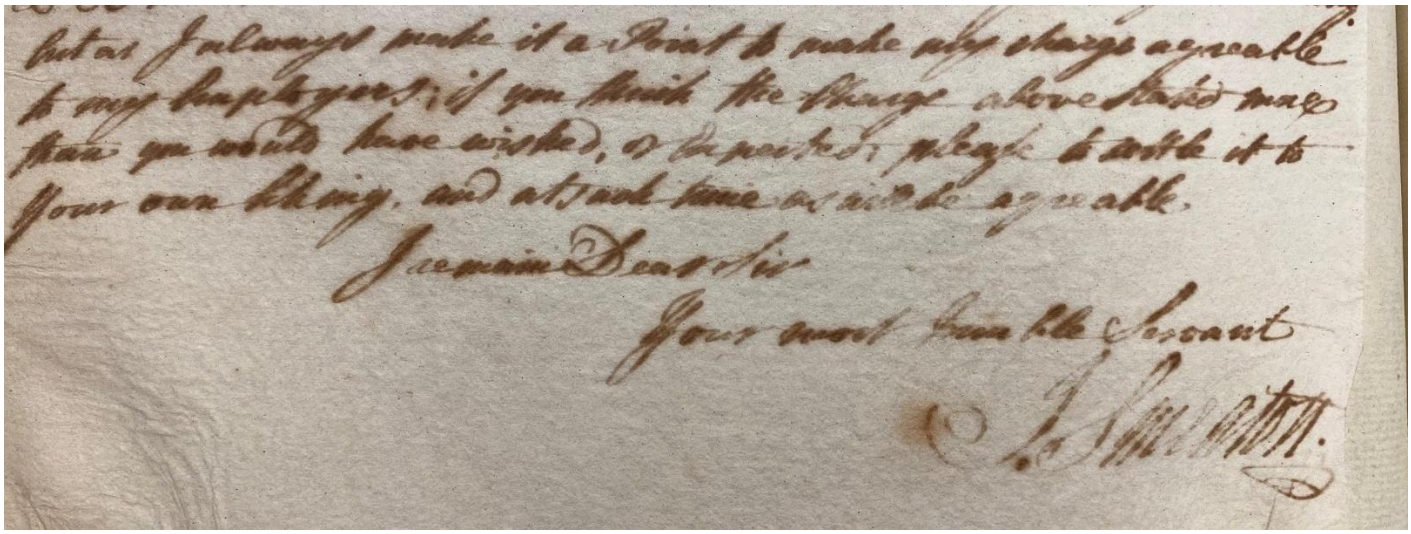
In the absence of a modern ‘clearing bank’ system it would be interesting to understand better how money was transmitted around the country. JS appears to have made great use of his good friend Holmes and his separate watchmaking business to turn his ‘Bills’ or ‘drafts’ into cash.

Secondly, whilst disputes were very rare JS made generous offers to more than one client to reduce his charges to what they thought reasonable, either if too expensive or technically not satisfactory. A very professional approach! (e.g. to the Carron Company 2nd February 1782,[7] and to Mr Smith 17 January 1783[8])



`but as I always make it a point to make my charges agreeable to my employers; if you think the charge above stated more than you would have wished, or expected, please to settle it to your own liking, and at such time as will be agreeable’ letter to Mr Smith.

A view on training of Assistants

JS had a surprisingly modern take on the benefits or otherwise of assistants. (See letter to Mr Galton Junior 15 January 1783[9]) ‘Once trained they go off and set themselves up as rivals in business.’ He had only 2 apprentices in his career, both of whom stayed for 14 years rather than the customary 7. However, during his career, he took good care of those assistants he had trained and valued, using them to supervise onsite his own projects and recommending some to his own clients when he was too busy to take on further work. He made great use of Henry Eastburn as his office assistant in both technical and administrative matters. Henry’s writing is much easier to read than JS and he was clearly more proficient with the machine letter copying system!

Reputation and Repeat business

John Smeaton developed a reputation any modern Civil Engineer would be proud of. He became the preferred Engineer in so many contemporary and major undertakings. It is perhaps illustrative of his modesty that he was particularly hard hit by the failure of Hexham bridge during an exceptional flood in March 1782. He took it very personally stating in his letters ‘that it cannot now be said that in the course of 30 years practice and engaged in some of the most difficult undertakings not one of Mr Smeaton’s works has failed’ (e.g. letter to Mr Pickernell 6 June 1782 [10].)

His other designs were not without fault, sometimes taking a while for modifications to bed them in. For example, his first Fire Engine was less than successful and some of his harbour designs required side effects to be designed out. This was to be expected since he was operating at the frontiers of knowledge and frequently advancing them. (no better example being the success of the Eddystone Light).

However, the best measure of his excellent reputation is the extent he attracted repeat business over his lifetime, sometimes decades after his first design the descendant of his first client would ask for another. No advertising was necessary.
An example we could all follow.

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Sources
For further study a comprehensive record of John Smeaton's life and works may be found Prof. A.W. Skempton's (editor et al) book 'John Smeaton, FRS, first published by Thomas Telford Limited in 1981. Copies available in the ICE Library.

References

1. SM/ML/1/131
2. SM/ML/1/89
3. SM/ML/2/135
4. SM/ML/1/105
5. SM/ML/1/61
6. SM/ML/1/146
7. SM/ML/1/31
8. SM/ML/1/146
9. SM/ML/1/148
10. SM/ML/1/66

Royal Society and ICE Archives working together: How Smeaton's drawings complement his correspondence

By Carol Morgan

As you have just read, we are lucky enough to have John Smeaton's letter book of 1764 and 4 volumes of machine letters, as well as printed volumes of his reports in the ICE archive collection. However, as you will also have gathered, the manuscript letters are not always easy to read, and Smeaton himself recognized the value of drawings to help explain his ideas. He wrote to Mr Weston `The rudest draft will explain Visible things better than many words[1].

Smeaton's drawings
During his life, John Smeaton (1724-1792) must have produced thousands of drawings. After Smeaton's death, in 1792, Sir Joseph Banks, President of the Royal Society bought his manuscripts, drawings and letter books. The Smeatonian Society later published his engineering reports, illustrated by some of the drawings. This work was carried out by John Farey Snr and Jnr., and Edward Farey, the latter leaving the drawings to the Royal Society in 1913.

According to a note by John Farey jnr. in volume 1 of the drawings, Smeaton `made all his drawings with his own hands'. Even after he had become more established and employed a draughtsman `he still continued to draw the lines of all his drawings to the proper scale on cartridge paper'.[2]

The drawings catalogue
In 1948 the Newcomen Society used a legacy to produce a printed catalogue of the drawings. There is a copy in our library which enables us to see how the drawings complement our collection of letters and reports.
As well as comments by the editor, the catalogue references notes made on the drawings by Farey. Quite a few drawings are linked to the volumes of published reports, and a few relate to the volumes of Machine letters held in our archive.
So, with a list of references in my hand, I duly visited the Royal Society archive to see what else I might discover.

Exploring the volumes
The drawings are bound in 6 volumes, according to subject. The pages or folios are numbered with drawings on the back of sheets identified with a `v' for verso. The references I required were in volumes 2 and 4.

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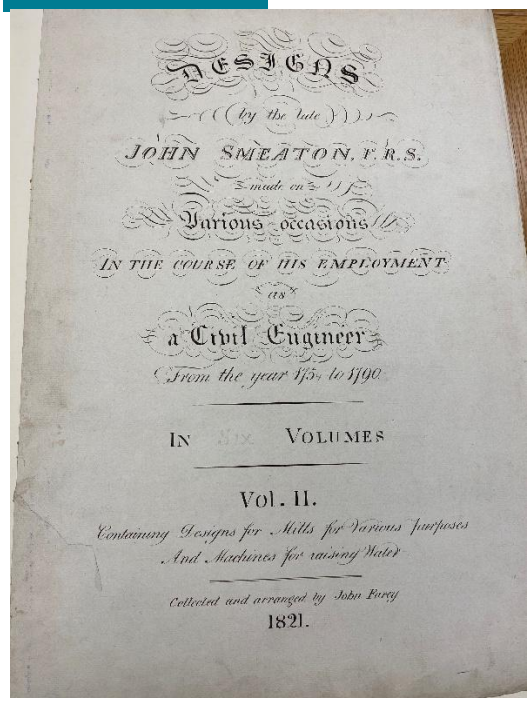

Title page, and selected other illustrations, courtesy of The Royal Society

The drawings are mainly final copies, as Smeaton wrote: `I do not think it within the compass of human knowledge, to form the best possible Design at once. Things are far better finished by touching and retouching as is usual, and necessary to the greatest Painter.' [3] There are a few rough drawings, including this one which is labelled `Scetches [sic] for Larbet dam …..'

Smeaton drawing Larbet dam apron, 1773 [Royal Society Smeaton drawings JS/2/62av]

This dam was one of several built for the Carron ironworks, Stirlingshire.

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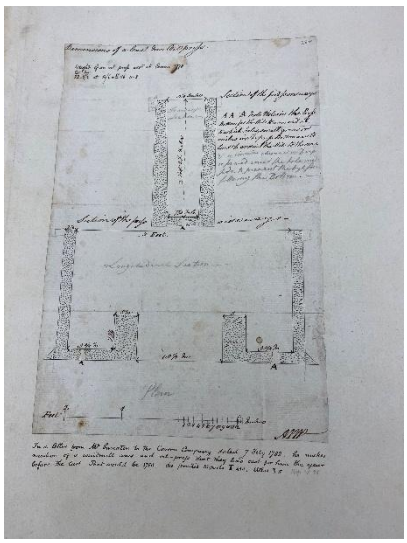
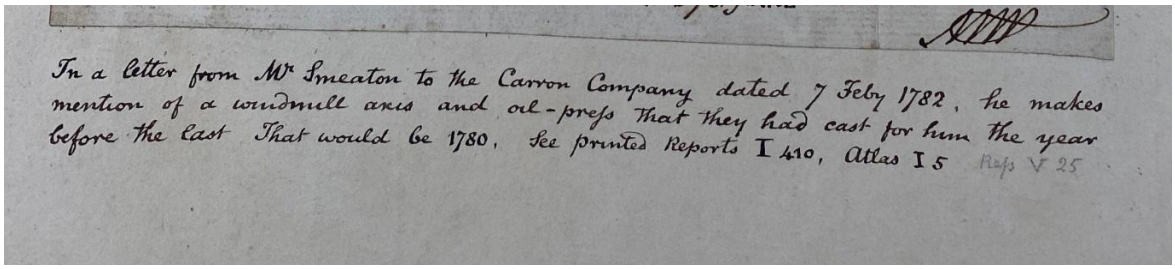
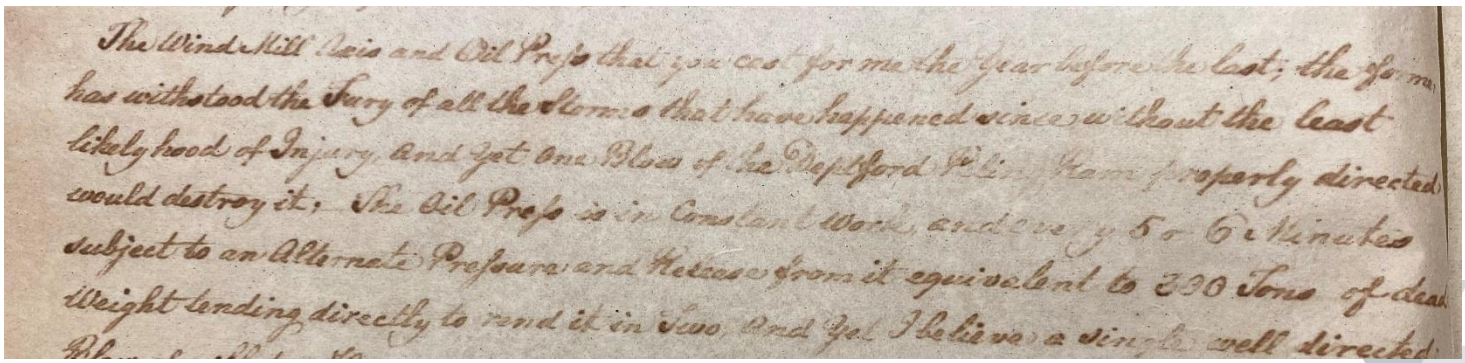
Larbet dam, ICE Panel for Historical Engineering Works
There are a few letters to the Carron Company ironworks in the Machine letter volumes, although nothing this early.

Links to the machine copy letters.
Most of the drawings were produced before Smeaton started using a letter copying press to produce copies. However, on a drawing of a cast-iron oil press, 1778, Farey refers to a letter to the Carron Company dated 7 February 1782. In this, Smeaton mentions an oil press the company made for him two years earlier. Presumably this was for extracting oil from olives or seeds, but no details of the client are mentioned.





Carron oil press and Farey's comment, signed 1778, [Royal Society Smeaton drawings JS/2/28v]



Extract from letter to Carron company referring to the oil press [SM/ML/1/25-28, p26], ICE Library and Archive.

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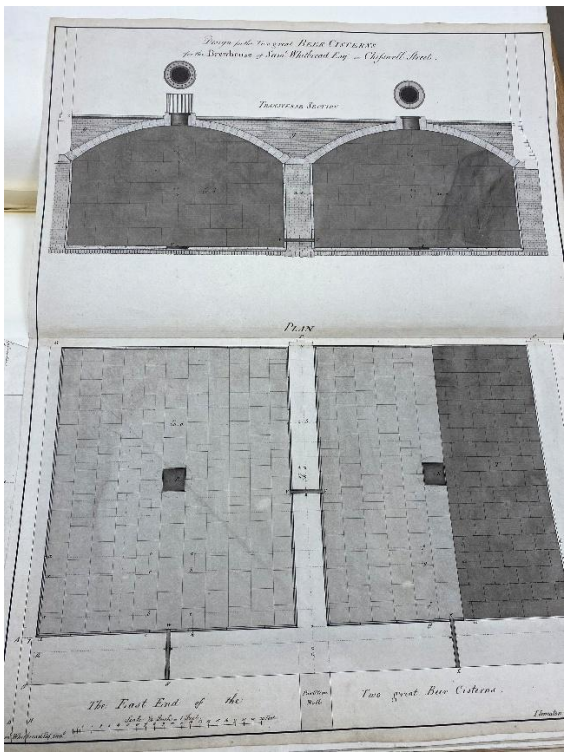
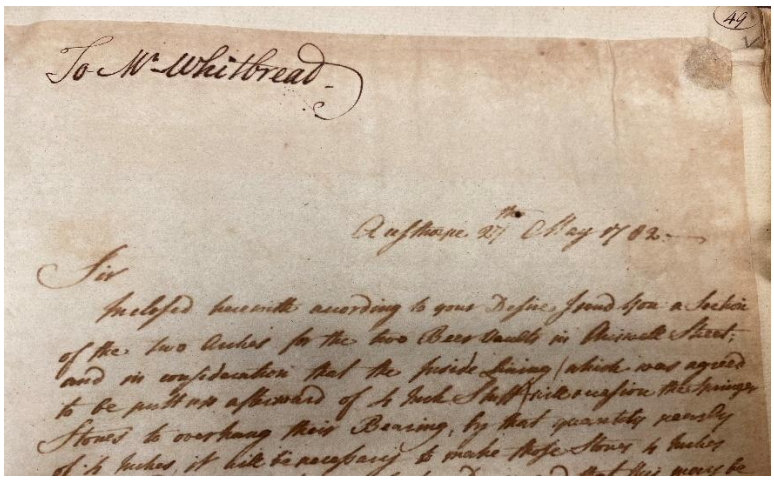
Whitebread's beer cisterns

Not all relevant Machine Letter references have been listed in the drawing catalogue, for example there are 4 drawings of the great beer cisterns designed for Samuel Whitbread's brewery at Chiswell Street. Smeaton mentioned these in a letter to Whitbread:



Beer cisterns, signed 1782 [Royal Society Smeaton drawings JS/4/52v-54v]



Letter to Mr Whitbread enclosing drawing of a section of the two arches for the beer vaults in Chiswell Street [SM/ML/1/49, 25 May 1782] ICE library and archive

An example of a copy press drawing.
Most of the drawings are by hand, however, the design for a coffer dam for the foundations of Harraton Bridge is a press copy. Last year, I wrote a blog referring to the difficulties Smeaton encountered when trying to make copies of his drawings in this way.

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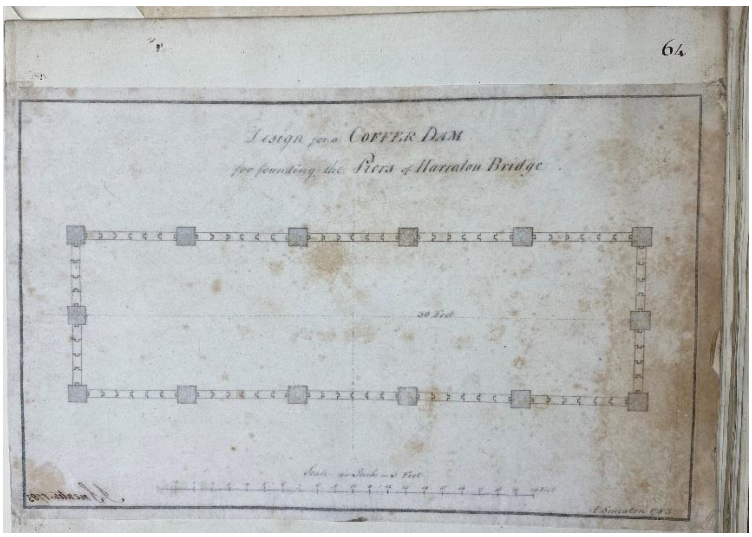
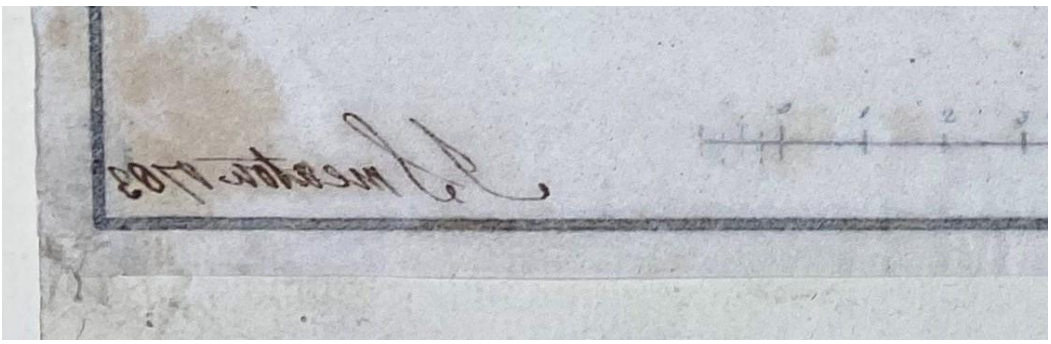
Smeaton had complained to James Watt that the ink was not as dark as when Watt demonstrated it and certainly this copy is fainter than the drawing which accompanies it. I've since found out from a letter in the James Watt papers, held by Birmingham Central Library, Watt replied saying Smeaton should have used the ink sooner and shaken the bottle before using [4]. The ink may well have continued to fade after use.

The copy is produced by pressing the original, drawn with slow drying ink, against a sheet of thin paper. The copy is then normally read through the back of this second sheet, so that the image appears as in the original. However, in this case, heavier paper has been used, with little transparency, so the image is reversed. This meant that any labelling was added after the copy had been made, but Smeaton had obviously signed the original and his signature appears backwards. Despite being faint, the copy has retained detail from the primary drawing.



Copy press drawing of design for a coffer dam for founding the piers of Harraton Bridge, signed 1783. [Royal Society Smeaton drawings JS/4/64]



Detail showing Smeaton's reversed signature.

A break from the grey
Almost all the drawings have been washed or shaded using shades of grey, however I did discover several relating to a bridge near Newcastle upon Tyne which had a little more colour.

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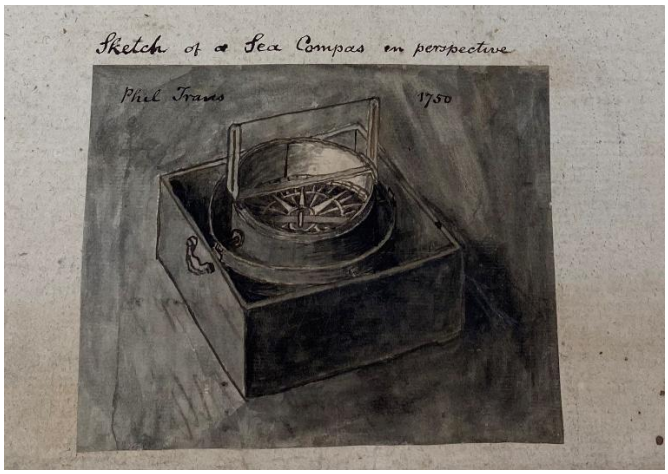
Sections of the river bed at 3rd, 4th and 6th piers of Tyne bridge, Newcastle, 1771 [Royal Society Smeaton drawings JS/4/67v]

The earliest drawings

Whilst looking for engineering drawings, I came across some illustrations in volume 4 relating to clocks and watches as well as a mariner's compass. These reflect Smeaton's early experience as a scientific instrument maker. This sketch appears to have been prepared for the Royal Society's Philosophical Transactions.



Mariner's compass, c.1750 [Royal Society Smeaton drawings JS/4/29v]

More to discover

Farey's notes also refer to a general letter book, letters received, letters sent and Reports and Estimates Books. The catalogue notes these are missing; perhaps they may reappear in the future. Luckily many of his reports were published in journals, including the Philosophical Transactions of the Royal Society and of course we have the four volumes of published reports.

Find out more:
Many of Smeaton's drawings are available to view at: https://pictures.royalsociety.org/home
Catalogue of the drawings A Catalogue of the civil & mechanical engineering designs 1741-1792 of John Smeaton, F.R.S. preserved in the Library of the Royal Society.

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Smeaton's Machine letters, with list of contents ``Machine" letters. 4 vols. 1781-90.
Smeaton's machine letters blog A peep into Smeaton's world: the invention of the copying press

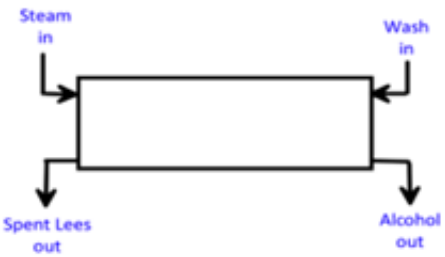
References:
1. 1764 letter book, 1 August, ICE Library and Archive
2. Smeaton drawings, JS/1, Royal Society Library and Archive
3. SM/ML/3/106, 22 July 1891, ICE Library and Archive
4. James Watt Papers, Letterbook 1, J Watt to J Smeaton, 27 April 1783, Birmingham Central Library

Aeneas Coffey and his contribution to fractional distillation

By Donard de Cogan: School of Computing Sciences UEA, Norwich (retired)

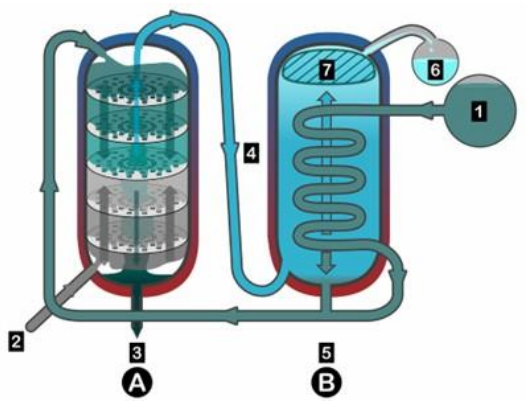
Dominic de Cogan: Law School, Cambridge University

Aeneas Coffey started his career as an Excise officer in Ireland with responsibility for closing down illicit (poitín) stills. In the period up to 1823 he undertook inspections of various items of equipment intended to reduce the possibility of avoiding payment of duties by distillers and in many instances, he made significant suggestions for their improvement. In 1823 the Government recognised that the existing Excise Act was flawed, and Coffey and his brother-in-law were asked to compare the technologies used by legal distillers in Ireland and Scotland. The wording of their report formed the basis of the 1823 Spirits Act. Shortly afterwards Coffey resigned from the Excise service and established himself as a distiller in Dublin. In 1830 he applied for and obtained a patent for a system for continuous distillation of spirits. This was basically a two phase counter-flow system.



Picture 1

The implementation involved two chambers termed the 'Analyser' and the 'Rectifier' as shown in the diagram adapted from https://commons.wikimedia.org/wiki/File:Column_still.svg



A Analyser
B Rectifier
1. Wash in
2. Steam in
3. Spent lees out
4. Alcohol vapour
5. Recycled less volatile components
6. Most volatile components
7. Condenser

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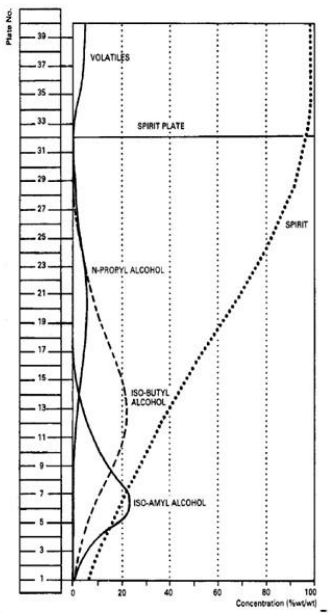
Steam entered the Analyser at 2 in the diagram above and heated the fermented wash which contained about 4% alcohol. The rising vapours transferred via 4 to the Rectifier where it was condensed by the effect of the cold wash entering the system at 1. In return, the wash was heated as it transferred to the Analyser. What the diagram above does not show is the fact that vapours rising up through the Rectifier passed through a series of trays with bubblers, which allowed the possibility of fractional distillation. These trays were termed 'plates' and the number of plates required to reach a certain level of condensate purity is still a term used in distillation theory. Ethyl alcohol at about 95% ABV was collected at tray 32, whereas other alcohols (reputed to be responsible for hangovers) were collected further down the column.



There is an early Coffey still on display at Kilbeggan distillery in Ireland

In order to adequately exploit his patent, he moved his operation from Dublin to London. At the time the Coffey still provided a great boost to the Whisky industry in Scotland. However, the fractional distillation aspects of his invention continue to have massive importance to the present time in industries such as petroleum refining.

Sources:

E.J. Rothery Æneas Coffey (1780-1852) Annals of Science 24 (1968) 53-71

Dominic de Cogan and Donard de Cogan Aeneas Coffey and the role of tax in the emergence of Modern Whiskey in "Studies in the History of Tax Law volume 11" Eds Peter Harris & Dominic de Cogan, Hart Publishing 2023 (ISBN 978-1-5099-6326-3)

Clifton Bridge Museum and Archives

By Hannah Little

Clifton Suspension Bridge Museum welcomes tens of thousands of visitors each year. As a heritage organisation, we are entrusted with preserving and looking after the history of the bridge and ensuring that the bridge's story is available for every visitor to explore and enjoy.

Supported by our team of friendly volunteers, our free museum is open every day from 10am to 5pm. The exhibition tells the story of

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Clifton Suspension Bridge; from its conception in 1753, to Isambard Kingdom Brunel's winning competition design, to its opening in 1864 and how it is maintained today.

Key items on display range from an original piece of iron bar used by Brunel to transport people and materials across the gorge during the bridge's construction, a rare sketch showing the building of the vaults, original tickets for its opening 1864 ceremony, to a 1920s engineer's notebook.

We also have an archive. This consists of records created and received by Clifton Suspension Bridge Trust and its predecessors, and consists not only of usual organizational records, such as minutes and financial accounts, but also technical records, drawings and research papers. A significant proportion consists of material created by the Bridge's most long-standing engineering consultant, Howard Humphreys (and his company's successors) who held this position from 1910 to 2006.

Copyright: Architectural Thread Ltd

It is not only the bridge's engineering that is documented. Clifton Suspension Bridge is an icon of Bristol and has always been an important tourist attraction. We hold a collection of Victorian and early twentieth century souvenirs, photographs, guidebooks, postcards, news cuttings and objects commemorating celebrations and documenting events in and around the Bridge – including its 1864 opening – and more recent events such as the last flight of Concorde.

View of the bridge

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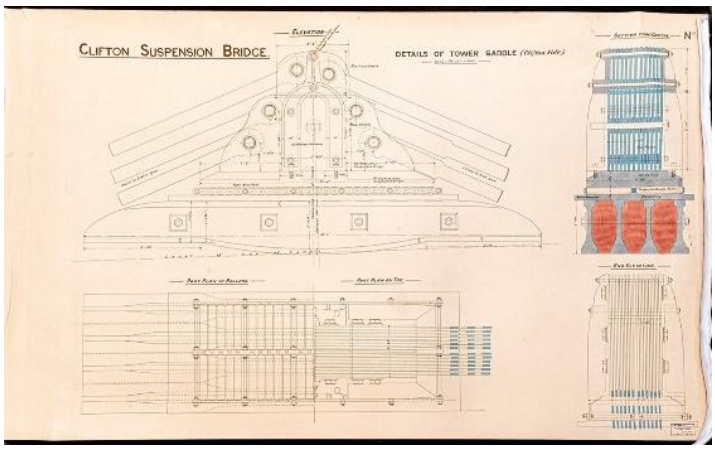
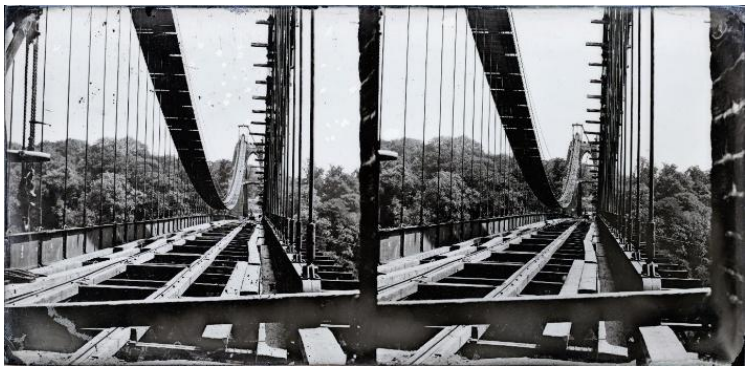


We also look after the Adrian Andrews collection. Entrusted to our care by the late bridge historian and author, the collection consists of research notes and prints, news cuttings and photographs relating to not only Clifton Suspension Bridge, but also bridges from across the globe. For instance, included are over 200 stereoscopic photographs that offer a visual record of the construction of Clifton Suspension Bridge in the 1860s and bridges that no longer exist, such as Brunel's Hungerford Bridge and the Niagara railway bridge.



Stereoscope image

Images and descriptions of our collections are available online for the public to research for free at https://archives.cliftonbridge.org.uk/ and we have a reading room for people to access our collections by appointment.

If you wish to know more, all enquiries should be directed to Bridge Archivist, Hannah Little, Clifton Suspension Bridge Trust, Bridge Road, Leigh Woods, Bristol BS8 3PA. Email: archives@cliftonbridge.org.uk

Recent acquistions and newly listed material

Docwra company photo albums

We have received 2 albums containing photographs relating to the Docwra company. The first belonged to Charles Preston Gibbons and will complement a set of notebooks we hold by him. The photographs include Canada Docks, Hopetown Bridge South Africa, an unidentified Russian Bridge and Ernest Docwra's Belsize car with passengers.

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The second album was presented to Colin Docwra by the employees of the firm of Thomas Docwra and Son `in commemoration of the successful termination of the recent action in the Court of Chancery before V.C. Bacon as to surplus capital', 1885. The album contains portrait photographs, presumably of members of the company. V.C. Bacon would be Sir James Bacon (1798-1895), Vice-Chancellor of the Court of Chancery, retired in 1886.

Page from the Docwra album, all the photographs appear to have been taken by F.A. Bridge, photographic artist, East Lodge, Dalston Lane, London.

We hope you have enjoyed this newsletter. If you have any comments, would like to submit an article, or appear as a guest archive, please contact us: archive@ice.org.uk.

Follow us on X @ICELibrary to see more of our collections.

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