An exploration of the life of Percy Ludgate

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Trinity College Dublin
Why is he important?
Percy Ludgate: why is he important?

- 2nd person in history to design *general-purpose computer*
  General-purpose computer == analytical machine & vice-versa
  In theory can solve any solvable problem
Percy Ludgate: why is he important?

• 2\textsuperscript{nd} person in history to design \textit{general-purpose computer}
  General-purpose computer == analytical machine & vice-versa
  In theory can solve any solvable problem

• Two \textit{mechanical} designs before the electronic computer era:
  1843: Charles Babbage’s analytical engine
  1909: Percy Ludgate’s analytical machine – very different
Percy Ludgate: why is he important?

- 2nd person in history to design *general-purpose* computer
  General-purpose computer == analytical machine & vice-versa
  In theory can solve any solvable problem

- Two *mechanical* designs before the electronic computer era:
  1843: Charles Babbage’s analytical engine
  1909: Percy Ludgate’s analytical machine – very different

- Subsequently:
  c.1914: *Electromechanical* designs begun
  c.1937: *Electronic* designs begun
Percy Ludgate: why is he important?

- He was *Irish*
  1883-1922: born, lived, died in Ireland
Percy Ludgate: why is he important?

- He was *Irish*
  1883-1922: born, lived, died in Ireland

- Worked in Dublin, published in Scientific Proc. Royal Dublin Society
  1991: *Ludgate Prize* Computer Science at Trinity College Dublin
Percy Ludgate: why is he important?

- He was Irish
  1883-1922: born, lived, died in Ireland

- Worked in Dublin, published in Scientific Proc. Royal Dublin Society
  1991: *Ludgate Prize* Computer Science at Trinity College Dublin

- He was born in Skibbereen
  2016: *Ludgate Hub* opened in Skibbereen
Mysteries
Percy Ludgate: mysteries

- Percy Ludgate died young and single in 1922 aged 39
  By 1987 there were no other descendants of his parents

So records are scant. Randell said:
“an archivist stated that by all normal criteria, it was clear that he had never existed”
Percy Ludgate: mysteries

- Percy Ludgate died young and single in 1922 aged 39
  By 1987 there were no other descendants of his parents

So records are scant. Randell said:
“an archivist stated that by all normal criteria, it was clear that he had never existed”

- Yet he did exist, with large number of relatives and acquaintances

First objective == related documents, photos, memories

Do they still exist? If so, where?
Percy Ludgate: mysteries

• His 1909 paper explains key principles of his machine, but said:
  “not possible in a short paper … any detail as to the mechanism … therefore, confine myself to a superficial description, touching only points of particular interest or importance”

So machine details are scant too
Percy Ludgate: mysteries

His 1909 paper explains key principles of his machine, but said: “not possible in a short paper … any detail as to the mechanism … therefore, confine myself to a superficial description, touching only points of particular interest or importance”

So machine details are scant too.

In 1909 he said: “many drawings of the machine and its parts”
In 1914 he said: “Complete descriptive drawings of the machine exist, as well as a description in manuscript”

Ultimate objective == those drawings & manuscript

Do they still exist? If so, where?
Babbage’s Analytical Engine
Babbage’s Analytical Engine:

• Entirely mechanical, precision engineering
Just about realizable at the time, and \textit{BIG}
Babbage’s Analytical Engine:

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  Just about realizable at the time, and **BIG**

- Very novel concept at the time
  Processing done in MILL based on addition
  MILL + STORAGE via clockwork cogs & gears *[Liebniz c.1671]*
  Programming + Input + Output via punched cards *[Jacquard 1801]*
Babbage’s Analytical Engine:

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  Programming + Input + Output via punched cards [Jacquard 1801]

• Never built, but Babbage left extensive drawings
  These are now being put into modern engineering software

So perhaps it will yet be built
Ludgate’s Analytical Machine
STORAGE

RODS in SHUTTLES

more PROGRAM CONTROL

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How does INDEX work? Like a SLIDERULE (logarithmic)

- length = log(3)
- length = log(2)
How does INDEX work?
Like a SLIDERULE (logarithmic)

length = \log(3)

length = \log(2)

2 \times 3 = 6

length = \log(2) + \log(3) = \log(6)
Ludgate’s Analytical Machine:

- Entirely mechanical, realizable with technology of time, SMALL

Ludgate’s design was VERY different to Babbage’s
Ludgate’s Analytical Machine:

• Entirely mechanical, realizable with technology of time, SMALL

Ludgate’s design was VERY different to Babbage’s

• MILL to add like Babbage [Liebniz c.1671]
  INDEX to multiply via Irish Logs [Ludgate 1909]
  STORAGE via rods & shuttles [Ludgate 1909]
  Programming + Input + Output via punched paper [Jacquard 1801]
Ludgate’s Analytical Machine:

• Entirely mechanical, realizable with technology of time, **SMALL**

Ludgate’s design was **VERY** different to Babbage’s

• MILL to add like Babbage [*Liebniz c.1671*]
  INDEX to multiply via *Irish Logs* [*Ludgate 1909*]
  STORAGE via *rods & shuttles* [*Ludgate 1909*]
  Programming + Input + Output via punched paper [*Jacquard 1801*]

• Never built, Ludgate’s drawings never found
  We are trying to “re-imagine” his design

Difficult to say if it can ever be built
Ludgate’s Analytical Machine: features

• Only a few features are stated in Ludgate’s 1909 paper. The rest must be deduced by contextual analysis of the paper.

• Base operation is *multiply* not addition.
• Multiply is done with *Irish Logarithms* by INDEX.
• Long multiply starts at left digit of multiplier.
• Numbers must be fixed-point.
• Multiply result accumulation units first, then tens by MILL.
• Timing implies pipelining tens carryadds with following multiplies.
• Instruction set: ADD, SUB, MUL, DIV, LOG, STO, BN, BZ, BV, NOP.
• Two-operand addressing for load.
• Two-operand addressing for store.
• Fast for 1909: add/sub 3 sec, mul 20sec, div 90sec.
• Storage of 192 variables implies (64 inner + 128 outer) shuttles equi-spaced.
• Hence storage size implies binary storage addressing.
• Numbers stored via rod for sign & every digit protruding 1-10 units.
• Data input/output via punched number-paper (or upper keyboard).
• Program input/output punched formulae-paper (or lower keyboard), one instruction per row.
• Manual preemption.
• Small size: 0.5m H x 0.7m L x 0.6m W.
Ludgate’s Analytical Machine: unknowns

• Almost everything on construction is unknown

• How numbers were stored on rods (digits or ordinals)
• How storage cylinders were rotated to select a shuttle
• How a shuttle was moved to the processing unit
• Exactly how the INDEX logarithmic mechanism worked
• Exactly how the MILL add/sub mechanism worked
• Where fixed-point decimal point was
• How pipelining carryadds was done
• Exactly how the result was written back to a shuttle
• Whether divide/log cylinders interfaced with INDEX or MILL
• The timing of substeps in executing instructions
• How many number-paper rows per variable
• Almost everything about program control (controlpath)
• Almost everything else about input & output
• The shape and size of anything
• And most other details …
Historical perspective
Ludgate’s Analytical Machine: perspective

- **X** = no influence on modern computers
  Perhaps yet to be felt, in radically different computers (Nano …)

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<thead>
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<tbody>
<tr>
<td><strong>X</strong></td>
<td>(a) Mechanical not electronic: very different design concerns</td>
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<tr>
<td></td>
<td>(b) Programming, processing, storage, input/output: just like modern computers?</td>
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<tr>
<td><strong>X</strong></td>
<td>BUT modern architecture was from 1946 report by John von Neuman</td>
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<td>?</td>
<td>(c) Babbage basis was addition (as in modern computers)</td>
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<tr>
<td><strong>X</strong></td>
<td>(d) Ludgate basis was multiplication via logarithms</td>
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<td>(e) Babbage called his processing unit a MILL (as in Victorian factories)</td>
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<tr>
<td><strong>X</strong></td>
<td>This term was inherited by influential 1960s Manchester computers</td>
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<td>BUT the modern term is Arithmetic/Logic Unit (ALU)</td>
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<tr>
<td><strong>X</strong></td>
<td>(f) Ludgate included a MILL, but no obvious influence from Babbage</td>
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<td>(g) Ludgate program control, subroutines, preemption like modern computer</td>
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<tr>
<td><strong>X</strong></td>
<td>BUT did not influence those</td>
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<td>(h) Ludgate input/output via punched paper rolls &amp; keyboards</td>
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<td>Punched tape &amp; keyboards used in modern computers to mid-1980s</td>
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<tr>
<td><strong>X</strong></td>
<td>BUT influenced by telegraph not Ludgate</td>
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Ludgate’s Analytical Machine: perspective

- Historically, there are four *Fathers of Computing*:
  1843: Charles Babbage, analytical engine
  1854: George Boole, logic [UCC]
  1936: Alan Turing, theory of computing
  1937: Claude Shannon, digital logic
  1948: Claude Shannon, information theory
Historically, there are four *Fathers of Computing*:
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- 1937: Claude Shannon, digital logic
- 1948: Claude Shannon, information theory

Boole, Turing & Shannon impact all aspects of modern society. Babbage does not… BUT is very notable for 1st *analytical machine* in history. His importance is historical.

He raised idea of *thinking machines* (controversial, like AI today).
Ludgate’s Analytical Machine: perspective

- Historically, there are four Types of Analytical Machines:
  - 1843: Babbage (mechanical, novel)
  - 1909: Ludgate (mechanical, very different)
  - 1920: Torres y Quevedo & successors (electromechanical)
  - 1949: 6 x 1st modern computers & successors (fully electronic)
Ludgate’s Analytical Machine: perspective

• Historically, there are four *Types of Analytical Machines*:
  1843: Babbage (*mechanical, novel*)
  1909: Ludgate (*mechanical, very different*)
  1920: Torres y Quevedo & successors (*electromechanical*)
  1949: 6 x 1st modern computers & successors (*fully electronic*)

• Ludgate is *notable for 2nd analytical machine in history*
  AND: *Irish Logarithmic indexes*
  AND: *1st multiply-accumulator (MAC) in a computer*
  AND: *1st division by convergent series in a computer*
  AND: *very novel concepts for storage & programming*

Like Babbage, his importance is *historical*
Ludgate’s Life
childhood
Ludgate’s Life: childhood

- 2-Aug-1883: born in Townshend St, Skibbereen
  Father: Michael Edward Ludgate, Kilshannig, Mallow, ex soldier
  Mother: Mary Ann Ludgate née McMahon, Iden, Sussex

1883-89: Gap of 7 years – where were they?
Ludgate’s Life: childhood

- Thom's Directory for 28 Foster Terrace, Dublin (no longer exists)
  - 1890: Ludgate, Michael Edward, teacher of shorthand
  - 1891: Ludgate, Michael Edward, Fred, Augusta, teacher ...
  - 1892-98: Ludgate, Michael Edward, sons & daugh, teachers ...

24 Foster Terrace, Dublin (NOT no.28)
Ludgate’s Life: childhood

• Percy’s schooling:
  1890-91: St. George’s Infants School (age 7-8)
  1892-95: said to be North Strand National School (age 8-12)
Ludgate’s Life: childhood

• Family were Episcopalian (branch of Anglican Church)
  Attended St.George's Church, Temple Street, Dublin
adolescence
Ludgate’s Life: adolescence

• Percy’s schooling:
  1896-98: secondary school (must have excelled) – where?
Ludgate’s Life: adolescence

- 1898: London Gazette: Percy appointed “Boy Copyist” age 15
- 1899: Ludgate family moved to 30 Dargle Rd, Drumcondra, Dublin
  father Michael in Kilmainham Prison (non-payment of debt)
- 1900: brother Frederick married Alice Walshe
Ludgate’s Life: adolescence

• 1898: London Gazette: Percy appointed “Boy Copyist” age 15
• 1899: Ludgate family moved to 30 Dargle Rd, Drumcondra, Dublin
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• 1901 Census:
  Frederick & Alice moved to 24 Dargle Rd
  father Michael in Balbriggan (28kms from family)
  Percy as Civil Servant National Education Office (Boy Copyist)
Ludgate’s Life: adolescence

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  Percy as Civil Servant National Education Office (Boy Copyist)
- Mar-1903: top Irish candidate in exam for Assistant Clerks
  MUST have excelled at Classics & Maths at school – where?
  Passed medical
  Was not appointed to a position (others were) – why?
- Aug-1903: Boy Copyist post expired (at age 20)
Ludgate’s Life: adolescence

- 1903: *started work on Analytical Machine*
  1909 paper (submitted Dec-1908): “six years’ work”
  Private hobby: “work nightly, until small hours of the morning”
Ludgate’s Life: adolescence

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- Oct-1904: passed exam for Clerkships 2\textsuperscript{nd} Division of Civil Service
  BUT *failed medical*
Ludgate’s Life: adolescence

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  1909 paper (submitted Dec-1908): “six years’ work”
  Private hobby: “work nightly, until small hours of the morning”

• Oct-1904: passed exam for Clerkships 2nd Division of Civil Service
  BUT *failed medical*

• Feb-1905: “*Case of Mr. Percy Ludgate – Irish Civil Service*”
  in House of Commons
  by Timothy Harrington MP (owned *United Ireland & Kerry Sentinel*)
  Negative response → end of Civil Service career (at age 21)
adulthood
Ludgate’s Life: adulthood

- From 1903 (age 20) what did he do?
  1911 Census: Percy as Commercial Clerk (Corn Merchant)
  Question: *when did this begin? (1903 …)*

Corn & Potato Factors were mostly in old buildings near Smithfield.
Ludgate’s Life: adulthood

- Dec-1908: submitted paper to RDS
- Jul-1909: review of paper by Prof.C.V.Boys published in Nature
Ludgate’s Life: adulthood

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- 1914: “Automatic Calculating Machines”
  Edinburgh 24-27th July (WW1 started 28th July)
  focussed on Babbage
  Mentioned Ludgate’s 1909 design, and his difference engine design
Ludgate’s Life: adulthood

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  Mentioned Ludgate’s 1909 design, and his difference engine design

- 1914-18: War Office committee (production/sale of oats for cavalry)
  led by T.Condren-Flinn, Kevans & Son accountants
  Planning/organisation on vast scale, Ludgate greatly praised
mature student
Ludgate’s Life: mature student

• 1914-17: studied accountancy at Rathmines College of Commerce

Rathmines College of Commerce (NOW)
Ludgate’s Life: mature student

- 1914-17: homeward bound

Rathmines College of Commerce (THEN)
Ludgate’s Life: mature student

- 1914-17: homeward bound

Enroute: Patrick Street
Ludgate’s Life: mature student

• 1914-17: homeward bound

Enroute: Christchurch
Ludgate’s Life: mature student

- 1914-17: homeward bound

Enroute: Dame Street
Ludgate’s Life: mature student

• 1914-17: homeward bound

Enroute: O’Connell Bridge
Ludgate’s Life: mature student

- 1914-17: homeward bound

Enroute: Sackville Street
Ludgate’s Life: mature student

• 1914-17: homeward bound

Enroute: Rotunda Room
Ludgate’s Life: mature student

• 1914-17: homeward bound

Enroute: Dorset Street
Ludgate’s Life: mature student

- 1914-17: homeward bound

**HOME**: 30 Dargle Road
Ludgate’s Life: mature student

- Also he would have seen Easter 1916 …

Enroute: O’Connell Bridge and Eden Quay
Ludgate’s Life: mature student

- Also he would have seen Easter 1916 …

Enroute: General Post Office and Sackville Street looking north
Ludgate’s Life: mature student

- Also he would have seen Easter 1916 ...

Enroute: Metropole Theatre and Sackville Street looking south
maturity
Ludgate’s Life: maturity

- 1917: honours in Accountancy (gold medal)
- 19xx-1922: accountant, Kevans & Son: “possessed characteristics one usually associates with genius, ... he was so regarded by his colleagues on the staff ... humble, courteous, patient and popular”
Ludgate’s Life: maturity

- 1917-1922: the daily merry-go-round

Circular Route Tram No.27
Ludgate’s Life: maturity

- 1918: WW1 ends

Peace Day Parade 1919, College Green

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Peace Day Parade 1919
Dame Street, Dublin
© RTÉ Stills Library
Cashman Collection
Ludgate’s Life: maturity

• “Percy … took long solitary walks … gentle, modest simple man”
  “… never heard him make a condemning remark about anyone”
  “… a really good man, highly thought of by anyone who knew him”
  “… Always appeared to be thinking deeply”
Ludgate’s Life: maturity

- “Percy … took long solitary walks … gentle, modest simple man”
- “… never heard him make a condemning remark about anyone”
- “… a really good man, highly thought of by anyone who knew him”
- “… Always appeared to be thinking deeply”

- Never married
tragic end
Ludgate’s Life: tragic end

- Dec-1921: brother Frederick died of TB
- Oct-1922: pneumonia after holiday in Lucerne
- 16-Oct-1922: Percy Edwin Ludgate died aged 39
- 22-Oct-1922: Frederick’s wife Alice died (having nursed Percy)
Ludgate’s Life: tragic end

- Dec-1921: brother Frederick died of TB
- Oct-1922: pneumonia after holiday in Lucerne
- 16-Oct-1922: Percy Edwin Ludgate died aged 39
- 22-Oct-1922: Frederick’s wife Alice died (having nursed Percy)

- By 1953 he, his parents and siblings had died
  Those living in Dublin were all buried in the same grave
- By 1987 his only niece Violet died
Ludgate’s Life: tragic end

- **Unmarked** grave, occupants: Frederick, Percy, Alice, Mary, Alfred
  Owned by Alfred, who made no Will
  Can only be marked by close descendants
  **BUT** there are *no descendants*
Ludgate’s Life: unknowns

• Do any family letters/photos/documents exist? Where the family were from 1883 to 1890? Do any Drumcondra locals remember them?

• Was he at North Strand National School? Did he attend secondary school?

• When did he join Corn Merchant? When did he start accountancy? When did he join Kevans & Son? Do his tax returns exist?

• Where is evidence of praise for WW1 efforts?

• What ill health caused rejection by Civil Service (was it TB)? Did he go to Lucerne for treatment? Was he in poor health when he contracted pneumonia? What did he actually die of?

• Was there a relationship with Timothy Harrington MP? Does his civil service file still exist in UK?

• ...

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Ludgate’s Family
Ludgate’s Family: origins

• 17xx: MATTHEW & MARY LUDGATE
  leased Marble Hill, Kilshannig (5km west of Mallow)
  original 18th century house (except portico) with 4ft-thick walls
Ludgate’s Family: origins

<table>
<thead>
<tr>
<th>Name</th>
<th>Birth Year</th>
<th>Death Year</th>
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<tr>
<td>MATTHEW LUDGATE</td>
<td>17xx</td>
<td></td>
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<tr>
<td>MARY XXX</td>
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Elizabeth:  
- Elizabeth: 1736, d.1748

David:  
- David: 1736/7

Jane:  
- Jane: 1740

Anne:  
- Anne: 1743

Mary:  
- Mary: 1746

Mary:  
- Mary: 1747

John:  
- John: 1752

Robert:  
- Robert: 1755

Mary:  
- Mary: 1759

Mary:  
- Mary: d.1747

Mary:  
- Mary: d.1748
Ludgate’s Family: origins

17xx: MATTHEW LUDGATE married MARY Xxxx
Elizabeth, David, Jane, Anne, Mary, Mary, John, Robert, Mary
1736, 1736/7, 1740, 1743, 1746, 1747, 1752, 1755, 1759
  d.1747 d.1748

1778: JOHN married ELIZABETH FARMAR
Mary, Katherine, Matthew, Michael, Robert, Elizabeth
1779, 1781, 1784, 1786, 1788, 1790
John, Jane, David, John, Margaret, Robert, Thomas
1793, 1795, 1797, 1799, 1801, 1802, 1804
  d.1794

17xx: Robert Farmar m. Elisabeth Eeee
Elizabeth
17xx
Ludgate’s Family: origins

17xx: MATTHEW LUDGATE married MARY Xxxx
Elizabeth David Jane Anne Mary Mary John Robert Mary
1736 1736/7 1740 1743 1746 1747 1752 1755 1759
d.1747 d.1748

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Mary Katherine Matthew Michael Robert Elizabeth
1779 1781 1784 1786 1788 1790
John Jane David John Margaret Robert Thomas
1793 1795 1797 1799 1801 1802 1804
d.1794

1837: ROBERT married SUZANNA WILLIS
Thomas Michael Mary Elizabeth Robert Richard
1838 1839 1842 1843 1845 1847
David William
1849 1853

17xx: Robert Farmar m. Elisabeth Eeee
Elizabeth
17xx

17xx: Xxxx Willis m. Yyyy Zzzz
Suzanna
1814
Ludgate’s Family: origins

- 1\textsuperscript{st} generation (MATTHEW LUDGATE) farmed at MARBLE HILL
- 2\textsuperscript{nd} generation (JOHN LUDGATE) farmed at SKARRAGH
- 3\textsuperscript{rd} generation (ROBERT LUDGATE) farmed at SKARRAGH too
Ludgate’s Family: unknowns

- Did his parents own 30 Dargle Road? (and did separation indicate an unhappy marriage?)
  Only two (Thomas & Frederick) married:
  Thomas & Bedelia’s son died in infancy – did they actually live in Peacehaven?
  Frederick & Alice’s 2 sons died in infancy – does anyone remember surviving daughter Violet?

- Large number of relatives and acquaintances
  Paternal: 5 uncles + 3 aunts + at least 7 cousins
  Maternal: 3 uncles + 1 maternal aunt + (presumably) cousins
  In-Laws: Bedelia Buckley & Alice Walshe’s relatives (1 uncle + 3 aunts + 3 cousins)

- Where are his relatives and acquaintances? For example, where are his Cork relatives?

1877: William Joseph Ludgate married Mary Alice Ferris (uncle William was Cork journalist)
  William   Charles   Isabella   Joseph   Robert   Arthur   Edward   (cousins of Percy)
  1878  1879  1881  1885  1883  1887  1889

1908: Robert Willis Ludgate married Mary Barrett (cousin Robert also Cork journalist)
  Richard Gerald   Margaret Mary
  1910  1913

1941: Margaret Mary Ludgate married John Joseph Coleman
  Mary P. Coleman
  1942

  Where is Mary P. Coleman (Cork city)?

- Where are his mother Mary Ann née McMahon’s relatives?
- Where are his sister-in-law Alice (Alicia) née Walshe’s relatives (Dublin city)?
- Where are his sister-in-law Bedelia (Bridget) née Buckley’s relatives (Doneraile, Mallow)?
  ...
Recent discoveries
Recent discoveries

- Until Christmas 2018 it was thought:
  - That by 1953 his parents and siblings had died
  - That by 1987 his only niece Violet died
  - That there were *no other descendants* of his parents
Recent discoveries

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  That by 1953 his parents and siblings had died
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• BUT then, astonishingly, a descendant family was discovered!
  1935: Violet gave birth to a daughter *Barbara*
  1936: Barbara was privately adopted and renamed
        And was brought up overseas
Recent discoveries

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• BUT then, astonishingly, a descendant family was discovered!
  1935: Violet gave birth to a daughter Barbara
  1936: Barbara was privately adopted and renamed
        And was brought up overseas

• Barbara married and moved to America
  then gave birth to and raised 6 children
  now has 7 grandchildren and 6 great-grandchildren
  Circumspect DNA matching has found various ancestral branches
        AND the grandchildren are allowed to erect a grave marker …
**Ludgate Team:**
- Dr. Brian Coghlan, Trinity College Dublin (*computer science*)
- Prof. Brian Randell, Univ. Newcastle, UK (*1970s papers ++*)
- Paul Hockie, London, UK (*genealogy ++*)
- Trish Gonzalez, Florida, USA (*genealogy*)
- David McQuillan, Wokingham, UK (*maths & mechanical*)
- Reddy O’Regan, Skibbereen (*records & legalities*)

**Acknowledgements:**
- Gerry Kelly (*mysterious contributor*)
- Prof. John Tucker, Univ. College Swansea, UK (*Riches thesis*)
- Canon Eithne Lynch, Mallow Church of Ireland (*records*)
- Dr. Susan Hood, RCB Library, Dublin (*records*)
- *National Archives of Ireland* (*records*)
- *www.irishgenealogy.ie* (*records*)
Joint Public Call:

- Brian Coghlan, Trinity College Dublin <coghlan@cs.tcd.ie>
  Adrienne Harrington, Ludgate Hub <adrienne@ludgate.ie>

- Public Call for information about Percy Ludgate:
  - about relatives
  - about acquaintances
  - related documents
  - related photos
  - related memories
  - Ludgate’s drawings

- The smallest snippet can often be a key!

- Also see: https://scss.tcd.ie/SCSSTreasuresCatalog/ (click on Ludgate)