AccessionIndex: TCD-SCSS-X.20121208.001
Accession Date: 8-Dec-2012
Accession By: Prof.J.G.Byrne
Object name: Charles Babbage's Engines
Vintage: c.1843
Synopsis: Irish interactions with Charles Babbage regarding his Difference Engines and Analytical Engine.

Description:
Professor John Gabriel Byrne retained an abiding interest in the history of computing down the ages, and in particular in Charles Babbage's and his engines. He collected works by Babbage and about him, and very importantly Ada Lovelace's famous translation of Menabrea's description of Babbage's Analytical Engine, see the list of collected items below and the Literature category of this catalog.

Babbage visited Ireland three times, and had a number of close friends from Ireland, who while not contributing at all to Babbage's enormous personal achievements, did interact in interesting ways with his efforts.

Babbage was first and foremost a first-class mathematician. He, Herschel and Peacock founded the Analytical Society in 1813 (and promoted the modernisation of teaching of mathematics in these islands) and the Astronomical Society in 1820. His deep understanding of finite differences informed his design of his Difference Engines.

Babbage's interest in calculating machines arose from his frustration in calculating large sets of mathematical tables and the errors that arose (exclaiming to his close friend Herschel "*I wish to God these calculations had been executed by steam*"). In 1823 he started working on his Difference Engine No.1, a fully automatic machine to calculate and print numerical tables, for example for astronomy, navigation, finance and business. He wrote to Humphry Davy indirectly asking for government support of his efforts. The government passed the letter to the Royal Society, who responded that he was highly deserving of public encouragement. He was eventually granted very substantial funding. Over the next decade he faced serious difficulties developing new machining techniques as well as the death of his wife and several of his children.

Remarkably, in 1827 in the midst of this, prompted by his friend Lt.Col.Thomas Frederick Colby of the Irish Ordnance Survey (another founder of the Astronomical Society), who wanted a compact set of field tables, Babbage created a greatly improved table of logarithms, a major achievement in itself, by comparing many existing tables, and where different, recalculating the correct value.

By 1832 a part of the Difference Engine No.1 had been completed. Then Babbage and his engineer Joseph Clement disagreed about compensation for moving the workshops to fireproof accommodation close to Babbage's house. Clement quit the project in 1833 and construction never resumed. Babbage could not recover the construction plans or tools, which were by law owned by his engineer; his efforts stalled and the government froze his funding, finally abandoning it in 1842. By then it is estimated Babbage had spent £17,000 of government funding and £20,000 of his own funds. Fortunately he had married an heiress then inherited a fortune from his father.

An Irish scientific writer, Dionysius Lardner, a TCD graduate who became the founding professor of natural philosophy and astronomy at University College, London, wrote about and popularised science and technology, and was influential in publicising Babbage's Difference Engine. In 1834 he wrote the lectures for the national tour of the Difference Engine, and an article for the Edinburgh Review. Reading the latter, Georg Scheutz and his son Edvard Scheutz began a simplified design in Stockholm, which was demonstrated in 1855, and ironically purchased by the British government in 1864, during Babbage's lifetime. Sixty years later Percy Ludgate disclosed a very different approach to difference engines [17].

With his Difference Engine No.1 stalled, Babbage conceived a much more ambitious machine, the Analytical Engine. This was a general purpose programmable machine able to find values for any algebraic function. It was never built, but represents the first conception of a machine able to do what modern computers can.

In theory the Analytical Engine is as capable as any modern computer (it is Turing complete), although most problems would be intractable on it, i.e. they would take far too long to execute. In modern terms it has been said to have a register-to-register architecture with two accumulators and memory for 1000 decimal sign-magnitude 50 digit numbers, but this is a fairly suspect statement. Alan Bromley [2] discussed this:

> It is tempting in describing the Analytical Engine to use modern terms such as **register** and **microprogram** in place of Babbage's **axes** and **barrels**. There is some risk in doing so because Babbage's elements differed in detail from their modern equivalents and had, in consequence, different functional characteristics.

So while Babbage's axes might be said to be registers, there is not a one-to-one correspondence, as for example they could store more than one number. In the Analytical Engine the memory (*Store*) is separate from the computation. The engine was programmed by punched cards, an idea taken from the very widely used Jacquard weaving loom, and the control unit (the *Mill*) used an analogue of microprogramming (Wilkes, said to have invented microprogramming c.1951, discovered this c.1971).

Prof.James MacCullagh, professor of mathematics at TCD, a valued friend, was very much interested in the Analytical Engine. In 1840 he was persuaded by Charles Babbage to join him at a meeting of the Italian Physical Society in Turin:

> *An excellent friend of mine, the late Professor MacCullagh, of Dublin, was discussing with me, at breakfast, the various powers of the Analytical Engine. After a long conversation on the subject, he inquired what the machine could do if, in the midst of algebraic operations, it was required to perform logarithmic or trigonometric operations.*
>
> *My answer was, that whenever the Analytical Engine should exist, all the developments of formula would be directed by this condition—that the machine should be able to compute their numerical value in the shortest possible time. I then added that if this answer were not satisfactory, I had provided means by which, with equal accuracy, it might compute by logarithmic or other Tables.*
>
> *I explained that the Tables to be used must, of course, be computed and punched on cards by the machine, in which case they would undoubtedly be correct. I then added that when the machine wanted a tabular number, say the logarithm of a given number, that it would ring a bell and then stop itself. On this, the attendant would look at a certain part of the machine, and find that it wanted the logarithm of a given number, say of 2303. The attendant would then go to the drawer containing the pasteboard cards representing its table of logarithms. From amongst these he would take the required logarithmic card, and place it in the machine.*

Upon this the engine would first ascertain whether the assistant had or had not given him the correct logarithm of the number; if so, it would use it and continue its work. But if the engine found the attendant had given him a wrong logarithm, it would then ring a louder bell, and stop itself. On the attendant again examining the engine, he would observe the words, "Wrong tabular number," and then discover that he really had given the wrong logarithm, and of course he would have to replace it by the right one.

Upon this, Professor MacCullagh naturally asked why, if the machine could tell whether the logarithm was the right one, it should have asked the attendant at all? I told him that the means employed were so ridiculously simple that I would not at that moment explain them; but that if he would come again in the course of a few days, I should be ready to explain it. Three or four days after, Bessel and Jacobi, who had just arrived in England, were sitting with me, inquiring about the Analytical Engine, when fortunately my friend MacCullagh was announced. The meeting was equally agreeable to us all, and we continued our conversation. After some time Bessel put to me the very same question which MacCullagh had previously asked. On this Jacobi remarked that he, too, was about to make the same inquiry when Bessel had asked the question. I then explained to them the following very simple means by which that verification was accomplished.

…

On mentioning my intention to my excellent friend the late Professor MacCullagh, he resolved to give up a trip to the Tyrol, and join me at Turin.

We met at Turin at the appointed time, and as soon as the first bustle of the meeting had a little abated, I had the great pleasure of receiving at my own apartments, for several mornings, Messrs. Plana, Menabrea, Mossotti, MacCullagh, Plantamour, and others of the most eminent geometers and engineers of Italy.

It is of course Menabrea's description of Babbage's Analytical Engine that Ada Lovelace later translated and extended in her famous monograph. James MacCullagh had in Feb-1842 urged Babbage to have it published (see Figures 22-23); the paper appeared in the *Bibliothèque Universelle de Genève* in Oct-1842.

Ada had become an enthusiastic supporter of Babbage's Analytical Engine after Mary Somerville, one of the rare contemporary female mathematicians and scientists, took 17-year-old Ada Lovelace, daughter of Lord Byron, to meet Charles Babbage, who showed Ada his working model of the Difference Engine. In 1843 she published a very much extended translation from the French of the paper written by the Italian engineer (and later Prime Minister) Count Luigi Federico Menabrea about Babbage's Analytical Engine. See the list of collected items below and the Literature category of this catalog.

Babbage was a friend of both Faraday and Wheatstone, so had they all lived just a little later the Analytical Engine might have been designed with electrical technology. In the early 1840s, after Babbage seeing Wheatstone's telegraph equipment, he briefly considered this but it seems the technology was not sufficiently advanced at the time.

In the event, the Analytical Engine was never built (to begin with, typically Victorian, it would be huge). The wealthy Joseph Whitworth (of *Whitworth Threads* fame), the world's leading manufacturer of machine tools (who in his youth had worked under Babbage's engineer Joseph Clement on the Difference Engine No.1) offered to help in building an Analytical Engine, but Babbage declined because government funding would still be needed. As late as 1878 a committee considered the advisability of constructing it, reporting at that year's meeting of the British Association for the Advancement of Science, again held in Dublin [6].

With hindsight from his work on the Analytical Engine, in 1847-1849 Babbage designed an improved Difference Engine No.2, able to calculate more quickly while using one-third as many parts.

Babbage was a leading figure in the formation of the Astronomical Society of London and read several papers there. William Parsons, 3rd Earl of Rosse, of Birr Castle in Ireland, a TCD graduate and eventually Chancellor of TCD, who was an especially talented engineer and astronomer, considered that Babbage's work had already benefited the economy many multiples of the state funding, principally through new approaches to precision machining. When he became President of the Royal Society in 1848, the Earl, who was a Whig, helped Babbage to lobby Lord Russell and his government for funding to build the Difference Engine No.2, but in 1852 the Whig government collapsed and was replaced by the Tory opposition led by Lord Derby. The Earl then persuaded Babbage to offer his plans to the state in exchange for a guarantee it would be built, and this proposal by Babbage was accompanied by letters of support from the Earl, James Nasmyth (who confirmed the previous benefits to industry) and John Herschel, but Derby and his Chancellor, Benjamin Disraeli, quickly rejected the offer. Then Derby's government collapsed too. Babbage was incensed at the exclusion of himself and his Difference Engine from the Great Exhibition of 1851, and wrote accordingly, which cannot have helped at all. It was 140 years before a working model was built (by Doron Swade and Alan Bromley), using contemporary materials, in time for Babbage's 1991 bicentenary [11].

At Birr Castle, the Earl had constructed 'Leviathan', a wooden telescope 58 feet long with a mirror six feet in diameter weighing four tons, all supported on walls 60 feet high. When completed, it could see further into space than ever before and revealed that some galaxies were spiral. Charles Babbage was the first person to sign the visitors' book. It has been rebuilt and is on public display and, appropriately enough, in 2016 a state-of-the-art *LOFAR* radio-telescope station is being built beside it.

Babbage was a friend of William & Maria Edgeworth of Edgeworthstown, Longford, Ireland. Maria Edgeworth was one of Jane Austen's favorite novelists, and would surely have known Chief Justice Thomas Langlois Lefroy, a brilliant TCD graduate from nearby Carrigglas Manor (and said to be Jane Austen's beau). Lefroy was interested in astronomy, visited the Leviathan on 30-Mar-1846, and wrote to his wife:

Yesterday was indeed a most interesting day. Lord Rosse and his wife were as kind to me as possible. The wonders of his telescope are not to be told. He says—with as much ease as another man would say, "Come and I'll show you a beautiful prospect"—"Come and I'll show you a universe, one of a countless multitude of universes, each larger than the whole universe hitherto known to astronomers." The planet Jupiter, which through an ordinary glass is no larger than a good star, is seen twice as large as the moon appears to the naked eye. It was all true what Doherty [a Chief Justice, more than six feet high] said, that he walked upright in the tube with an umbrella over his head before it was set. But the genius displayed in all the contrivances for wielding this mighty monster even surpasses the design and execution of it. The telescope weighs sixteen tons, and yet Lord Rosse raised it single-handed off its resting place, and two men with ease raised it to any height.

At home in Dorset Street, London, his soirees were a social highlight, usually half social and half science, with each part in separate but interconnecting rooms.

The Dorset Street Saturday evening soirees continued as regular events during the season, usually attended by two or three hundred guests: the Fittons, the Lyells, the Somervilles, the Grotes; legal friends, clerical friends, and artistic friends; any visiting practitioner of science with an introduction from one of Babbage's many friends abroad; visitors from Scotland, Ireland, one of the provincial cities or the country. At one of the evenings the young Cavour [*Founder of Modern Italy*] first met de Tocqueville [*French political thinker, who had an English wife*]. They were lively and intelligent gatherings and Babbage's drawing-room was one of the great meeting places of liberal intellectual Europe. For a decade the Difference Engine in its case of mahogany and glass could be put on display, besides being shown to the many people who came specially to inspect it.

When Babbage was a child his mother once took him to see an exhibition of machinery at Hanover Square. The exhibitor, who called himself Merlin, noting Charles's precocious interest in mechanical detail, took him upstairs to the attic workshop to see some still more wonderful automata. There he saw two silver nudes, about a foot high, the craftsman's masterpieces, still unfinished:

One of these walked or rather glided along a space of about four feet, when she turned around and went back to her original place. She used an eye-glass occasionally, and bowed frequently, as if recognizing her acquaintances. The motions of her limbs were singularly graceful.

The other silver figure was an admirable danseuse, with a bird on the fore finger of her right hand, which wagged its tail, flapped its wings and opened its beak. The lady attitudinized in a most fascinating manner. Her eyes were full of imagination, and irresistible.

In 1834 Babbage chanced on the dancing lady at the auction of the contents of Weeke's mechanical exhibition in Cockspur Street where she had lain in an attic, neglected for many years. She was in reasonable condition apart from want of polishing and he secured her for £35. He repaired and cleaned the mechanism himself, and placed he under a glass case on a stand in his dining room. Dressed by some of his female friends she was soon executing here figures at the Dorset Street parties. The dancing lady and the Difference Engine contrast nicely two sides of Babbage's character: the deep earnestness and his sense of fun. However serious Babbage might be, however deeply his interests were involved, he was never a bore.

An example is given from Babbage's *Passages from the Life of a Philosopher* [4]:

A gay but no means unintelligent crowd surrounded the automaton. In the adjacent room the Difference Engine stood nearly deserted; two foreigners alone worshipped at the altar. One of them, but just landed from the United States, was engaged in explaining to a learned professor from Holland what he had himself in the morning gathered from its constructor.

Leaning against the doorway, I was myself contemplating the strongly contrasted scene, pleased that my friends were relaxing from their graver pursuits, and admiring the really graceful movements produced by the mechanism; but still more highly gratified at observing the deep and almost painful attention of my Dutch guest, who was questioning his American instructor about the mechanical means I had devised for accomplishing some arithmetical object.

Some of his quotations may reflect his sense of fun:

The Council of the Royal Society is a collection of men who elect each other to office and then dine together at the expense of this society to praise each other over wine and give each other medals.

Whenever a man can get hold of numbers, they are invaluable: if correct, they assist in informing his own mind, but they are still more useful in deluding the minds of others.

The errors which arise from the absence of facts are far more numerous and more durable than those which result from unsound reasoning respecting true data.

What is there in a name? It is merely an empty basket, until you put something into it.

Scientific knowledge scarcely exists amongst the higher classes of society. The discussion in the Houses of Lords or of Commons, which arise on the occurrence of any subjects connected with science, sufficiently prove this fact.

It was apparently also evident during a visit to TCD as outlined below. Trinity College Dublin was founded in 1592 by Queen Elizabeth I, and was very much part of the academic establishment in the 19th century. When visiting Dublin for the 1835 meeting of the British Association for the Advancement of Science, Charles Babbage stayed in Trinity College Dublin, in rooms reserved for him by the Provost of Trinity, Bartholomew Lloyd (they were both on the Mathematical and Physical Sciences committee of the association, of which Lloyd was President, the future Earl of Rosse was Vice-President and Babbage was a Trustee, and both were members of the Royal Irish Academy and the Royal Society). Colby and Hamilton also attended. This is described in [3] and [9]:

The annual jamborees of the British Association formed part of Babbage's summer holidays. After the first meeting at York the Association went the round of the university cities: Oxford, Cambridge, Edinburgh, and then Dublin. Edinburgh and Dublin were capital cities and Dublin particularly provided an intensive round of entertainments. There were so many visitors that only a fraction of those wishing to attend could be accommodated. Some of the more earnest members thought there was too much frivolity. Babbage thoroughly enjoyed himself.

Although he had several invitations from friends to stay with them Babbage preferred to occupy the rooms which the provost and fellows of Trinity placed at his disposal. After a few days a learned friend advised Babbage that he was giving offence to his hosts by wearing a bright green waistcoat: O'Connell's colours in the heart of the protestant university. Babbage was anxious to remove the source of offence but his friend pronounced every other waistcoat Babbage had with him objectionable on some similar ground. A visit to the tailor yielded only a multicoloured cloth which was unobjectionable on symbolic grounds, but a trifle gay for breakfast. However there seemed to be no choice, so wearing this politically neutral garment Babbage for a time acquired the reputation of a dandy.

Note that the School of Computer Science and Statistics, and the Trinity Centre for High Performance Computing, occupy about half of the Lloyd Institute, named after father and son, Provost Bartholomew Lloyd (father) and Provost Humphrey Lloyd (son), both notable academics.

Babbage made contributions to many areas of science, for example, at this meeting he introduced a subject that would no doubt have been of interest to his Irish hosts [5]:

At the fifth meeting of the British Association for the Advancement of Science, at Dublin, Professor Babbage brought forward a plan for ascertaining the age of peat

mosses by annual layers of the trees found in them. If, for instance, there were two wide rings separated by a narrow one, it would show that at some period two years of favourable growth had been divided by one unfavourable year; and it is possible that by observing similar rings in some very old trees still standing, we might be able to ascertain the period of their growth to have been the same as that of the timber found in bogs or mosses.

A cache of papers was discovered with some Babbage descendants in Ireland, but many of his children moved to Australia and other British colonies (and in Western Australia, Carnarvon's vintage tramway runs over Babbage Island, named after Charles Babbage [8], to the end of the One Mile Jetty). His wife's brother William Wolryche-Whitmore had introduced the *South Australia Colonisation Act 1834*. His son Benjamin Herschel Babbage moved to South Australia as a surveyor, contributing amongst other things to the *Overland Telegraph Line* from Darwin to Adelaide (see the memorial to the final connection at the very remote *Frews Ponds1* between Newcastle Waters and Daly Waters in the Northern Territory). His youngest son Major-General Henry Prevost Babbage spent most of his life in India but eventually retired to England and constructed specimens of part of the Difference Engine [12]. He gave one each to the Cambridge's Whipple Musuem, to University College London, to Harvard University, and to Benjamin Herschel Babbage's son Charles Whitmore Babbage (presumably named after Babbage and wife Georgina Whitmore), who took it to New Zealand. The last of these was discovered, along with various papers now in the Wanganui Museum, on a farm in New Zealand in the late 1970s by Garry Tee of the Univ.Auckland.

The figures below are from Prof.J.G.Byrne's IFIP-1986 exhibit and also from his 1992 TCD Quatercentenary exhibit.

Trivia1: Charles Babbage refused both a knighthood and baronetcy, but had endless academic titles
Trivia2: Charles Babbage invented the speedometer and the locomotive cowcatcher
Trivia3: Charles Parsons, youngest son of the 3rd Earl of Rosse, invented the compound steam turbine

Several emulators exist for difference engines [13, 14, 15] and analytical engines [16].

The homepage for this catalog is at: https://www.scss.tcd.ie/SCSSTreasuresCatalog/
Click *'Accession Index'* (1st column listed) for related folder, or *'About'* for further guidance.
The items below are more properly part of the Literature category of this catalog, but are listed here for convenience.

Accession Index	Object with Identification
TCD-SCSS-V.20121208.866	About a dozen typed captions, all mounted on black cardboard, relating to Charles Babbage, c.1986, literature: Dept.Computer Science, Trinity College Dublin. *[Prof.J.G.Byrne's IFIP-1986 and 1992 TCD Quatercentenary exhibits]*
TCD-SCSS-V.20121208.870	Ada Lovelace's famous translation with an 'Addition', Prof.J.G.Byrne's offprint of Ada Lovelace's translation of L.Menabrea's 'Sketch' of the Analytical Engine, incorporating an offprint of Charles Babbage's 'Addition', c.1843.
TCD-SCSS-V.20121208.016	Charles Babbage - Pioneer of the Computer, 1982, literature: Hyman, A., Cambridge, OUP: Oxford.
TCD-SCSS-V.20121208.037	Charles Babbage and his Calculating Engines(1), 1991, literature: Swade, D., Science Museum, London.
TCD-SCSS-V.20121208.038	Charles Babbage and his Calculating Engines(2), 1991, literature: Swade, D., Science Museum, London.
TCD-SCSS-V.20121208.079	The Difference Engine - Charles Babbage and the Quest to Build the First Computer, 2000, literature: Swade, D., Viking, N.Y.
TCD-SCSS-V.20121208.080	Irascible Genius - A life of Charles Babbage, inventor, 1964, literature: Moseley, M., Hutchinson, London.
TCD-SCSS-V.20121208.081	Passages from the life of a Philosopher by Charles Babbage [1864], 1969, literature: Babbage, C., Augustus Kelley, N.Y.
TCD-SCSS-V.20121208.082	Charles Babbage and his Calculating Engines - Selected writings, 1961, literature: Morrison, P. & M.(edd), Dover, N.Y.
TCD-SCSS-V.20121208.382	Babbage and the birth of the computer, 1983, literature: Newscientist vol.99 no.1375, 15 September 1983.
TCD-SCSS-V.20121208.527	The Babbage Papers in the Science Museum Library - A cross-referenced list, 1991, literature: Bromley, A., Science Museum: London.
TCD-SCSS-V.20121208.640	Table of the logarithms of the natural numbers from 1 to 108000 , 1844, literature: Babbage, C., Murray: London, contains a printed inscription from Babbage to Lt-Colonel Colby of the Royal Engineers.
TCD-SCSS-V.20121208.641	The ninth Bridgewater Treatise - A fragment, 1837, literature: Babbage, C., Murray: London.
TCD-SCSS-V.20121208.642	Reflections on the decline of science in England and on some of its causes, 1971, literature: Babbage, C., Irish University Press: Shannon.
TCD-SCSS-V.20121208.865	A framed set of 5x5 twenty-two pence UK stamps issued in honour of Charles Babbage, c.19xx, literature: UK Post Office.
TCD-SCSS-V.20121208.671	IFIP Congress '86 - Dublin, Ireland, 1-5 September, 1986 - Preliminary Programme, 1986, literature: IFIP.
TCD-SCSS-V.20121208.675	Preprint of the proceedings of the IFIP congress 62, Munich

	August 27 to September 1, 1962, 1962, literature: North Holland: Amsterdam.
TCD-SCSS-V.20121208.677	ICS 1986 Yearbook - IFIP Congress '86, 1986, literature: Irish Computer Society: Dublin.
TCD-SCSS-V.20121208.678	Information Processing 86 - Proceedings of the IFIP 10th World Computer Congress ... Participants Edition, 1986, literature: Kugler, H.-J. (ed), North-Holland: Amsterdam.
TCD-SCSS-V.20161219.001	Table of the logarithms of the natural numbers from 1 to 108000, proof copy to the 1st Edition, Babbage, C., Murray: London, contains a printed inscription from Babbage to Lt-Colonel Colby of the Royal Engineers, c.1827.
TCD-SCSS-X.20121208.002	Brian Coghlan, Speculations on Percy Ludgate's Difference Engine, work-in-progress analysis.
Ludgate Folder	Mobile-friendly user interface to Ludgate folder

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3. Anthony Hyman, *Charles Babbage: Pioneer of the Computer*, p.174 (*The Analytical Engines: Social Life)*, Cambridge, OUP: Oxford, p.174, 1982.

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10. Subrata Dasgupta, *It Began with Babbage: The Genesis of Computer Science*, OUP USA, 2014.

11. Doron Swade, *The Difference Engine – Charles Babbage and the Quest to Build the First Computer*, New York, 2001.

12. Henry Prevost Babbage, *Babbage's Calculating Engines: a collection of papers by Henry Prevost Babbage*, London, 1889; Los Angeles, 1982.

13. Maarten Pennings, *Difference Engine*, see: http://www.fampennings.nl/maarten/diffeng/
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14. Joseph Rishi, *Babbage's Difference Engine Simulation*, see: http://www.pages.drexel.edu/~rgj26/DEP.html
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15. Nathan Myhrvold, *Babbage Difference Engine #2: JavaScript non-pipelined emulation*, see: http://ed-thelen.org/bab/bab-diff-JavaScript.htm
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16. John Walker, *The Analytical Engine*, see: http://www.fourmilab.ch/babbage/contents.html http://www.fourmilab.ch/babbage/applet.html
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17. Brian Coghlan, *Speculations on Percy Ludgate's Difference Engine*, see: https://www.scss.tcd.ie/SCSSTreasuresCatalog/miscellany/TCD-SCSS-X.20121208.002/BrianCoghlan-Speculations-on-Percy-Ludgates-Difference-Engine.pdf
Last viewed 26-Oct-2021.

Figure 1: Charles Babbage

Charles Babbage
(1791-1871)

1791		Born 26th December in Walworth , Surrey
1810		Went up to Trinity College Cambridge and studied mainly mathematics
1814		Married Georgiana Whitmore in Teignmouth, Devon and took his B.A.
1816		Elected a Fellow of the Royal Society
1820		Helped to found the Astronomical Society
1822		A model of a difference engine with six figure-wheels was announced in an open letter to Sir Humphry Davy, President of the Royal Society
1823	[1]	Following Government funding Difference Engine No. 1 with six orders of differences and 20 digits and a printing apparatus was started.
1827	[15]	Published a Table of Logarithms of numbers from 1 to 108,000, principally for Thomas Colby, who was in charge of the Irish Ordanance Survey.
1828		Elected to the Lucasian Chair of Mathematics at Cambridge which he held until 1839
1829		A Committee appointed by the Royal Society reported favourably on Babbage's difference engine.
1832		Published *On the economy of Machinery and Manufactures* —the first textbook on OR
1833		A small portion of the Difference Engine was completed but work stopped mainly due to a row with Joseph Clement, the engineer. First meeting with Ada, daughter of Lord Byron
1834	[19]	Babbage had the idea for the Analytical Engine, the forerunner of the Computer
1835	[22]	Visited Dublin for the meeting of the British Association for the Advancement of Science and stayed in TCD
1841	[20]	Visited Turin with James MacCullagh and explained the Analytical Engine to a group of Italian scientists including L.F. Menabrea
1843	[21]	Ada, Lady Lovelace, translated Menabrea's article on the Analytical Engine and published it in Taylor's Scientific Memoirs, Vol iii
1847		Work on the Analytical Engine virtually ceased
1851		Developed a new signalling system for lighthouses which was first used in the USA
1852	[9]	The Earl of Rosse, as President of the Royal Society, made a last attempt to get Government funding for Difference Engine No. 2
1854		Per George Scheutz and his son Edvard mad a successful small difference engine in Sweden
1864	[24]	*Passages from the Life of a Philosopher* published
1871		Death of Babbage

The numbers in [ ] refer to items on display

Figure 2: Significant events in the life of Charles Babbage

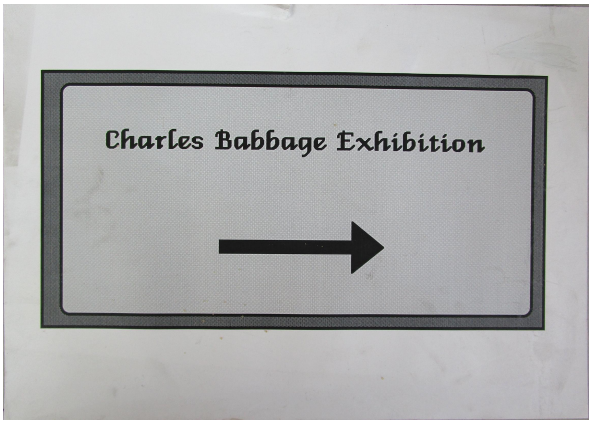


Figure 3: Sign from Prof.J.G.Byrne's IFIP-1986 exhibit on Charles Babbage

Babbage and Ireland

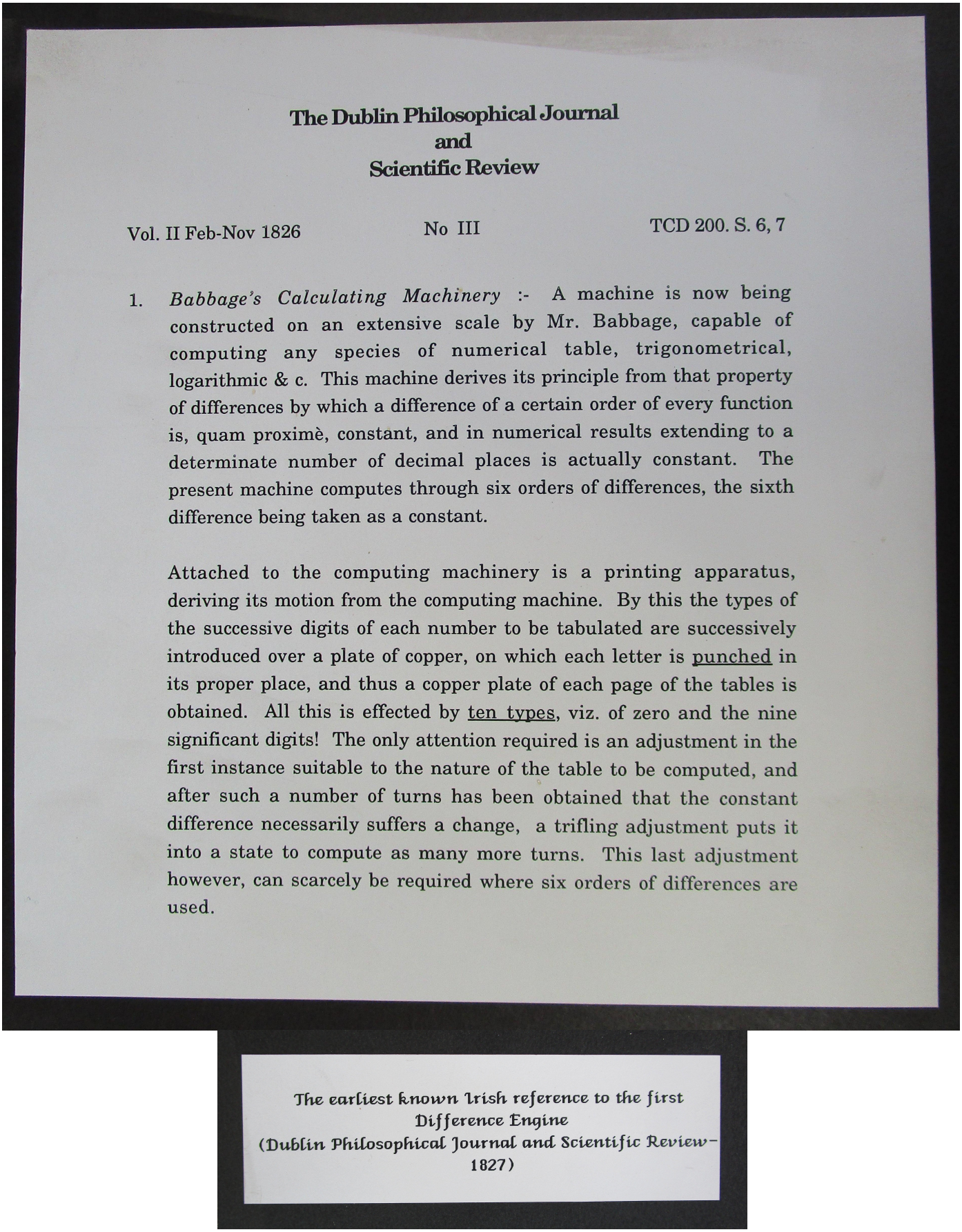
Babbage visited Ireland on at least three occasions. He first came in 1827, following the death of his wife, daughter and father. His great friend, Sir John Herschel came with him and they visited Thomas Colby who was just completing the second measurement of the baseline which turned out to be within 12 thousandths of an inch of the first measurement (according to Maria Edgeworth). T.C.D was also included in the visit.

Babbage came again in 1834 for the meeting of the British Association for the Advancement of Science. He stayed in the College and in *Passages from the life of a Philosopher* [24] he describes an amusing incident about his green waistcoat. A friend pointed out that O'Connell's colour would not be acceptable in T.C.D. The rest of the incident is described on the pages which are displayed [24].

Babbage came to Ireland again in 1850 and visited the Earl of Rosse at Birr Castle [9,23] and Thomas Romney Robinson at Armagh Observatory.

In addition to MacCullagh, Babbage corresponded with Sir William Rowan Hamilton and Humphrey Lloyd, the Professor of Natural and Experimental Philosophy, who was well for the terrestrial magnetism project which he organised and the instruments which he developed.

Figure 4: Charles Babbage and Ireland
It is likely that 'who was well' should be 'who was well known'



The Dublin Philosophical Journal
and
Scientific Review

Vol. II Feb-Nov 1826 No III TCD 200. S. 6, 7

1. *Babbage's Calculating Machinery* :- A machine is now being constructed on an extensive scale by Mr. Babbage, capable of computing any species of numerical table, trigonometrical, logarithmic & c. This machine derives its principle from that property of differences by which a difference of a certain order of every function is, quam proximè, constant, and in numerical results extending to a determinate number of decimal places is actually constant. The present machine computes through six orders of differences, the sixth difference being taken as a constant.

Attached to the computing machinery is a printing apparatus, deriving its motion from the computing machine. By this the types of the successive digits of each number to be tabulated are successively introduced over a plate of copper, on which each letter is punched in its proper place, and thus a copper plate of each page of the tables is obtained. All this is effected by ten types, viz. of zero and the nine significant digits! The only attention required is an adjustment in the first instance suitable to the nature of the table to be computed, and after such a number of turns has been obtained that the constant difference necessarily suffers a change, a trifling adjustment puts it into a state to compute as many more turns. This last adjustment however, can scarcely be required where six orders of differences are used.

The earliest known Irish reference to the first Difference Engine
(Dublin Philosophical Journal and Scientific Review–1827)

Figure 5: The earliest known Irish reference to Difference Engine No.1 (Dublin Philosophical Journal and Scientific Review, 1827)

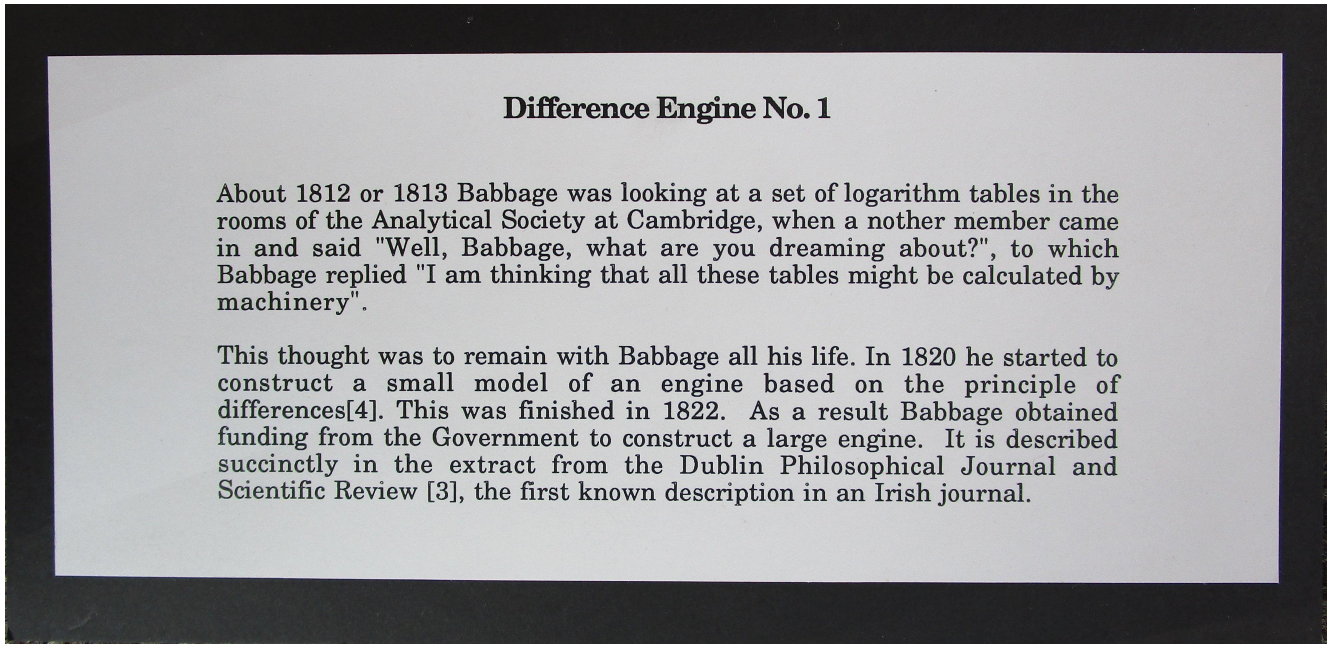


Figure 6: Charles Babbage's Difference Engine No.1

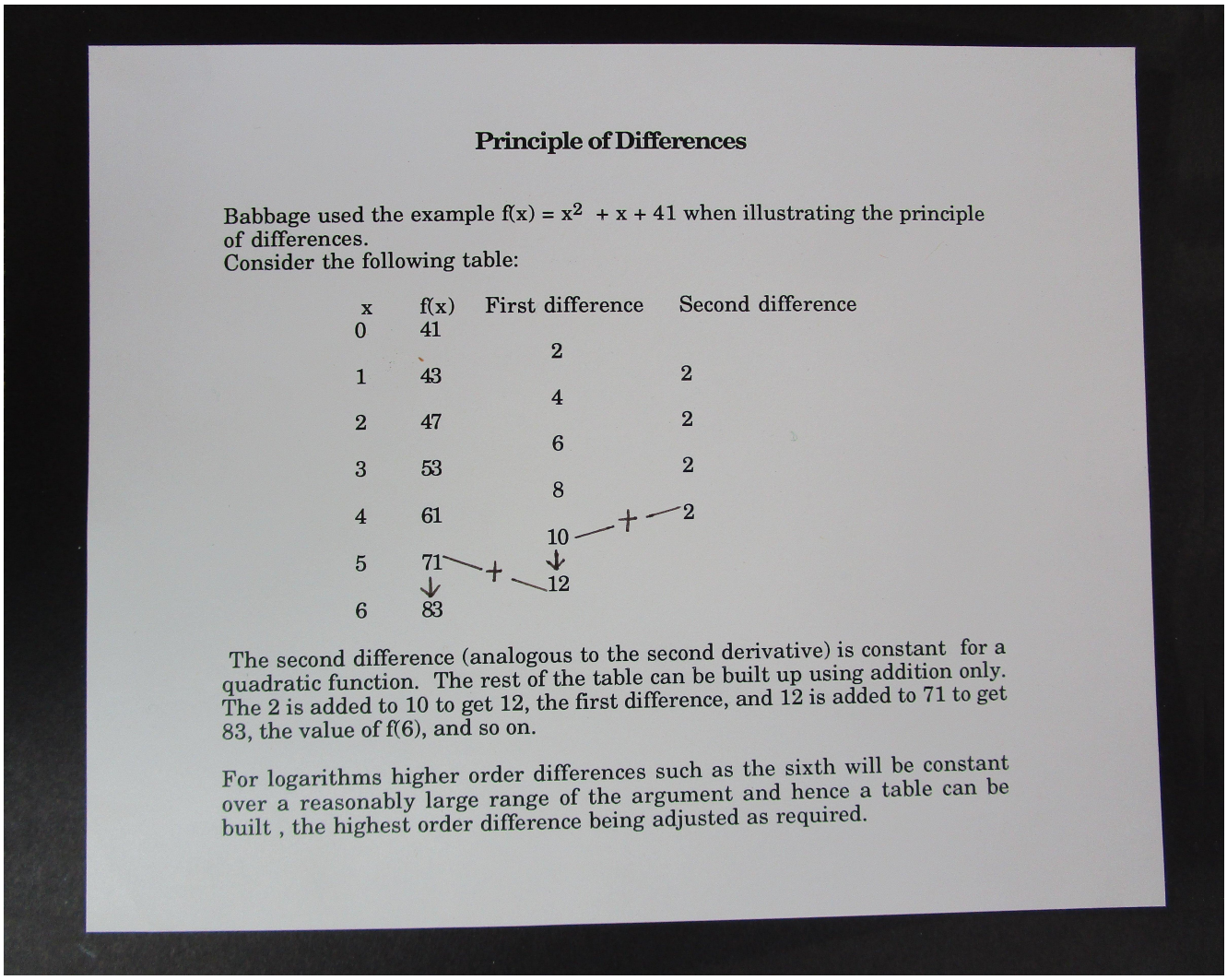


Figure 7: The Principle of Differences

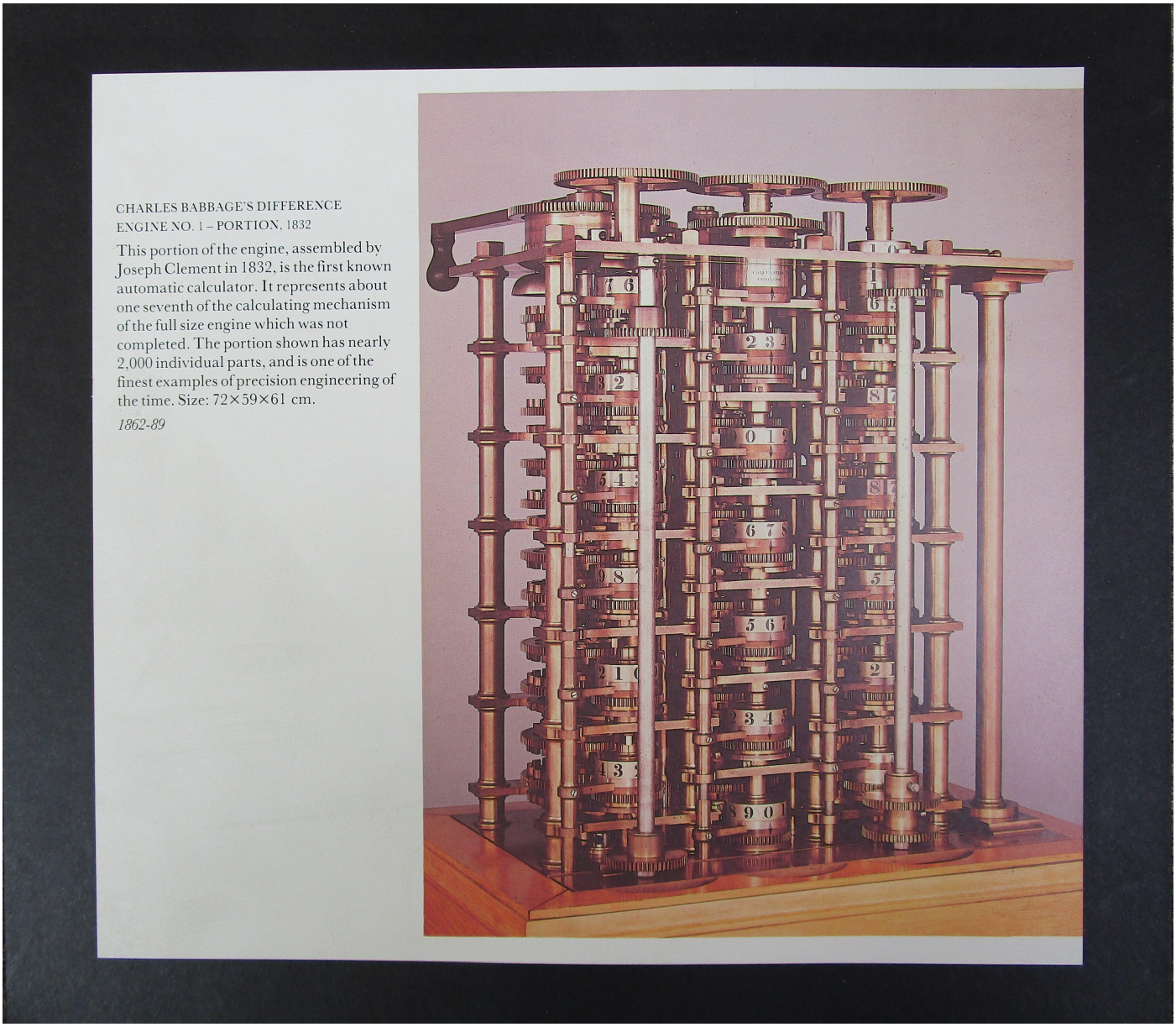


Figure 8: Portion of Charles Babbage's Difference Engine No.1 constructed by 1832 (it was this that was demonstrated to Ada Lovelace)

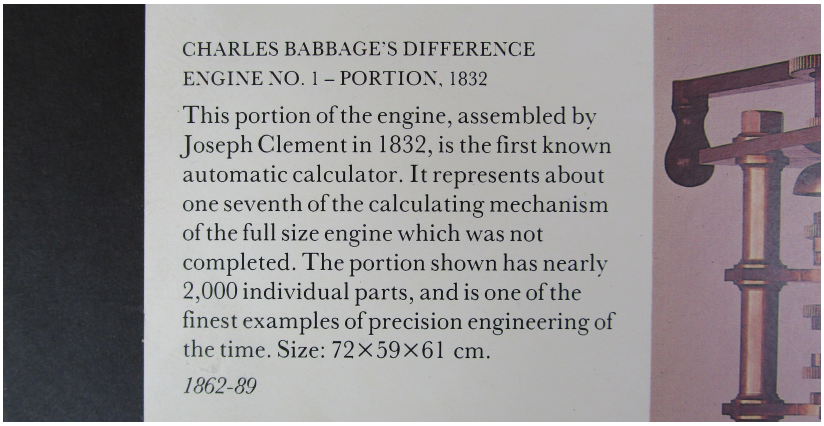


Figure 9: enlarged text from Fig.15 of Charles Babbage's Difference Engine No.1

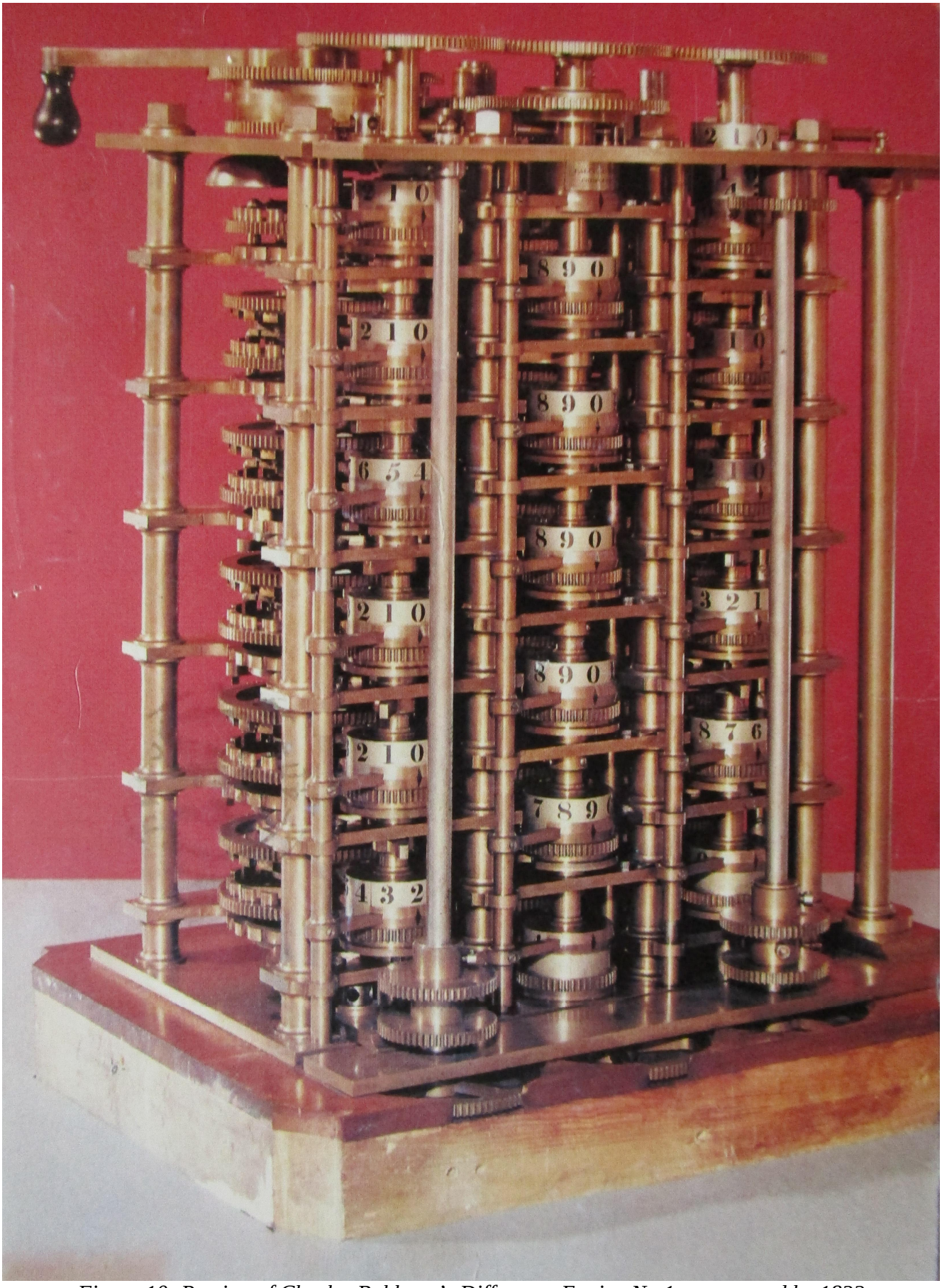


Figure 10: Portion of Charles Babbage's Difference Engine No.1 constructed by 1832

The Earl of Rosse and Difference Engine No. 2

The third Earl of Rosse, William Parsons, was famous for his 72 inch reflecting telescope which he built at Birr Castle[8]. From 1849 to 1854 he was President of the Royal Society, the leading Scientific institution in Britain, then and now. Babbage was a fellow and was interested in astronomy, being one of the founder members of the [Royal] Astronomical Society. He visited Birr Castle in 1850 and was the first to sign the Visitors Book[22], which has been kindly loaned by the present Earl of Rosse. Babbage had drawn up a specification and plans for a new difference engine, No. 2, and he asked the Earl of Ross to present his case to the Government. The Earl wrote to Lord Derby, the Prime Minister, on the 20th July 1852 [11]. Lord Derby passed the papers to the Chancellor of the Exchequer, Benjamin Disraeli (originator of the phrase "lies, damn lies and statistics") and added his opinion " that Mr. Babbage's ideas appear to be so indefinitely expensive, the ultimate success so problematical and the expenditure so large and so wholly incapable of being calculated that the Government ought not to take upon itself any further liability". It is hardly surprising that Disraeli rejected the proposal. Babbage was incensed and wrote a long reply to Lord Rosse [10].

Figure 11: The Earl of Rosse and Babbage's Difference Engine No.2

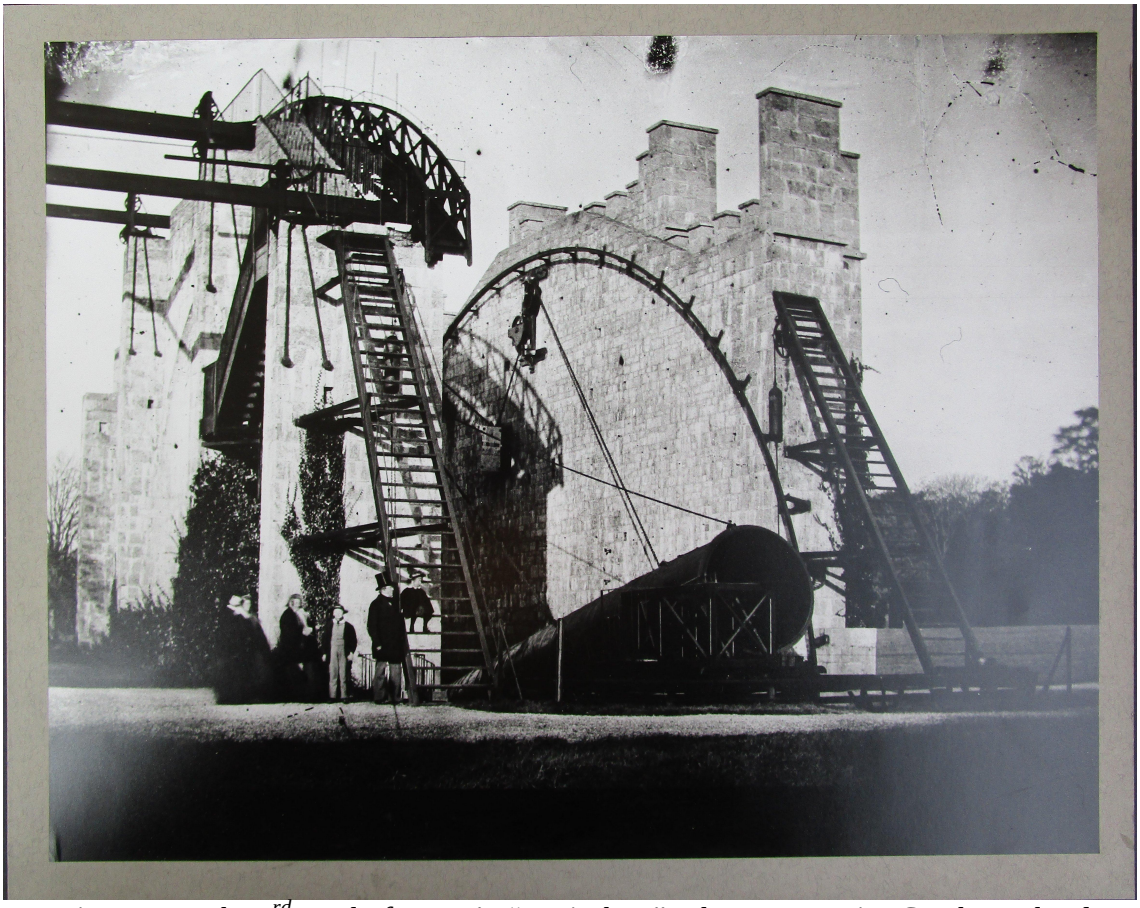
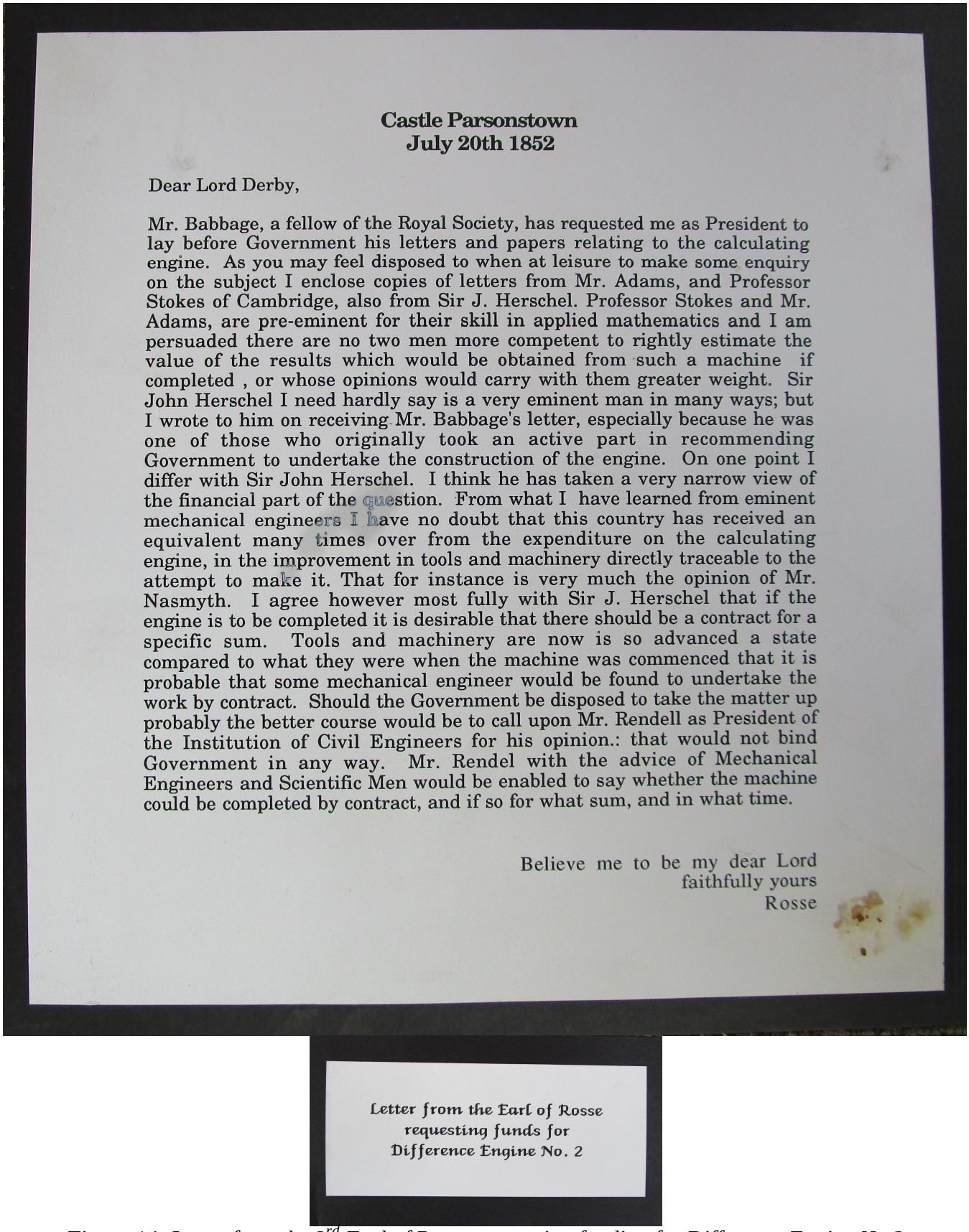


Figure 12: The 3rd Earl of Rosse's "Leviathan" telescope at Birr Castle, Ireland
(the largest telescope in the world from 1845 to 1917)
Charles Babbage was the first to sign the Visitor's Book

Figure 13: The 3rd Earl of Rosse, William Parsons



Castle Parsonstown
July 20th 1852

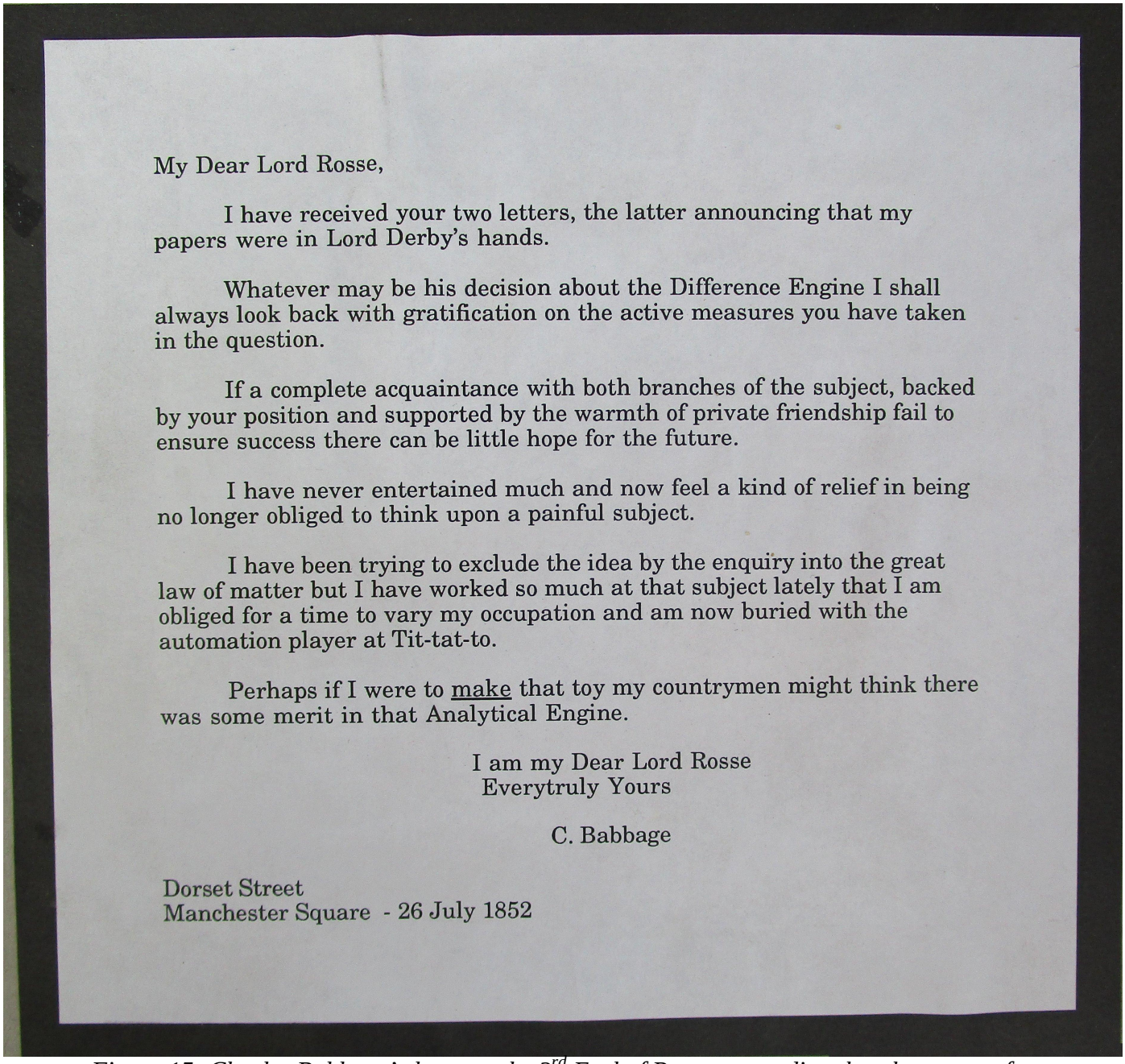
Dear Lord Derby,

Mr. Babbage, a fellow of the Royal Society, has requested me as President to lay before Government his letters and papers relating to the calculating engine. As you may feel disposed to when at leisure to make some enquiry on the subject I enclose copies of letters from Mr. Adams, and Professor Stokes of Cambridge, also from Sir J. Herschel. Professor Stokes and Mr. Adams, are pre-eminent for their skill in applied mathematics and I am persuaded there are no two men more competent to rightly estimate the value of the results which would be obtained from such a machine if completed , or whose opinions would carry with them greater weight. Sir John Herschel I need hardly say is a very eminent man in many ways; but I wrote to him on receiving Mr. Babbage's letter, especially because he was one of those who originally took an active part in recommending Government to undertake the construction of the engine. On one point I differ with Sir John Herschel. I think he has taken a very narrow view of the financial part of the question. From what I have learned from eminent mechanical engineers I have no doubt that this country has received an equivalent many times over from the expenditure on the calculating engine, in the improvement in tools and machinery directly traceable to the attempt to make it. That for instance is very much the opinion of Mr. Nasmyth. I agree however most fully with Sir J. Herschel that if the engine is to be completed it is desirable that there should be a contract for a specific sum. Tools and machinery are now is so advanced a state compared to what they were when the machine was commenced that it is probable that some mechanical engineer would be found to undertake the work by contract. Should the Government be disposed to take the matter up probably the better course would be to call upon Mr. Rendell as President of the Institution of Civil Engineers for his opinion.: that would not bind Government in any way. Mr. Rendel with the advice of Mechanical Engineers and Scientific Men would be enabled to say whether the machine could be completed by contract, and if so for what sum, and in what time.

Believe me to be my dear Lord
faithfully yours
Rosse

Letter from the Earl of Rosse
requesting funds for
Difference Engine No. 2

Figure 14: Letter from the 3rd Earl of Rosse requesting funding for Difference Engine No.2



My Dear Lord Rosse,

I have received your two letters, the latter announcing that my papers were in Lord Derby's hands.

Whatever may be his decision about the Difference Engine I shall always look back with gratification on the active measures you have taken in the question.

If a complete acquaintance with both branches of the subject, backed by your position and supported by the warmth of private friendship fail to ensure success there can be little hope for the future.

I have never entertained much and now feel a kind of relief in being no longer obliged to think upon a painful subject.

I have been trying to exclude the idea by the enquiry into the great law of matter but I have worked so much at that subject lately that I am obliged for a time to vary my occupation and am now buried with the automation player at Tit-tat-to.

Perhaps if I were to make that toy my countrymen might think there was some merit in that Analytical Engine.

I am my Dear Lord Rosse
Everytruly Yours

C. Babbage

Dorset Street
Manchester Square - 26 July 1852

Figure 15: Charles Babbage's letter to the 3rd Earl of Rosse on reading that the request for funding for Difference Engine No.2 had been sent to the Prime Minister, Lord Derby

My dear Lord Rosse

The state of painful suffering in which Lady Lovelace remains at present has delayed my thanking you for your letter and its enclosure from Lord Derby. A few days will probably terminate the suffering of my poor friend.

My first impression on reading L^{d} Ds letter was that I ought to make no further attempt to force a generous offer on a reluctant country, in fact it appears that I have thrown pearls before swine.

With regard to J. Hume he is honest but not qualified for such a subject: besides I have always felt and acted upon the feeling that the subject is above all political movements. It has in former times been m,ore than once suggested to me that O'Connell would be willing to take up the Engine, and you know what his influence has been over my whig friends. I have always replied that I would rather give up all hope of ever seeing the engine made than that the shadow of so dishonest a man should pass across it.

On consulting Hawes who shares with you fully in the perception of the vast importance of the substitution of mechanical for mental labour, he pointed out yet another course which from his official experience deserves attention. He remarks that L.^{d} D's decision rests upon the grounds of unlimited expense but that two propositions are entirely passed by

1st The offer of the Diff. Eng. N^{o} 2

2nd The proposal to refer the question of cost to the Inst^{n}. of Civil Engineers

Hawes notion is first to ascertain whether it would be agreeable to your views to address another letter to L^{d}. D. on the subject. In case it should Hawes could embody his notions in a draft of such a letter to L^{d}. D. for your consideration.

His argument would be that none but professional Engineers who had examined minutely the drawings could be accepted as judges by the public and that the question of the cost of making the engine should be referred to the Inst^{n}. of Civil Engineers for their opinion. It being understood that whatever might be the nature of that decision it should not be considered as pledging the Gov^{t}. to construct the Engine.

I feel that I have very imperfectly expressed Hawes' views which appeared to me at the time to be quite sound.

My own personal objections to moving in the question are in some measure removed by this course being taken by my friends. There is however another reason in its favour which makes it fit that I should not object to it.

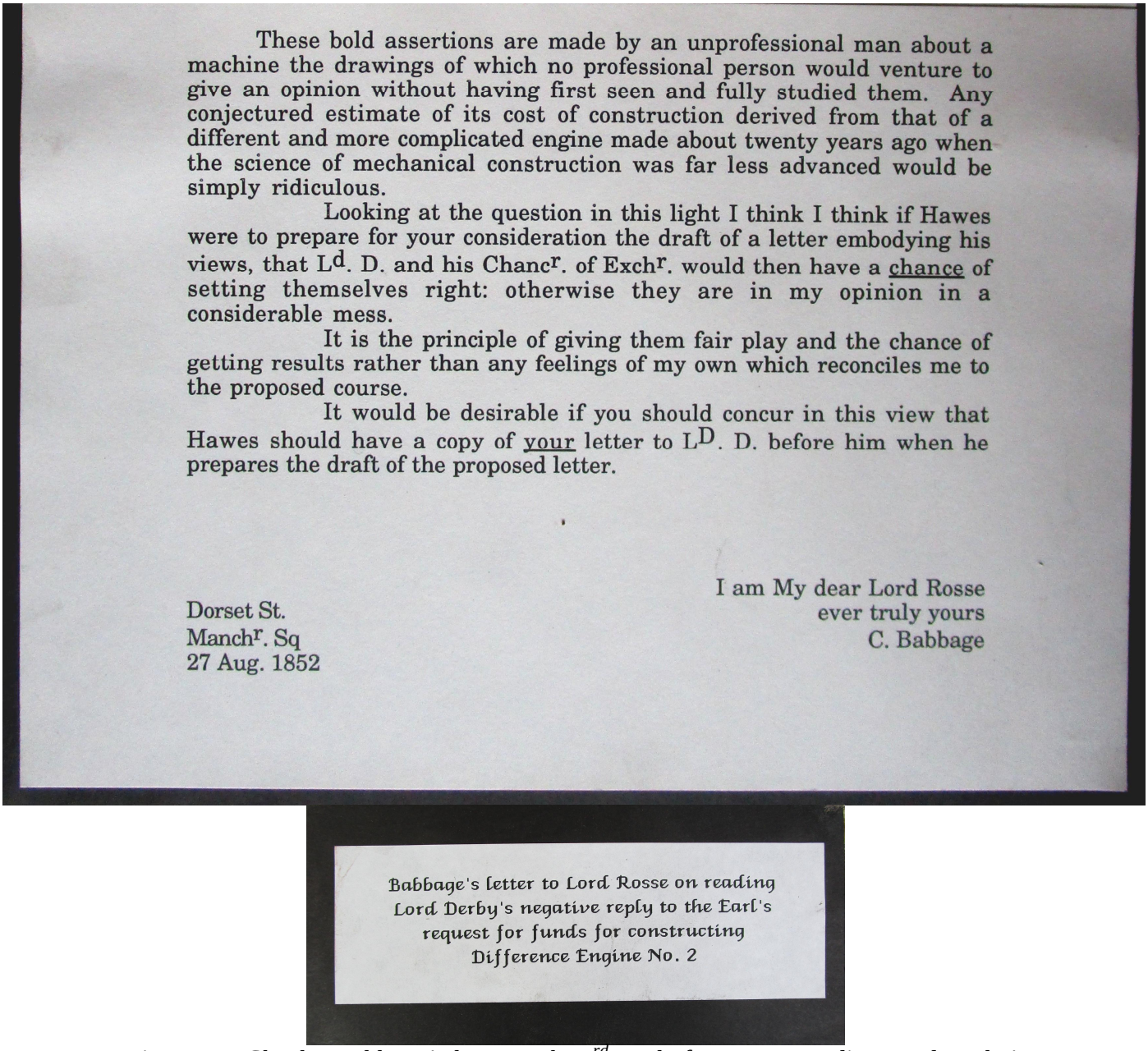
The flippant term of "<u>Mr. B's projects</u>" applied by the Chanc^{r}. of the Exch^{r}. to the offer of my drawings of Diff. Eng. N^{o}. 2 which have not been arrived at under an expense of £10,000 I can afford to smile at and forgive. But I am convinced that if L^{d} Derby's letter were known it would be most injurious to the reputation of the Chanc^{r}. of the Exch^{r}. both for prudence and for sagacity. He assigns to L^{d}. D. four reasons for refusing

1st Indefinite expense

2nd Problematic success

3rd Expenditure <u>certainly</u> so large

4th D itto <u>utterly incapable</u> of being calculated



These bold assertions are made by an unprofessional man about a machine the drawings of which no professional person would venture to give an opinion without having first seen and fully studied them. Any conjectured estimate of its cost of construction derived from that of a different and more complicated engine made about twenty years ago when the science of mechanical construction was far less advanced would be simply ridiculous.

Looking at the question in this light I think I think if Hawes were to prepare for your consideration the draft of a letter embodying his views, that L^d. D. and his Chanc^r. of Exch^r. would then have a chance of setting themselves right: otherwise they are in my opinion in a considerable mess.

It is the principle of giving them fair play and the chance of getting results rather than any feelings of my own which reconciles me to the proposed course.

It would be desirable if you should concur in this view that Hawes should have a copy of your letter to L^D. D. before him when he prepares the draft of the proposed letter.

I am My dear Lord Rosse
ever truly yours
C. Babbage

Dorset St.
Manch^r. Sq
27 Aug. 1852

Babbage's letter to Lord Rosse on reading Lord Derby's negative reply to the Earl's request for funds for constructing Difference Engine No. 2

Figure 16: Charles Babbage's letter to the 3rd Earl of Rosse on reading Lord Derby's rejection of the request for funding for Difference Engine No.2

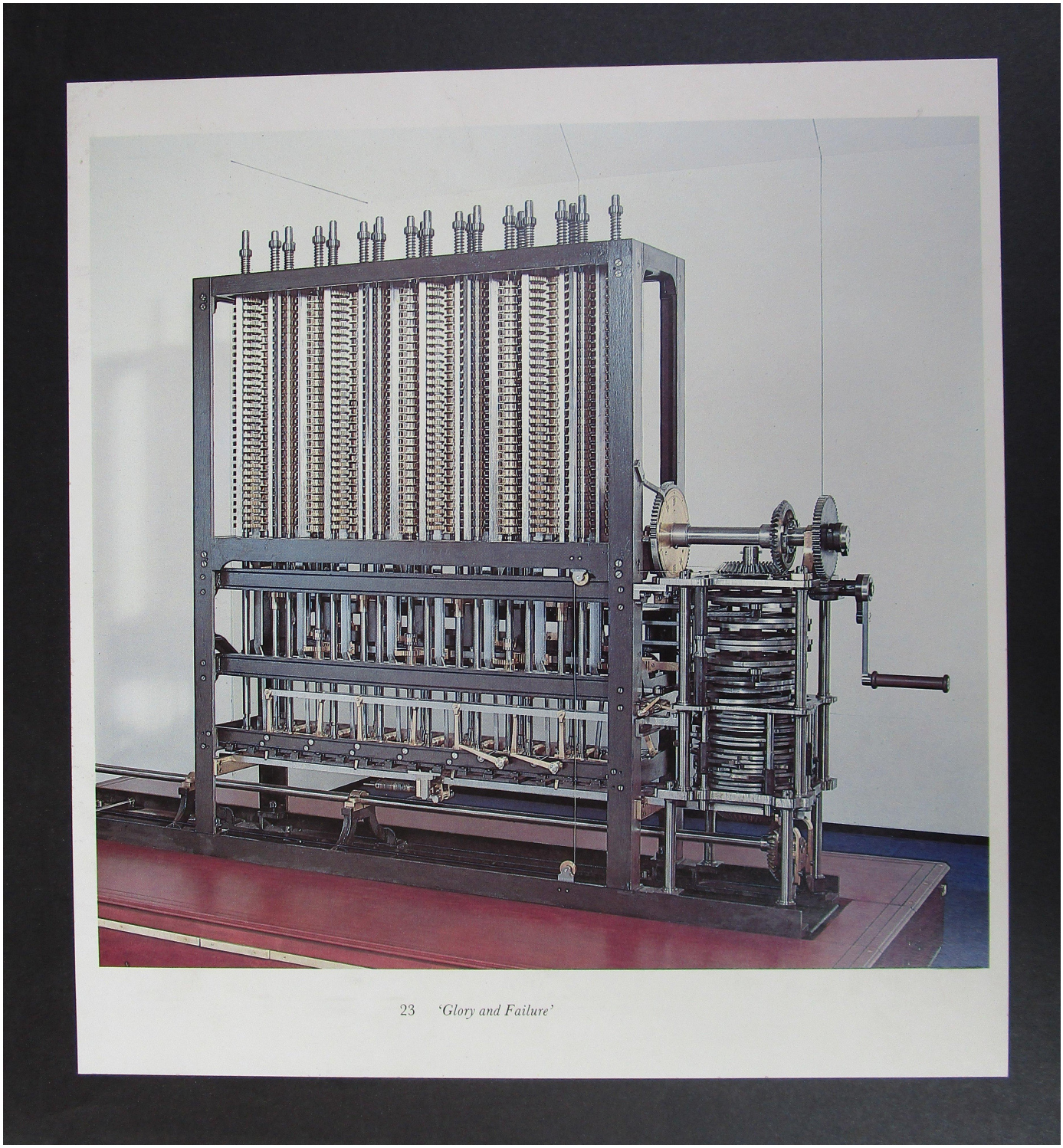


Figure 17: Charles Babbage's Difference Engine No.2 in the Science Museum, London Completed in 2002 [11], with 8,000 parts, 11 feet long, and weighing five tons

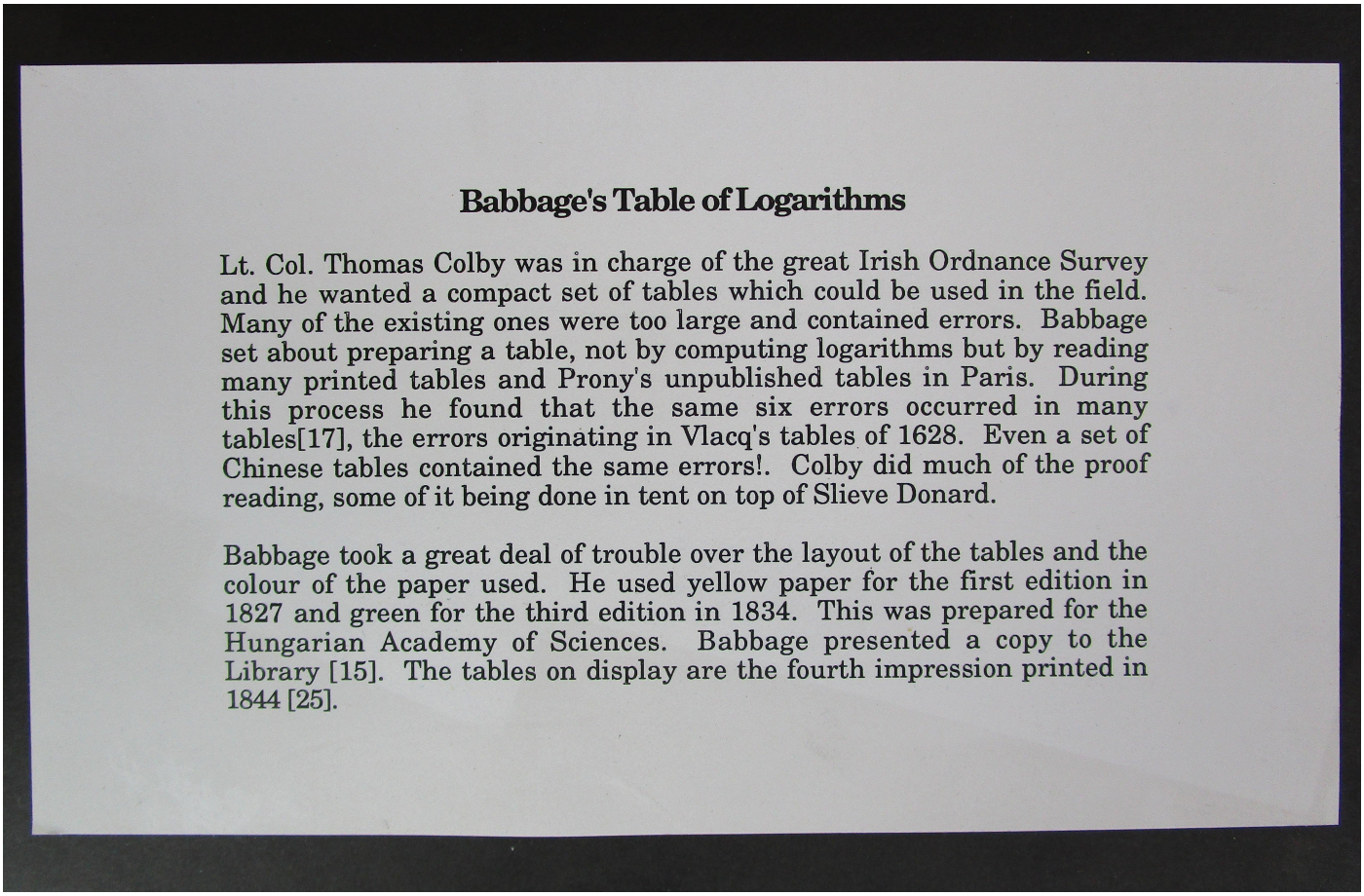
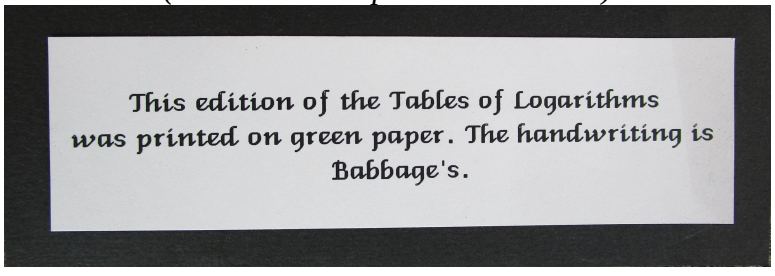


Figure 18: Charles Babbage's Table of Logarithms

NEXT PAGE

Figure 19: Charles Babbage's Tables of Logarithms, 3rd Edition, 1834 (1st Edition was published in 1827)



TABLE

OF THE

LOGARITHMS

OF THE

NATURAL NUMBERS,

FROM

1 to 108000.

BY

CHARLES BABBAGE, Esq., M.A.,
Lucasian Professor of Mathematics in the University of Cambridge,
F. R. S. L. AND E. HON. M. R. I. A. F. R. A. S. F. C. P. S.
SOC. PHILOMATH. PAR. SOC. CORR., ACAD. DIJON SOC., ACAD. MARS.
ET ACAD. BRUX. SOC. CORR., SOC. PHYS. ET HIST. NAT. GEN. SOC. HON., IMP. ET REG. ACAD. MOD.,
IMP. ET REG. ACAD. GEORGOF. FIORENT., ACAD. LYNC. ROM., IMP. ET REG. ACAD. PAD.
ET REG. ACAD. NEAP. SOC. CORR., REG. ACAD. HAFNIÆ. SOC.,
ET REG. ACAD. MONAC. SOCIUS CORR., &c.

STEREOTYPED.—THIRD EDITION.

LONDON:
PRINTED FOR THE HUNGARIAN ACADEMY OF SCIENCES.

1834.

PUBLISHED BY CHARLES KNIGHT, LUDGATE STREET.

IV. *Notice respecting some Errors common to many Tables of Logarithms.* *By* CHARLES BABBAGE, *Esq., Foreign Secretary of the Astronomical Society.*

Read March 9, 1827.

HAVING lately printed a stereotype table of the logarithms of natural numbers, for the use of the Survey of Ireland, I observed among the errors detected in various tables during the eight readings to which it was subjected, several which appeared common to many of them. This circumstance induced me to examine some other tables at the same numbers; and I find that there are six errors which are common to almost all tables: those of VEGA, the recent impressions of CALLET and my own, are the only ones entirely exempt. The following table shows the sixth and seventh figures, and in a few cases also the eighth, ninth and tenth figures, of the logarithms in the respective tables: the erroneous figures being indicated by a bar placed above them.

24,626	38,962	57,628	57,629	63,747	67,951	Natural Numbers.	
$\bar{3}9751$	$1\bar{3}420$	$35\bar{8}75$	$10\bar{4}36$	$97\bar{4}12$	$58\bar{4}24$	Vlacq, fol. Gouda	1628
$\bar{3}9751$	$1\bar{3}420$	$35\bar{8}75$	$10\bar{4}36$	$97\bar{4}12$	$58\bar{4}24$	Vlacq, fol. London	1633
39	$1\bar{3}$	35	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	E. Wingate, 12mo. London ..	1633
$\bar{3}9\bar{7}$	$1\bar{3}4$	$35\bar{9}$	$10\bar{4}$	$97\bar{4}$	$58\bar{4}$	Newton, fol. London	1658
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Sherwin, 8vo. 1st ed. London ..	1726
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Sherwin, 8vo. 2nd ed. London ..	1741
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Sherwin, 8vo. 3rd ed. London ..	1742
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Gardiner, 4to. London	1742
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Sherwin, 8vo. 4th ed. London ..	1761
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Sherwin, 8vo. 5th ed. London ..	1770
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Gardiner, 4to. Avignon	1770
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Schulze, 8vo. Berlin	1778
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Gardiner, 4to. Fiorenze	1782
39	12	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Taylor, 4to. London	1792
38751	12420	35475	10836	97512	58524	Vega, fol. Leipsic	1794
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Callet, 8vo. Paris	1795
$\bar{4}0$	$1\bar{3}$	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Delambre, Tab. Dec., 4to. Paris	1801
39	12	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Hutton, 8vo. 4th ed. London ..	1804
39	12	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Hutton, 8vo. 5th ed. London ..	1811
39	12	35	11	98	59	Vega, 8vo. 5th ed. Leipsic	1820
39	12	$3\bar{6}$	$1\bar{0}$	$9\bar{7}$	$5\bar{8}$	Hutton, 8vo. 6th ed. London ..	1822
39	12	35	11	98	59	Babbage, 8vo. London	1826

Figure 20: Charles Babbage's Notice on Tables of Logarithms, from Memoirs of the Astronomical Society of London, Volume 3, part 1, 1827

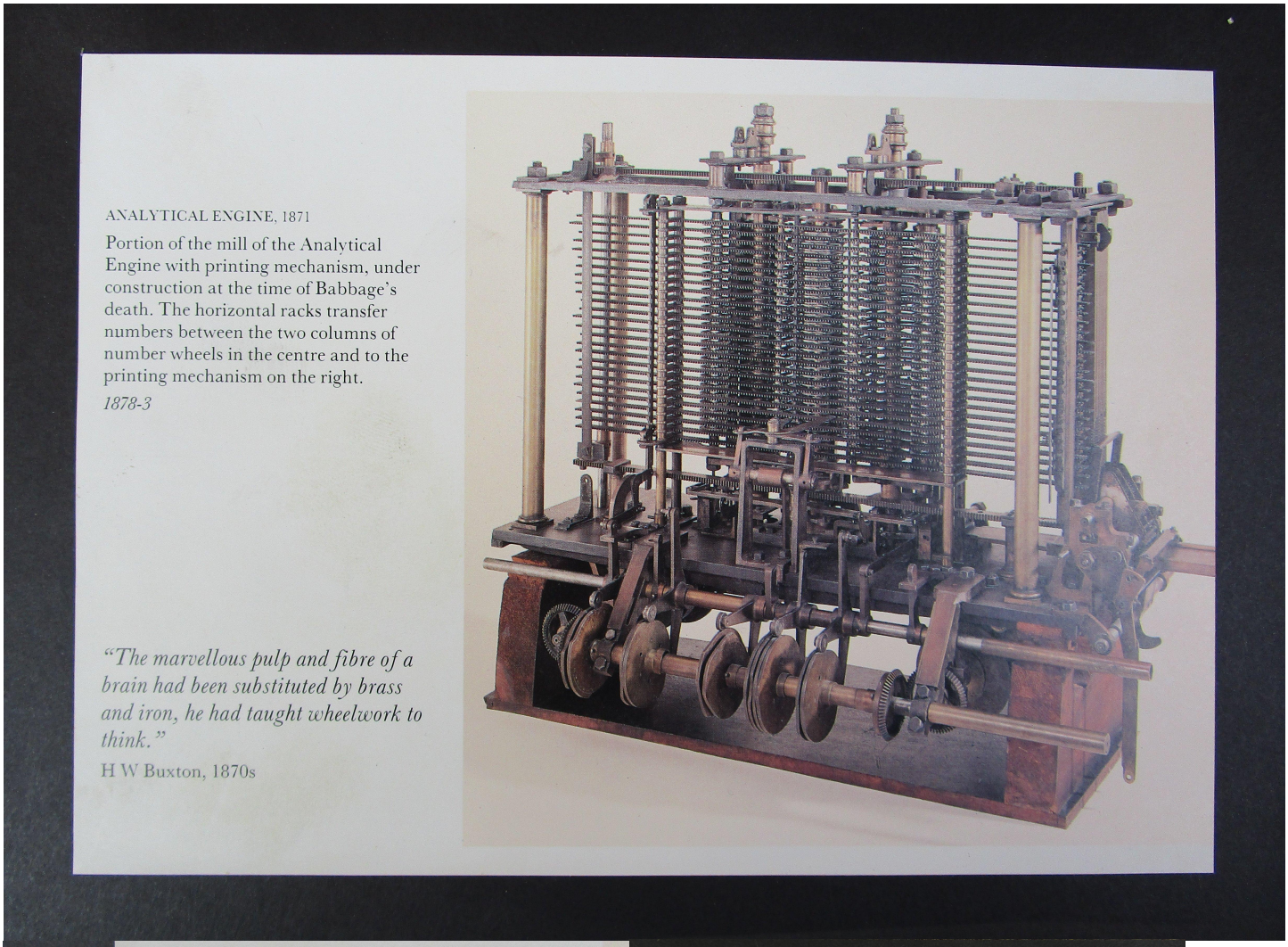
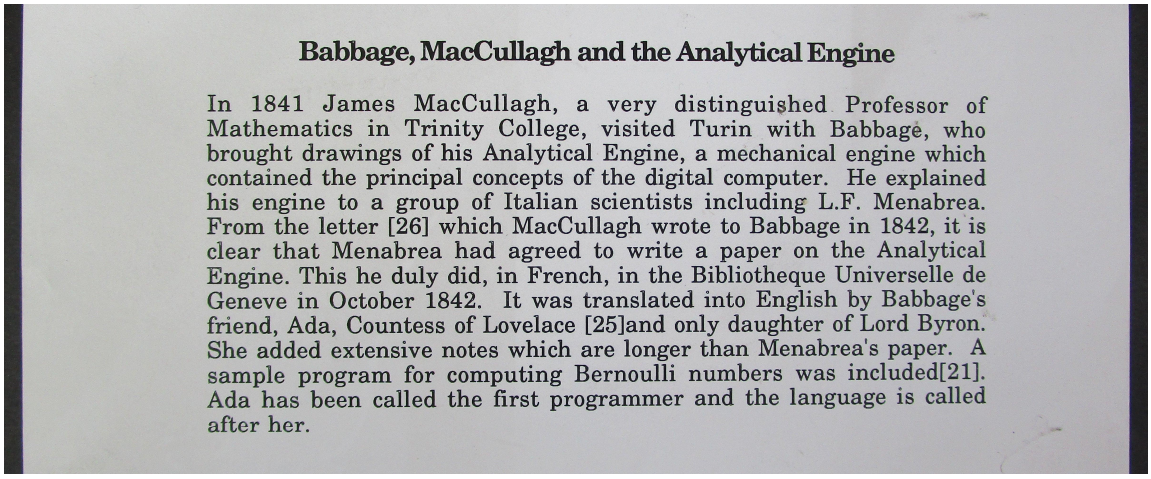


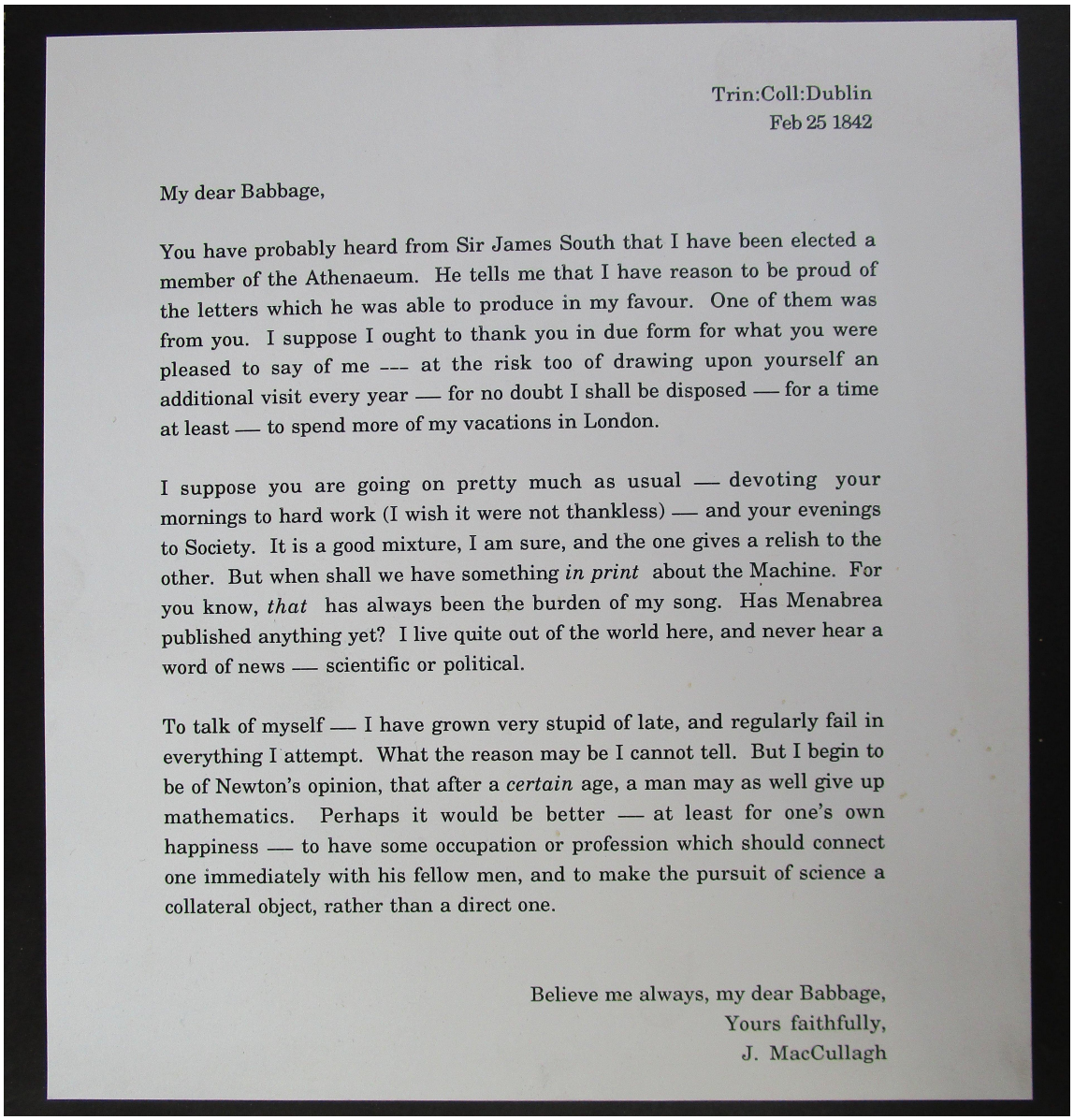
Figure 21: Mill of Babbage's Analytical Engine



Babbage, MacCullagh and the Analytical Engine

In 1841 James MacCullagh, a very distinguished Professor of Mathematics in Trinity College, visited Turin with Babbage, who brought drawings of his Analytical Engine, a mechanical engine which contained the principal concepts of the digital computer. He explained his engine to a group of Italian scientists including L.F. Menabrea. From the letter [26] which MacCullagh wrote to Babbage in 1842, it is clear that Menabrea had agreed to write a paper on the Analytical Engine. This he duly did, in French, in the Bibliotheque Universelle de Geneve in October 1842. It was translated into English by Babbage's friend, Ada, Countess of Lovelace [25]and only daughter of Lord Byron. She added extensive notes which are longer than Menabrea's paper. A sample program for computing Bernoulli numbers was included[21]. Ada has been called the first programmer and the language is called after her.

Figure 22: Charles Babbage, James MacCullagh and the Analytical Engine



Trin:Coll:Dublin
Feb 25 1842

My dear Babbage,

You have probably heard from Sir James South that I have been elected a member of the Athenaeum. He tells me that I have reason to be proud of the letters which he was able to produce in my favour. One of them was from you. I suppose I ought to thank you in due form for what you were pleased to say of me --- at the risk too of drawing upon yourself an additional visit every year — for no doubt I shall be disposed — for a time at least — to spend more of my vacations in London.

I suppose you are going on pretty much as usual — devoting your mornings to hard work (I wish it were not thankless) — and your evenings to Society. It is a good mixture, I am sure, and the one gives a relish to the other. But when shall we have something *in print* about the Machine. For you know, *that* has always been the burden of my song. Has Menabrea published anything yet? I live quite out of the world here, and never hear a word of news — scientific or political.

To talk of myself — I have grown very stupid of late, and regularly fail in everything I attempt. What the reason may be I cannot tell. But I begin to be of Newton's opinion, that after a *certain* age, a man may as well give up mathematics. Perhaps it would be better — at least for one's own happiness — to have some occupation or profession which should connect one immediately with his fellow men, and to make the pursuit of science a collateral object, rather than a direct one.

Believe me always, my dear Babbage,
Yours faithfully,
J. MacCullagh

Figure 23: A letter from James MacCullagh's to Charles Babbage
This explicitly urges publication of Menabrea's description of the Analytical Engine, which was then famously translated and extended by Ada Lovelace

Figure 24: Portrait of Ada Lovelace on the front page of the Computer Bulletin (Series 2, Number 21, Sep-1979)

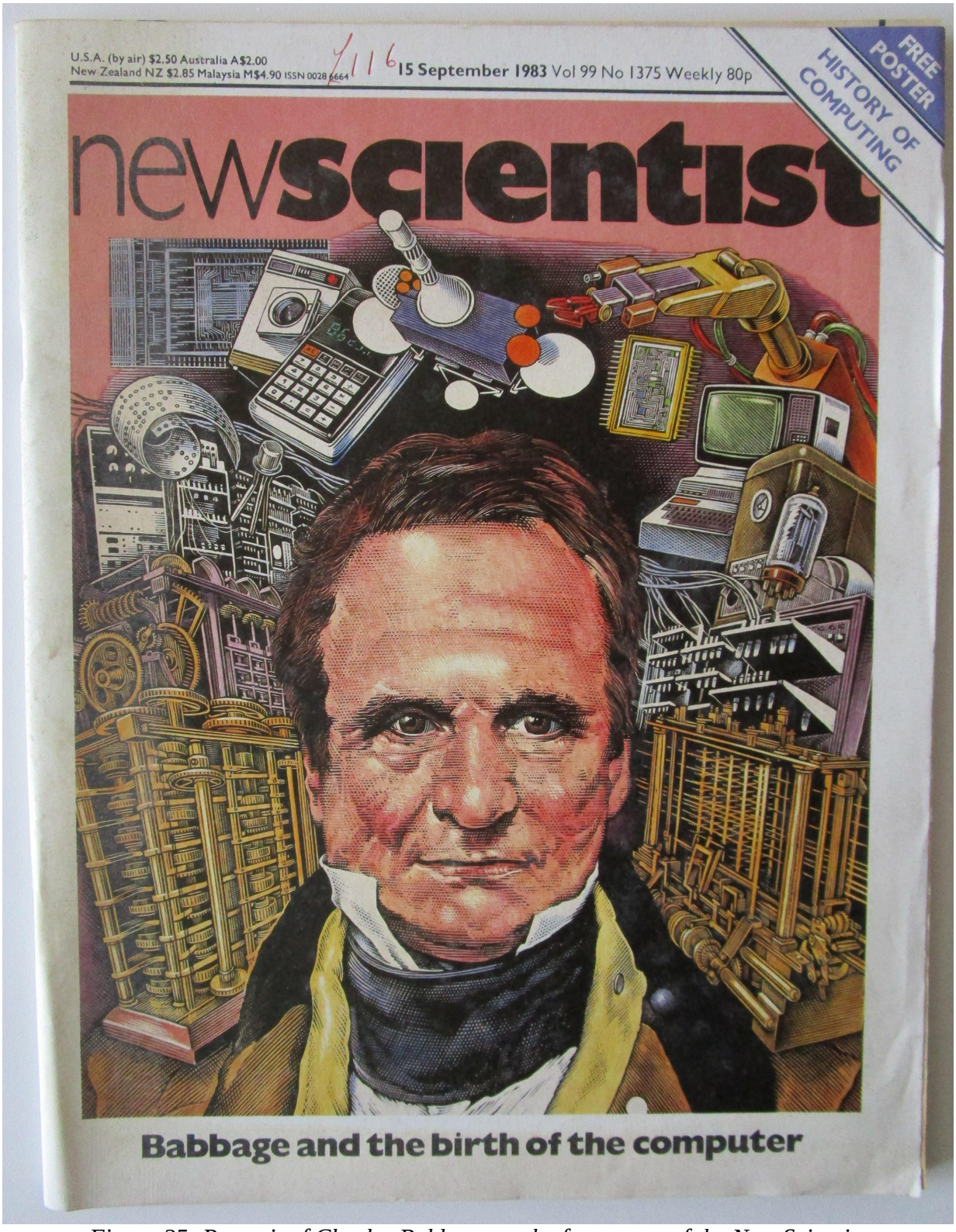


Figure 25: Portrait of Charles Babbage on the front page of the New Scientist (15-Sep-1983, Vo.99, No.1375)

Figure 26: Stamp issue by British Post Office 5-Mar-1991 on bicentenary of Charles Babbage's birth

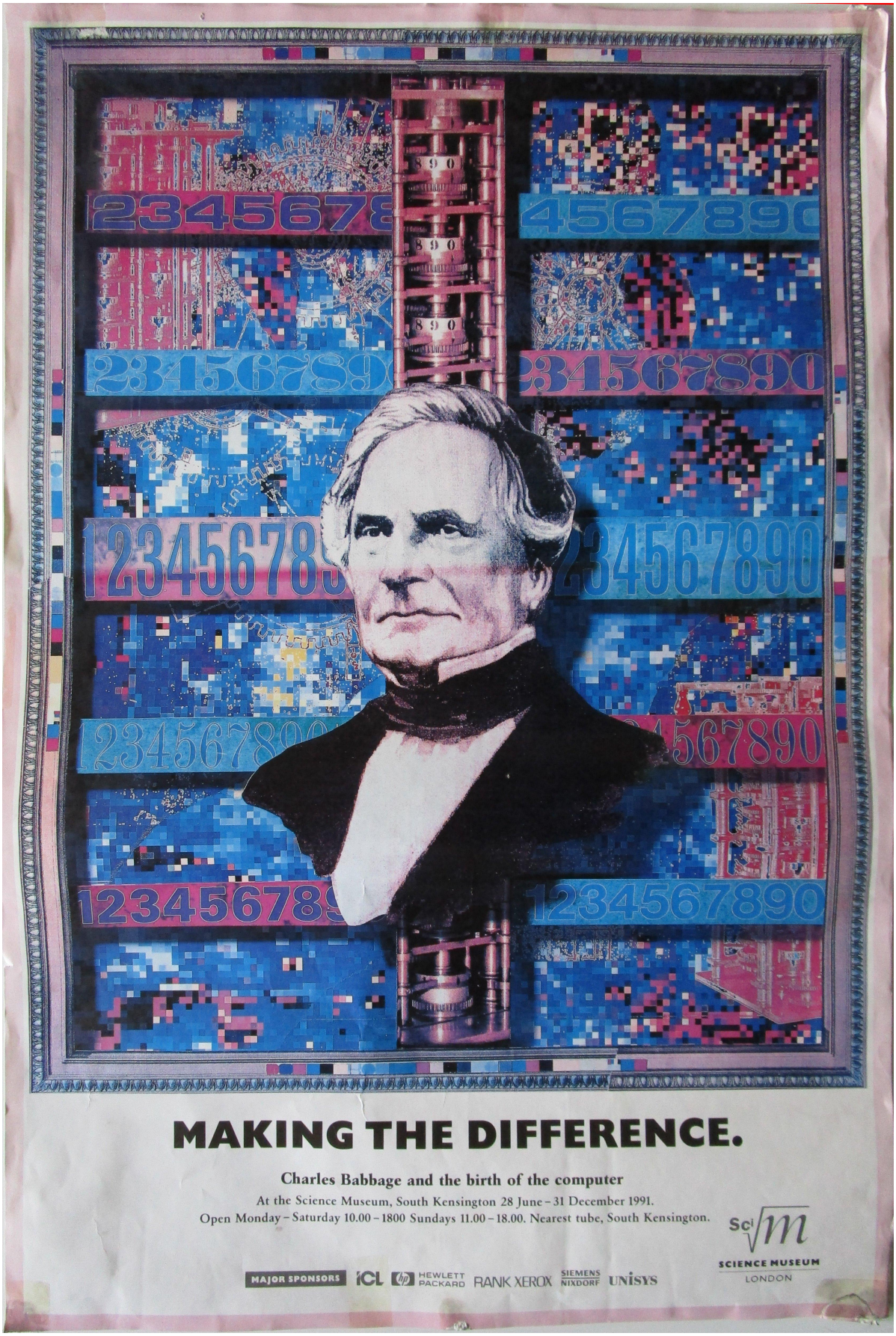


Figure 27: London Science Museum poster c.1991 on bicentenary of Charles Babbage's birth

Figure 28: Poster c.1991 on bicentenary of Charles Babbage's birth

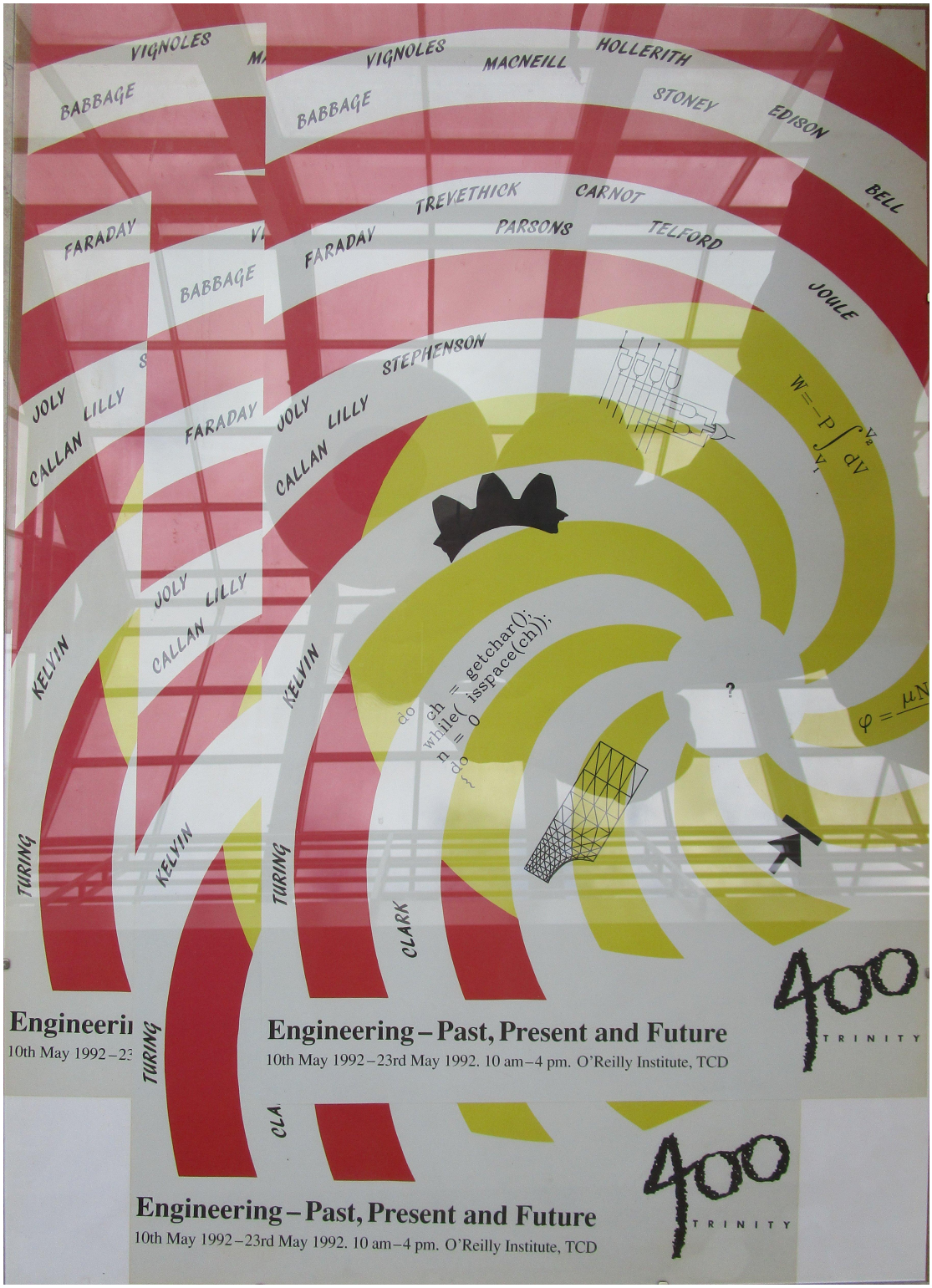


Figure 29: Poster for Prof.J.G.Byrne's 1992 TCD Quatercentenary exhibit, which included Babbage

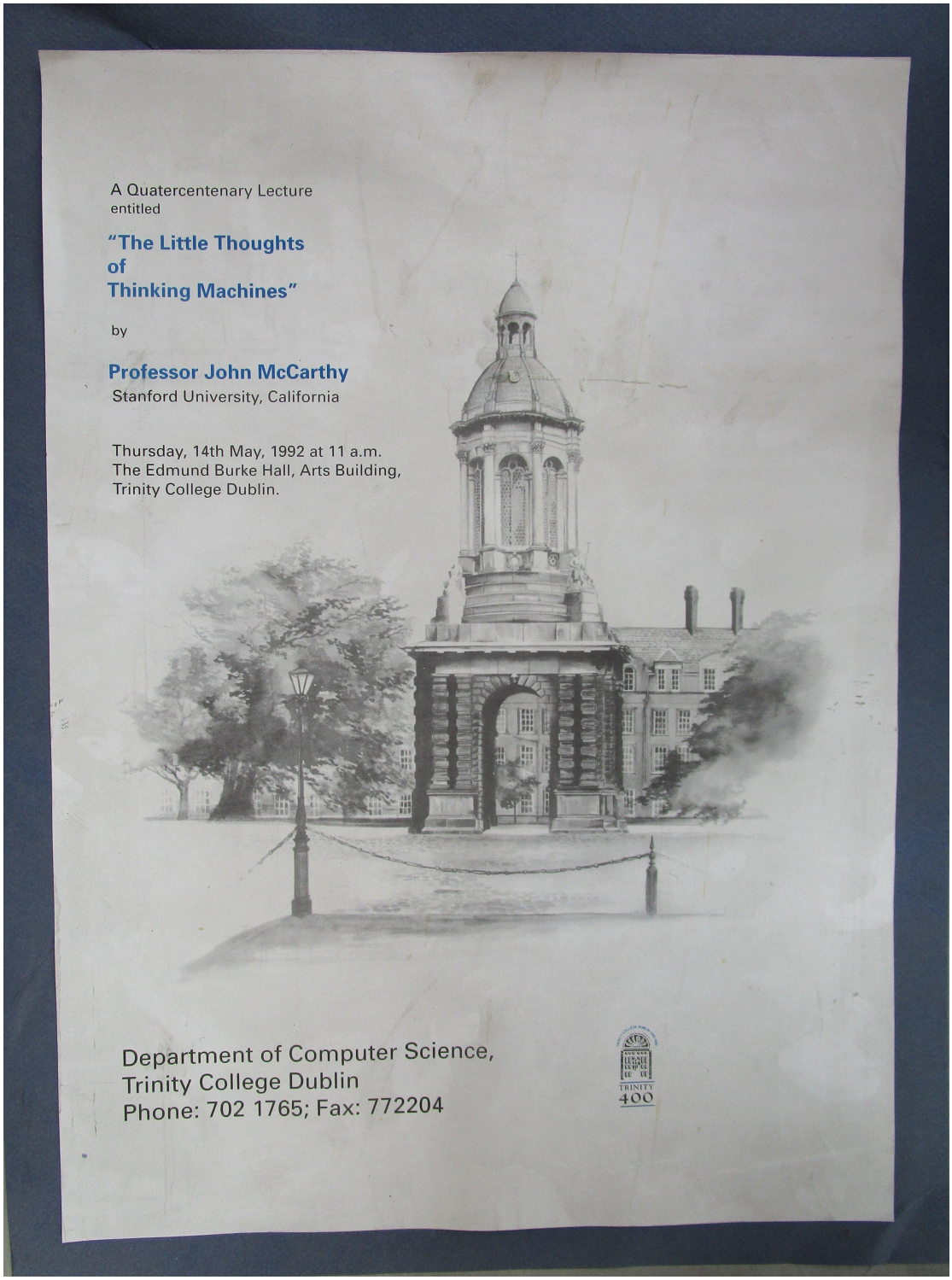


Figure 30: Poster for TCD Quatercentenary lecture by Prof.J.McCarthy

Figure 31: Queen Elizabeth I, 1533-1603
(from the National Portrait Gallery, by Marcus Gheeraerts the Younger, c.1592)