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Object name: Percy E. Ludgate Prize in Computer Science

Vintage: c.1909

Synopsis: Prize in memory of Percy Ludgate's novel 1909 design for an Analytical Engine, the next after Babbage's.

**Description:**

Percy Edwin Ludgate (1883-1922) was notable as the second person to publish a design for an Analytical Engine, after Babbage [6, 7]. Strangely enough, he was not a scientist, but an accountant, born in Skibbereen and employed in Dublin, Ireland, working in his spare time in isolation from 1903 to 1909, who was not aware of Babbage's work until later. Indeed his engine was based on multiplication using rods in shuttles plus 'slides' like a digital evocation of sliderules, with input on a perforated paper sheet or roll, while Babbage's was based on addition using cogs and wheels, with input on punched cards. From Prof.Brian Randell's 1982 paper "*From analytical engine to electronic digital computer: The contributions of Ludgate, Torres, and Bush*" in the IEEE Annals of the History of Computing [9]:

"Babbage had planned to use columns of coaxial toothed wheels to represent numbers ... Ludgate planned to represent each multidigit number by a set of sliding rods in a shuttle and to arrange such shuttles around a cylindrical shuttle box, which merely had to be rotated to bring the right number to the arithmetic unit.

...

Ludgate's planned arithmetic unit was even more novel ... indeed, as far as I know, unique-scheme for multiplication, based on what a contemporary delightfully termed "Irish Logarithms" [3]. Multiplication involved converting all the digits of the multiplicand and a single digit of the multiplier to index numbers [*'logarithms'*]; the index number corresponding to the multiplier digit was added to each of the index numbers corresponding to multiplicand digits (by additive linear motion); the results were then converted back to give a set of two-digit partial products."

Ludgate's engine had conditional and unconditional instructions with an opcode, two operand addresses, and one or two result addresses, multiplication was via partial products as above, and division was via successive approximation seeded from a table of reciprocals. It had 192 x 20-digits of memory, could multiply in 10 seconds and take logarithms in 120 seconds, could input and store data and programs, had a printer, and even a fledgling operating system, could be stopped at any stage to add new variables, and could execute subroutines. It was designed to be motor driven and would be a compact and portable 2-ft cube.

The use of a perforated paper sheet or roll presaged what became by the 1950-70s a widely-used method for program and data I/O, although punched cards and paper tape were widely used by the time of Ludgate, whereas Babbage's use of Jacquard's recently invented cards was entirely novel.

Ludgate published an account of his work in Apr-1909 [2], thanking Charles Vernon Boys. Fig.2 shows the first page of Ludgate's paper. C.V.Boys then reviewed this

paper in *Nature* in Jul-1909 [3], see elsewhere in this catalog, and in 1914 Ludgate wrote an article in the *Napier Tercentenary Celebration Handbook* [4].

Half a century later, when in the 1970s Randell was investigating Babbage and Lovelace, calculating machines and the prehistory of computing, the *Napier Centenary Handbook* was the second most obvious and accessible reference to consult about calculating machines (the first was Baxandall's *Calculating Machines and Instruments: Catalogue of Collections in the Science Museum* [33]). The former had a chapter on Analytical Engines, and this was by Ludgate, a name that was unfamiliar, which ended with the paragraph which led to Ludgate's 1909 article. The only person contacted who admitted any previous awareness of the Ludgate name was Maurice Wilkes (leader of the EDSAC team), but it's not known if he'd read the 1909 article. It has been suggested this was also the case for Howard Aiken (leader of the Harvard Mk.1 team) [34]. From the 1970s Randell highlighted Ludgate's work [8, 9].

Shortly afterwards an undergraduate project at University College Swansea explored the implementation of an electronic version of a Ludgate-type arithmetic unit [13, and see the related folder in this collection]. A subsequent analysis of Ludgate's machine by David McQuillan (a TCD maths graduate) is now online [10, 11]. Randell also provided an entry on Ludgate for the Dictionary of Irish Biography [12].

Although Charles Vernon Boys was thanked by Ludgate in his paper, it was conveyed to the publishers (RDS) by Prof.Conway. This may denote Conway was the referee, as was then common; it is known that Conway first reviewed the paper, and suggested Boys reviewed it. However, their influence has yet to be fully investigated.

*Trivia: Conway was Prof.Mathematical Physics at UCD for 40 years, then President of the Royal Irish Academy, then president of UCD*

Babbage's analytical engine (for which extensive drawings survive) has never been constructed, as it would be as big as a cathedral with precision mechanics. Nor (as far as is known) has Ludgate's machine been constructed yet, despite apparently being a better candidate than Babbage's, a 60cm cube not the size of a cathedral, and using low tolerance rods/shuttles not tight-tolerance cogs/wheels. The lack of drawings mitigates against reconstruction, which would be more a re-imagining (nonetheless an informal background modelling effort has begun in the School of Computer Science and Statistics, TCD, any help welcome). Given the complexity of the machine it seems unlikely Boys or Conway received copies of Ludgate's plans before his death (there would have been copious sheets of drawings), but the possibility that might have happened after death does exist. If his plans were discovered it would cause a sensation.

Ludgate appears to have found his index numbers ("Irish Logarithms") without recourse to theory. Andries de Man has created a useful educational emulator for these [35, 36]. Logarithmic indexes can be derived as *Jacobi indexes*, but Ludgate's indexes are different. As happens surprisingly often with novel inventions, in the same year as Ludgate's 1909 paper a sliderule with Jacobi indexes was designed by Prof.Schumacher of Germany [37] and later manufactured as the Faber Model 366.

Prof. John Gabriel Byrne of the Dept. Computer Science, Trinity College Dublin, collected an original offprint of Ludgate's 1909 paper in the RDS Proceedings, and in 1991 instigated a prize in memory of Percy E. Ludgate, awarded to the student who submits the best project in the senior sophomore year of the Moderatorship in Computer Science. Later Dr. Brian Coghlan donated a RDS Proceedings reprint containing Ludgate's 1909 paper and a 1909 *Nature* containing Boys' review, and Dr. Chris Horn donated a 1914 *The Handbook of the Napier Tercentenary Celebration* to this collection.

*Trivia: a John Byrne lived next door to Percy Ludgate's home*

### **Percy Ludgate's life**

It is said little is known about Ludgate himself. Again from Randell [9], and see Fig.1:

"But who was Ludgate ... an archivist stated that by all normal criteria, it was clear that Ludgate had never existed. Eventually, however, the heroic efforts of the librarian of the Royal Dublin Society, who telephoned all the Ludgates in the Dublin telephone directory, traced Ludgate's niece, who enabled me to obtain his picture"

Percy Ludgate's father Michael Ludgate was born c.1840. In 1858, aged about 18, he enlisted in the 2<sup>nd</sup> Battalion 20<sup>th</sup> Foot, becoming a sergeant in 1859 (Fig.8). He married Mary McMahon (born c.1841) in Winchester in 1863 (Fig.7). In 1871 he was posted to Bellary, Madras, India, and was pensioned in 1876 (Fig.8). He collected his pension in Skibbereen in 1882, where Percy was born. By 1890 the family had moved to Foster Terrace in Dublin, where Michael seems to have become a shorthand teacher (Figs.9, 10). In 1899 he was imprisoned for debt (Fig.11), and his wife Mary and sons Frederick, Alfred and Percy moved to Drumcondra, Dublin (Figs.20, 21). On release Michael appears to have lived apart from his family in Balbriggan, County Dublin. From Randell [9]:

"Percy Edwin Ludgate was born on 2 August 1883, at the house of his parents Michael and Mary Ludgate in Townshend Street, Skibbereen, County Cork, Ireland [Fig.12]. He was the youngest of four [surviving] children, all boys, his brothers being names Thomas, Frederick and Alfred. His father, Michael Ludgate, was born at Mallow, County Cork, and was married while serving in the army. He and his wife spent a part of their married life in India, where their first [surviving] child, Thomas, was born. The second [surviving] child, Frederick, was born in Winchester in 1879. Later the family moved to Ireland, first to Skibbereen, and later to Dublin, where Percy was brought up. It is believed that Percy Ludgate attended North Strand Parish School, and that he studied accountancy at Rathmines College of Commerce, Dublin, and was awarded a gold medal by the Corporation of Accountants on the occasion of his final examinations, which he passed with distinction. (Efforts to confirm these details of his education have not so far met with any success.) He attended St. George's Church, Temple Street, Dublin [Figs.17, 18]."

**Mystery to be Solved:** However, in Mar-2014 a "[G.J. K.](mailto:emailgk@btinternet.com)" <[emailgk@btinternet.com](mailto:emailgk@btinternet.com)> emailed a Microsoft Word document entitled "*Percy Edwin Ludgate – Irish Civil Service Saga*" [14] plus a Microsoft Excel spreadsheet of the Ludgate family tree [15] to Prof. Brian Randell, his interest having been stimulated by Mark Ward's article [28] about Randell's work. Although he identified himself as Gerry Kelly, the document 'Properties' identify the author as "user", and the company as "Hewlett-Packard". The

email address now elicits no response. Despite intensive searches the author has not been located and so it is not possible to properly attribute these documents; any information that can resolve this unsatisfactory situation is very welcome. The document and family tree substantially add to the collected information on Percy Ludgate. Further information about the Ludgate family has since been added to the family tree, see the updated version in Figs.3 and 4.

Gerry Kelly added in the email:

“The 1911 census revealed that Percy was one of thirteen children, five of whom were surviving. Your original profile only mentions four (which may have been the case at the time of Percy's death). I've managed to identify a further four (pos. five) but not the fifth surviving child. Their places of birth co-inside with the movement and Stations of the 60th Foot, 3rd Battalion to which Percy's father was attached.

Intriguingly, I also came across a record of Percy being born in Liverpool with a residence stated as Lancashire (attached). There is also a Civil Registration record of the birth in Skibbereen. Both the 1901 and 1911 Census state Place of Birth as Co Cork. It is possible that his mother was staying in Liverpool with relatives at the time (she was English born) or Percy arrived before her planned travel back to Ireland.”

The latter is almost certainly a red-herring. Gerry Kelly also emailed Randell a very useful summary of the 1901 and 1911 Irish Census (Figs.26, 27).

Michael and Mary Ludgate had thirteen children, most of whom died in early childhood, but as only 8 have been found, maybe the census taker added 5 surviving to 8 borne. Whatever the numbers, Mary Ludgate in particular must have had a significant burden of sorrow, as most of her family predeceased her.

Percy Ludgate, his mother Mary and brother Alfred lived at 30 Dargle Road, Drumcondra, Dublin. Another of his brothers, Frederick, wife Alice and family (including Violet Ludgate, see later) lived nearby in Drumcondra (Figs.19, 23). His eldest brother Thomas and wife Bedelia lived in Cork city (Figs.22, 25). Thom's Irish Almanac of 1891 for Dublin shows an Augusta Ludgate and a Fred Ludgate as shorthand teachers (like Percy's father Michael Ludgate). The 1911 Census (fig.24) indicates that Percy's mother had five surviving children, so Augusta Ludgate must have still been alive, and certainly the 1901 UK Census lists an Augusta Ludgate (born India) in Liverpool, and the 1911 UK Census lists an Augusta Ludgate (born India) in St.Pancras, London. Percy Ludgate's niece Violet, who was born in Tullamore, and subsequently lived nearby in Drumcondra, died in 1987 aged 84 [Fig.16].

Gerry Kelly's document is shown below, with original footnotes changed to citations:

### Percy Edwin Ludgate – Irish Civil Service Saga

It appears that Percy Ludgate had ambitions to join the Irish Civil Service. The following note outlines the chronology.

On 4<sup>th</sup> November 1898 the Civil Service Commission (CSC) placed notice in the London Gazette (LG) that Percy Edwin Ludgate was registered as a “Temporary Boy Copyist (New Class)” [16]. Although the upper age criterion was eighteen, he had just celebrated his fifteenth birthday three months before. These positions were

qualified through competitive examination [17] and would certainly be a sought after entry level for a career in the Civil Service. The Regulations and Remuneration for temporary boy copyists were also published in the LG and give some insight to the role [18, 19]. It marks the start of his ambition to join the Irish Civil Service. According to the 1901 Census on 31<sup>st</sup> March, Percy was working as a Boy Copyist at the National Education Office (17 ½ years old).

The CSC gave notice in the LG on 7<sup>th</sup> Nov 1902 of an Open Competitive Examination for situations as Assistant Clerks (Abstractors) [20]. Percy applied and subsequently sat the examination on 10<sup>th</sup> February 1903. The top fifty candidates were announced on 13<sup>th</sup> March and published in the LG on 17<sup>th</sup> March 1903. He was the top Irish candidate being placed nineteenth in the Order of Merit [21, 22]. This did not result in him being offered a position despite him passing a formal medical examination. A spot check in the LG of other Irish candidates on the Order of Merit confirms they were offered positions on 30<sup>th</sup> March. The Regulations for Assistant Clerks (Abstractors) are attached for reference [23]. Boy Clerks were not retained on the Register beyond the age of twenty and Percy would have had to step down from this position on 1<sup>st</sup> August 1903 (if indeed he stayed until this date or was released earlier).

The LG published the “Regulations respecting Open Competitive Examinations for Clerkships in the Second Division of the Civil Service” on 23<sup>rd</sup> August 1904 and gave further notice of an examination to be held on 18<sup>th</sup> October 1904 [24]. Percy competed successfully for this more senior graded clerkship but failed the medical examination. Consequently his certificate was not issued.

On 20<sup>th</sup> February 1905 in the House of Commons the “Case of Mr. Percy Ludgate – Irish Civil Service” was raised during Questions in the House [25]. The question was put by Mr. Timothy Harrington MP Dublin Harbour (and former consecutive three term Mayor of Dublin from 1901 to 1904). The Financial Secretary of the Treasury responded (Mr. Victor Cavendish MP, soon to be the 9<sup>th</sup> Duke of Devonshire). The oral question would have been pre-submitted through the Speaker of the House (William Court Gully) and oral answer prepared by The Treasury which was responsible for the Irish Civil Service at that time. The questioner petitions for Percy Ludgate to undergo a new medical examination with a view to being certified for one or other of the above positions. The answer corrects some factual inaccuracies posed in the question but the response is not supportive. It seems that Percy’s hope of a career in the Civil Service ended at this point. Percy was 21 years old at the time.

According to the 1911 Census, Percy was working as a Commercial Clerk at a Corn Merchant [26]. It could be that his experience in this business qualified him to be included on the associated War Office Committee “headed by Mr. T. Condren-Flinn, senior partner of Kevan & Son” [8]. If he had not already been working for this accountancy firm, the assignment may have introduced him to them and the offer of a staff position. It is ironic that having been rejected by the State, his later contribution to the War Effort would be so valued.

The London Gazette publishes promotions, exam results and public announcements by the civil service commission.

The question on Percy Ludgate to the House of Commons and its answer were as follows:

Irish Civil Service—Case of Mr. Percy Ludgate.  
Hansard HC Deb 20 February 1905 vol 141 cc619-20 619 [25]

§ MR. T. HARRINGTON (Dublin Harbour)

I beg to ask the Secretary to the Treasury whether he is aware that Mr. Percy E. Ludgate, of Drumcondra, passed the Civil Service examination for assistant clerkship, abstractor class, in October, 1903, and was medically examined by the physician selected by the Civil Service Commissioners and declared fit for the service; that, without having received an appointment as assistant clerk, he competed successfully for a second division clerkship, but failed to satisfy the examining physician as to his fitness; that, in consequence of the latter medical examination, Mr. Ludgate's certificate of qualification given in the former case has been cancelled, thus penalising him for one appointment by reason of his success in securing another; and, if so, whether he will take steps to have him medically examined with the view to his securing one or other of the above appointments, and will he say whether there is any difference in the medical standard of qualification required for assistant clerkship or second-division clerkship.

§ THE FINANCIAL SECRETARY OF THE TREASURY (Mr. VICTOR CAVENDISH,) Derbyshire, W.

The facts are 620 substantially as stated in the hon. Member's Question, except that Mr. Ludgate's certificate as assistant clerk was never granted, and therefore was not cancelled; and that the date of the examination referred to was February, 1903, and not October, 1903. As nearly a year had elapsed since Mr. Ludgate's medical examination for an assistant clerkship, it was necessary to re-examine him before issuing him a certificate for a second-division clerkship. The result of the medical examination proving unsatisfactory the Civil Service Commissioners were unable to grant a certificate for either position. The medical requirements are practically the same in both cases.

Very little is known of Ludgate's subsequent accountancy history. In Jun-1917 he sat and passed as top Irish candidate in the accountancy exams [31, and see Fig.6], of the Corporation of Accountants. From Randell [9]:

“Percy Ludgate worked as an auditor until his death, with the firm of Kevans and Son, 31 Dame Street, Dublin [29], which later transferred to Westmoreland Street, and is now part of the firm of Cooper Brothers. It seems almost certain that his work on the analytical machine was a private hobby which, according to his niece [Violet Ludgate], 'he used to work at nightly, until the small hours of the morning'. He never married. Quoting from another letter that I received from Miss Ludgate: 'Percy liked walking; he took long solitary walks. I do not think he had many other interests. He attended his parish church services regularly. He was very gentle, a modest simple man. I never heard him make a condemning remark about anyone. I would say he was a really good man, highly thought of by anyone who knew him. Always appeared to be thinking deeply.' The photograph is believed to have been taken a few years before his death.”

The Corporation of Accountants (1891-1939) merged with the Association of Certified and Corporate Accountants (ACCA) Dublin in 1939; the latter may have a record of their former member. According to the obituary of Dan McGing, a leading Dublin accountant who joined the Dublin-based chartered accountancy firm Keane & Co and who qualified as a chartered accountant in 1968: “In 1968, Dan's firm amalgamated with Kevans and Son, and Peterson Morrison & Co, and at the same time merged with Coopers & Lybrand, one of the then leading accountancy firms in the world” [30]. Coopers & Lybrand became Price Waterhouse Cooper (PWC), with an office in Dublin (they currently sponsor the Six Nations rugby). From Randell [9]:

“The one other person I have traced who has recollections of Percy Ludgate is Mr. E. Dunne, of Cooper Brothers, who joined the firm of Kevans and Son early in 1921. According to Mr. Dunne, 'My association with Mr. Ludgate was quite brief, but I had known him by repute for some time ... As a person he possessed the characteristics one usually associates with genius, and he was so regarded by his colleagues on the staff ... Like all men of his stature he was humble, courteous, patient and popular, and his early death closed a career that was full of promise for the future ... The books and other memoranda of his disappeared and whether they were taken away by Percy before he became ill, or treated as part of the flotsam when Kevans and Son moved to Westmoreland Street, I cannot say.' During the 1914-18 war he worked for a committee, set up by the War Office, headed by Mr. T. Condren-Flinn, senior partner of Kevans and Son. The task of this committee was to control the production and sale of oats, over a wide area of the country, in order to maintain a supply for the cavalry divisions of the army. This involved planning and organisation on a vast scale and Ludgate was much praised for the major role that he played. It is interesting to note that this provides a further parallel to the work of Charles Babbage who, because of his book *On the Economy of Machinery and Manufactures*, has often been called one of the originators of what is now known as 'Operational Research'.”

Percy Ludgate died on 16 October 1922 (Fig.13) shortly after his return from a holiday in Lucerne. A death notice appeared in the Irish Times two days later, see Figures 46 and 47. At the time he was living with his widowed mother and his brother Alfred, at 30 Dargle Road, Drumcondra, Dublin. Again from Randell [9]:

“He developed pneumonia, and his brother Frederick's wife (or rather, widow, since Frederick had died nine months earlier) who had helped to nurse Percy during his fatal illness, contracted pneumonia herself and died six days after Percy, leaving a daughter, Violet, who is now the sole surviving descendent of Michael and Mary Ludgate.

In his will [*Figs.14, 15*], drawn up some five years before his death, Percy Ludgate had appointed his brother Alfred as his executor, and had willed the residue of his estate to his mother. His assets, mostly government stocks, amounted to somewhat over £800, and included a mere £10 for his personal effects. There is no means of knowing whether his drawings and manuscripts relating to the analytical engine were amongst these personal effects. His mother died in 1946, aged 97, and his brother Thomas, who had lived most of his life in Peacehaven, Sussex, in 1951. If any drawings or manuscripts had remained in the family they would presumably have passed into the possession of Percy's brother Alfred. However, there is no indication

that this happened, and at Alfred's death in 1953 no such papers were found amongst his effects.”

Note that in the 1901 and 1911 Census the age of Ludgate's mother implies she was born in 1841, so if she died in 1946 she would have been aged 105-106; in fact she died in 1936, aged 95-96. The birthdate in the 1939 UK Registration shows Thomas Ludgate, Chailey (16 miles from Peacehaven), was Percy Ludgate's brother Thomas.

From Percy Ludgate's probate notices, including London assets of £192 (Fig.15), his total assets were £885.7s.4d (Fig.14), worth in 2017 about €57,000, so by age 39 he had modest assets. Beneficiaries of his will are clearly pertinent to locating his plans. Fortunately, even though the Customs House fire occurred on 25-May-1921 and the Four Courts fire on 28-Jun-1922, both predated his probate. Moreover, although the Irish civil war lasted until mid-1923, his original probate survives intact. And even more fortuitously, despite the fires and war, his original handwritten will survives, the only known example of his handwriting and his signature.

Percy Ludgate is an important person in Irish computing history, some may say a genuine Irish computing hero, although not quite of the stature of George Boole (whose work impacts on all aspects of modern life). His role is gradually being recognised in Ireland, where IT manufacturing is now a very important part of the economy. In Nov-2015 the *Ludgate Hub* initiative was formulated in his honour as a digital facility (a “state-of-the-art co-working space”, similar to a startup office) in his place of birth, Skibbereen, and opened in Jul-2016 [32]. There is certainly a strong case that a blue plaque in his memory be erected at 30 Dargle Road, Drumcondra.

Many thanks to the ‘Ludgate team’ of Dr.Brian Coghlan, Prof.Brian Randell, Paul Hockie, Trish Gonzalez, David McQuillan and Reddy O'Regan for engagement, guidance, detail and evidence, especially to Paul Hockie for expert genealogical research, Prof.Randell for the photo of Percy Ludgate, and the mystery Gerry Kelly.

Many thanks also to Prof.John Tucker, University College, Swansea, for permission to publish the 1973 undergraduate project report from by D.Riches (*An Analysis of Ludgate's Machine Leading to the Design of a Digital Logarithmic Multiplier*) from the Dept.Electrical and Electronic Engineering, University College, Swansea [13] in the related folder in this catalog.

On the Ludgate family, Dr.Susan Hood of the RCB Library [58] and the Rector of Mallow Church of Ireland, Canon Eithne Lynch, have been very gracious and helpful.

Many thanks to Adrienne Harrington of the Ludgate Hub, and Victoria and Simon Kingston of the West Cork History Festival 2019, and Lorcan Clancy, for arranging and recording *An exploration of the life of Percy Ludgate* at the festival, see the slides, audio, video, and podcast in the related folder in this catalog.

See the extensive set of documents and evidence in the related folder in this catalog. The homepage for this catalog is at: <https://www.scss.tcd.ie/SCSSTreasuresCatalog/> Click 'Accession Index' (1st column) for related folder, or 'About' for further guidance.

Any further information relating to Percy Ludgate would be very welcome. Please email the contact person given on the homepage of this catalog.