ARTICLES, REVIEWS and other PAPERS

Aeberhard, J., (2011), **From Tea Shops to Computer Company: The Improbable Story of LEO (Lyons Electronic Office)**, published as background story for 60th anniversary of roll-out of first LEO job. See
http://www.computinghistory.org.uk/pdfview/web/viewer.html?file=/downloads/56323 - magazineMode=true
Dropbox https://www.dropbox.com/s/gmoxhwycv79jg2l/LEO%2060th%20editorial%20background er.doc?dl=0

- Aeberhard, J., (2019), **Reminiscences of my PR role with LEO**. In Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 14-16, Autumn.
    - Aeberhard, J., (2019), **From Tea Shops to Computer Company: the Improbable Story of LEO**, Resurrection, Number 88, Winter/Spring, 2019/2020, online at and http://www.computerconservationsociety.org/resurrection/res88.htm
-
- Aeberhard, J (2022) LEO Remembered published 28thSeptember 2022 – **Press** Release**.**
    - **IN AT THE START OF BUSINESS COMPUTING**
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    - What was it really like to be in at the start of business computing, to attempt what no-one had done before, to develop totally new ways of processing and managing data that would eventually completely change the way business operates across the world?
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    - A flavour of what it felt like can be had from the reminiscences of over 80 people who variously worked on LEO (Lyons Electronic Office), the world's first computer to run business applications, and its successor machines, now being published as a book this month (28 September). Coming out strongly through the book, "LEO remembered," is the shared excitement from those involved - designers, engineers, programmers, operators and sales people alike - in knowing that they were onto something big.
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    - Noting this, the book's joint editors, Hilary Caminer and Lisa McGerty, comment: "First hand testimony takes us to the heart of the day-to-day routine, the frustrating task of locating and mending hardware and software faults, the camaraderie built from working together on never-before-tackled systems and programming problems, the ethos that LEO instilled and that stayed with its people in their later, often very distinguished careers."
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    - **LEO story**
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- The LEO story began in 1947 when the board of the large J. Lyons & Co catering group, then under the threat of being swamped by paperwork, stumped up the princely sum of £3000 (£83,000 in today's money) to help fund the completion of Cambridge University's large scientific computer known as EDSAC. Once it was working, Lyons adapted EDSAC to become LEO for the very different needs of business where relatively straightforward calculations, but in much larger volumes, were involved.
- This was in no way a straightforward task. Frank Land, one of the ground-floor LEO pioneers, commented: "What is not generally appreciated, and is part of the remarkable story that unfolded, is that Lyons, famed for baking bread and feeding people, actually built the computer using their own resources on site at their Cadby Hall headquarters".
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- The bold decision by the Lyons board bore fruit when, in November 1951, just over 70 years ago, the resulting LEO ran its first live business application, a bakeries valuation job, the first in the world to do so. Lyons retained this lead through most of the 1950s and early 1960s, setting up a company, LEO Computers Ltd, to develop and sell computers at home and overseas before eventually merging with International Computers and Tabulators (ICT) in a final fling for the British computer industry.
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- The LEO story ended in 1981 when the last of the LEO computers, a LEO 326, one of a large number operated by the Post Office for telephone billing, was finally turned off, the same year coincidentally when the last of the Joe Lyons famous teashops closed its doors.
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- 'LEO remembered' is published, with financial support from the AIT Trust, by the charities LEO Computers Society and the Centre for Computing History, based in Cambridge. It has a foreword by Dame Stephanie Shirley CH and an introduction by Professor Frank Land OBE.
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- The book is available, priced £8 plus postage, from LEOremembered@leo-computers.org.uk

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- ends –

- **Photo caption:**

- Frank Land, now in his nineties, an early LEO programmer, with the new book, “LEO remembered.” He led the LEO company’s early sales and systems consultancy team for 15 years and then took his experience in another direction into academic research and education.
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- 1. The LEO Computers Society is committed to promoting and protecting LEO's history. Membership of the Society is open to all ex-employees of LEO Computers and its succeeding companies, anyone who worked with a LEO computer and anyone with a specific interest in the history of LEO Computers. Among its members are pioneers from the very early days of computing and membership is currently free of charge. Visit www.leo-computers.org.uk. Follow @leocomputers51.
- 2.. Established in 2006, the Centre for Computing History is a charitable heritage organisation with a strong focus on learning. Since opening in Cambridge in August 2013, the Centre has helped people understand how tech has shaped the modern world and revolutionised the way we live, work and play through interactive displays and exhibitions, our schools programme, learning events and

workshops, and an astonishing collection of computers old and new. Visit www.computinghistory.org.uk. Follow @computermuseum

- Ainsworth, B. (2013) **Leo Computers in Australia** in Museum Victoria Collections http://collections.museumvictoria.com.au/articles/12682
- Agar, J. (1996) **The Provision of Digital Computers to British Universities up to the Flowers Report** (1996), Computer journal, Vol. 39, No. 7, pp 630-642.
- Anderson, D., Delve, J. (2004) **Pioneers of Payroll on computers**: LEO, the Army, the Navy Dockyards and De Havilland, IEEE Annals of the History of Computing, ISSN: 1058-6180.
- Anon, (1951), **A Royal Visitor: Princess Elizabeth visits Cadby Hall**, Lyons Office Journal, Vol. 2, Number 21, March. Report with photo of the visit which includes meeting John Simmons and T.R. Thompson showing LEO I to Royal Party. A copy is held in the London Metropolitan Archive under catalogue number ACC/3527/310
- Anon (1947-1954) **LEO Chronicle**, Lyons and Office Management Association. Papers of John Simmons, Reference Number: 363/S4/11, Warwick University, Modern Records Centre. The Chronicle is a diary of events and activities relating to the development and operation of LEO computing – an invaluable source. http://contentdm.warwick.ac.uk/cdm/ref/collection/leo/id/242
- Anon (1949) '**A non-technical description of E.D.S.A.C'**. How the Cambridge Electronic Calculator works, J. Lyons & Co., June 1949. http://www.leo-computers.org.uk/images/How%20EDSAC%20Works.pdf
- Anon (1952) **'The Laymans Guide to LEO'**, J. Lyons & Co.
  Intended for the Lyons' Management only a small number were printed. The original version was about 75 pages, though later versions were much longer. Copies are held in the John Simmons Archive at Warwick University Modern Records Centre Showcase: Pioneers: Innovators in Science and Technology, and can be downloaded from: http://contentdm.warwick.ac.uk/cdm/ref/collection/leo/id/263 http://www2.warwick.ac.uk/services/library/mrc/explorefurther/images/pioneers/ files as item MSS.363/S4/12 and at the University of Manchester John Rylands Library, http://archives.li.man.ac.uk/ead/html/gb133nahc-leo-p1.shtml, filed as item C130. Appendix 13 in Peter Bird's book LEO: The First Business Computer is extracted from the guide.
- Anon (1953), **Personality Profile T.R. Thompson**, Lyons Office Journal. Vol. 1, July 1951 to June 1953, available as part of the Lyons archive held at the London Metropolitan Museum, catalogue entry: " ACC/3527/311 Lyons Office Journal. Published for J. Lyons and Co. Ltd. Clerical department.
- Anon (1954) **LEO Lyons Electronic Office,** Published by J. Lyons & Co., Cadby Hall, Feb 16th.
- Anon (1954) **'Electronic Abacus'**, The Economist, pp. 789-791, 13th March, probably authored by Mary Goldring.
- Anon (1955) Leaflet on "**Computer Training Courses**", by LEO Computers.
- Anon (1957) **It's Quicker by Computer: 'LEO' Works our Rail Distances**, The Times, June 24.

- Anon (1957) **Political & Economic Planning, 'The LEO Computer: a case study in the use of an electronic computer in routine clerical work',** Three Case Studies in Automation, July, probably authored by Leonard Tivey.
- Anon (1960) **'Getting to grips with computers'**, The Times Newspaper, reprinted in The Times Newspaper, August 4th 2000.
- Anon (1960) '**Notes on Commissioning of LEO Automatic Office at the Ministry of Pensions'**, The Vol. 15Computer Journal, British Computer Society, Vol. 2, No. 4, pp.198, January.
- Anon (1960) **Advanced Data Processing**, a clip from the "Engineer" for 22 July 1960, probably the earliest reference to LEO II in print, and concentrating on the microprogramming feature.
- Anon (1960) **Command by Magnetic Rings**, a clip from New Scientist for 21 July 1960.
- Anon (1960) **Introducing LEO III**, a clip from The Stock Exchange Gazette for 12 August 1960, announcing the development of LEO III in more general terms.
- Anon (1962), **LEO: Three Jobs at Once**, Advertisement in for LEO III Computer Journal, Vol 5, Number 1. A copy of the advertisement is held at the Cambridge Centre for Computer History and can be obtained from Jude Brimmer the archivist
- Anon, (1963-64), **New Computers for the Post Office,** Post Office Telecomms Journal**, Vol, 15,16,** an account with photos of the Post Office purchase of two LEO III computers for over £1 million.
- Anon (1963) **EE-LEO Brochure for LECTOR System**, Data Processing Journal, February, page 15.
- Anon (1964), **Quis LEO Aptitude test**, comprising Introduction and Explanation, Instructions for giving test, the Test Itself, Correct answers' The document as digitized by John Hoey in Australia and a copy is available from Frank Land, f.land@lse.ac.uk
- Anon, (1965-66), **The Post Office enters the Computer Age,** Post Office Telecomms Journal, Vol. 16.17, reporting on the purchase of 5 computers valued at more than £2 million.
- Anon (1965) **Daily Mail Obituary for LEO I**, 9th January. Plus other items about LEO initiatives in Eastern Europe.
- Anon (1967), September **LyonsMail** short note and photos of Lyons Managing Director Samuel Salmon viewing restart of LEO III/7 following the catastrophic fire at the Lyons computer installation. More information on the incident can be found in Peter Bird's book LEO: The First Business Computer page 164 to 166.
- Anon, **LEO Computer**, a useful summary of the LEO story which does need editing, http://en.wikipedia.org/wiki/LEO_(computer)
- Anon, (circa 1958), **LEO II at Stewarts and Lloyds**, in http://www.corby.gov.uk/sites/default/files/Electronic%20Computers.pdf
- Anon, **LEO Computers in Australia**, http://collections.museumvictoria.com.au/articles/12682

- **Anon** (2016), London Remembers Website, **Erection of LEO Plaque,** brief report and photos of plaque https://www.londonremembers.com/subjects/leo-computers-society?memorial_id=10108

- Anon (2017), **Quotation from a Director of J. Lyons**, "I attended a Board meeting when for 1 hour and 59 minutes there was a heated debate about the price of a cup of tea in Teashops.
'A rise of a penny or half a penny!'
At the end of the row John Simmons, of whom everyone was in awe, asked for a further 2 million pounds for work on Leo. Passed without debate."

- Anon, (2018), **Meet LEO, the World's First Business Computer**, London Science Museum Website. The LEO story including photos in 1200 words, **STORY CONTENT:** What is the LEO computer? Why did Lyons tea shops need a computer? Who built LEO—and how? What tasks could LEO carry out? What difference did LEO make to efficiency? What else was LEO used for? Were there other computers to rival LEO? Is LEO still being used today? Find out more. https://www.sciencemuseum.org.uk/objects-and-stories/meet-leo-worlds-first-business-computer

- Anon, (2021), An Introduction to Silicon Valley's Computer History Museum including listing of LEO artefacts and an introduction to extensive Oral History collection.

- Archibald, H., (1997), **Stewarts and Lloyds Steelworks**, in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 20, pp. 243 – 248.

- Aris, J.B.B., (1997), **The LEO approach an evaluation** in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 4, Chapter 27, pp.321-336.

- Aris, J.B.B. (1996) **'Systems Design – Then and Now'**, Resurrection, Journal of the Computer Conservation Society, Summer.

- Aris, J.B.B., (1998), **Inventing Systems Engineering**, Proceedings of Conference Computers in Europe: Past, Present and Future, Kyiv, pp 33 – 46, October.

- Aris, J.B.B. (2000) **'Inventing Systems Engineering'**, IEEE Annals of the History of Computing, Vol. 22, No. 3, pp. 4-15, July-September.

- Aris, J.B.B., Land, F.F., Mellor, A. (eds.) (2003) **LEO Conference Report**, Journal of Strategic Information Systems, Volume 12, Issue 4, Pages 253-398, December.

- Avery, R. (2001) **The World's first commercial computer went into operation 50 years ago in Britain. Who developed it?**, The Times Supplement Tomorrow's Today, 24 page supplement sponsored by Microsoft, pp 20-21, May 31st. Hilary Caminer holds a copy.

- Beck, Arnold, (194) **Oral History,** Electronic Engineer, interviewed by William Asprey of the Charles Babbage Institute, describes working for Standard Telephone and Cables in the late 1940s on designing thermionic valves for Lyons and EDSAC which failed. Asked why they failed he notes "Mainly because it wasn't reliable enough. I don't want to make excuses, but when development things like that started, people didn't really appreciate the standards of reliability that were required. Down the

road here at EDSAC they didn't appreciate the troubles they'd get with the cathode failures on lots of their double diodes" https://ethw.org/Oral-History:Arnold_Beck

- Behr, B. (ed.) (2014) **LEO Computers Society Newsletter**, Autumn, with contributions from Jessica Bradford (Science Museum), Peter Byford, Bernard Behr, David Holdsworth (Computer Conservation Society), Frank Land and Michael Storey. http://www.leo-computers.org.uk/images/2014_Newsletter.pdf
- Behr, B. (ed.) (2015) **LEO Computers Society Newsletter**, summer, with contributions from Peter Byford, Ralph Land, Norman Witkin, Neil Lamming, Gloria Guy, Bill Sant and David Holdsworth. http://www.leo-computers.org.uk/images/NewsletterSummer2015.pdf
- Bentley, R. (2003). **The Teashops that ruled the IT World,** Computer Weekly. Available at: http://www.computerweekly.com/feature/The-tea-shops-that-ruled-the-IT-world Based on review of Georgina Ferry's book **A Computer called LEO.**
- Bergin, T. J. (2007) **Mainframe Computers**, a listing of mainframe computer manufacturers providing a chronology of their main products, including LEO Computers and the successor companies: IT
- Bergin, T. J (1997) **User-Driven Innovation: Review**, ACM Computing reviews, July, http://www.computingreviews.com/review/Review_review.cfm?review_id=120073&listname=search – *link takes you to the login page of 'Computing Reviews' – need to be a member of ACM to access.*
- Berry, T. (2002) **Lessons from LEO the Lyons**, Financial Director, January 2002 http://www.financialdirector.co.uk/financial-director/feature/1742501/lessons-leo-lyon
- Bidmead, C. (2011) **David Caminer, creator of the first business computer**, Reg Hardware, Unsung Heroes of Tech, 27th September 2011 http://www.reghardware.com/2011/09/27/heroes_of_tech_david_caminer/
- Bird, P. (1990/91) **LEO, the Pride of Lyons**, British Journal of Administrative Management, pp 20,21, included is brief biography of Peter Bird on page 20. https://www.dropbox.com/search/personal?path=&preview=Peter+Bird+Bio.doc&qsid=469381169251703462780611097759 43&query=peter+bird&search_token=maaZCi5EZfs9ghMHde3MaOmE5gIkeIs7mVlUbNhfSkQ%3D
- Bird, P., (2011), **Thomas Raymond Thompson. Obituary**, Oxford Dictionary of National Biography, online, 19th May 2011
- Blobel. J., (2019), **The Future of Computer History**, ITNOW, pages 65-66, December issue. Blobel, University of Paderborn, advocates the need to teach computing history for an understanding of IT today.
- Blyth, T. (2015) **Information Age? The challenges of displaying information and communication technologies**, Science Museum Communications Spring 2015, http://dx.doi.org/10.15180/150303 The **Thein** October 2014 including the LEO exhibit.
- Bodsworth, V., (2019), Editor: **LEO Matters, Newsletter of LEO Computers Society**, Vol. 5, Spring, pp 1 – 14. The issue includes articles by Vince Bodsworth, Edd Thomas, Lisa McGerty, Graham Briscoe, Alan Cooper, Tony Morgan, and Dag

Spicer, as well as an introduction by Peter Byford. https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf

- Bodsworth, V.,(2019), **The National Museum of Computing History "TNMoC"**, LEO Matters, Vol. 5, Spring 2019, pp. 2 – 4, Newsletter of the LEO Computers Society, https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf
- Border, A.. (2019), **Lifetime AIS Member Receives OBE**, AIS News and Press: Insider, https://aisnet.org/news/455414/Lifetime-AIS-Member-Receives-OBE-Award.htm
- Bradford, J. (2014) **Information Age at the Science Museum celebrates LEO,** in Behr, B. (editor) LEO Computer Society Newsletter: http://www.leo-computers.org.uk/images/2014_Newsletter.pdf
- Braithwaite, M. (1998) **User-Driven Innovation: the World's first Business Computer: Review,** European Journal of Information Systems, Vol.7, pp 74-75.
- Brimmer, J., (2019), Rebuilding the LEO Archive: An Archivists View, in Caminer, H., (Editor), Behr, B., (Production), (2019). LEO Matters, LEO Computers Society, Vol 6, pages 3-4, Autumn.
- Brindley, H. (2008) **On being employed by a computing pioneer – Leo Fantl**, an account of the author's experience working in South Africa for LEO, slapHappe, https://slapphappe.wordpress.com/2008/06/30/on-being-employed-by-a-computing-pioneer-leo-fantl/
- Bringslid, M. M. (2016) **7 Ways Computers will change our lives**, Blog on Eric Scmidt Presentation , LSE 14th October, http://blogs.lse.ac.uk/studentsatlse/2016/10/18/7-ways-computers-will-change-our-lives/
- Briscoe, G. (1994) **The First Business Computer**, Review of Peter Bird's book in Management Services, February, p. 35.
- Briscoe, G. (1994) **Computing was a piece of cake**, The British Journal of Administrative Management, February/March, p 23 and 27.
- Briscoe, G. (2016) **1950s Computer Training Package**, Resurrection, Issue Number 73, pp25-33.
- Briscoe, G. (1967-2000) **Graham Briscoe Productivity Collection Pamphlets**, a collection of texts and http://www.open.ac.uk/libraryservices/documents/Graham_Briscoe_Productivity_Collection_pamphlets.pdf

Briscoe, G, (2019), **LEO and the Managers: Unearthing its ownership**, an account of the research carried out by Graham Briscoe to discover the copyright holder for the John Simmons book **LEO and the Manager** and the successful transfer of publication rights to the LEO Computers Society. Resurrection, Issue Number 85, Spring 2019, pp. 25-26. The LEO archive in Dropbox includes three documents including a letter from Stuart MacNab, Director J. & Co. dated 28th January 2019, addressed to Peter Byford chair of LEO Computers Society , confirming the transfer of intellectual property rights of documents relating to LEO I to LEO Computers Society. https://www.dropbox.com/s/9e2er7hfs4d2a6u/Graham%20Briscoe%20re%20Lyons%20System.docx?dl=0 and https://www.leo-

computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf LEO Matters, Vol. 5, Spring 2019. pp. 8 – 9,

- Brooks**, T., (2021),** LEO, A Pioneer of Computing for Persons with Disabilities**,** to be published in **LEO Matters**. **This a was written by Tom Brooks, who joined LEO as a programmer in June 1963 working on several projects on the Post Office contract including Stores, Telephone Billing, P O Statistics, PO Savings Bank. The article reports on the project using the Post Office LEO machines to produce a Braille system to be used by blind programmers. The successful project was involved the Post Office, the RNIB and LEO personnel and was launched in response to the agreement between the Post Office and EELM for EELM to support Post Office 'social' applications**.

- Bryant, A., Land, F.F., (2020, 2021), A Conversation between Frank Land and Antony Bryant, paper published in Journal of Information Technology. Part 1 and 2 published online June 5, 2020 Research Article. and accepted for publication over two issues in 2020 Part 1 Part 1 in print version, Vol. 35, issue 4, pages 361 – 375, A 'conversation' between Frank Land (FL) and Antony Bryant (AB): PART I - Antony Bryant, Frank Land, 2020 (sagepub.com)

- **Part 2 in Vol. 36, issue1 pages 39 -55, March 2021. A 'conversation' between Frank Land [FL] and Antony Bryant [AB] – : Part 2 - Antony Bryant, Frank Land, 2021 (sagepub.com)**

- **Reprinted as a selected paper in Schlagwein, D. (Editor, December, Thirty-Five Years of the Journal of Information Technology. To celebrate this, the editors have selected and made open access JIT sample papers across the years via a special collection: https://journals.sagepub.com/page/jin/35yearsjit**

- Buelow, R., (2021), **Business Computing**, Nixdorf Museum Forum, commemorating LEO I's first business application in November 1951. The blog notes *inter alia* the filing of German patents for the LEO computer in the Munich Patent Office in 1964. https://www.hnf.de/en/home.html

- Butt, P. J., (2011), **TR Thompson –** The Leo Computer: A London connection**, GLIAS Newsletter,** GREATER LONDON INDUSTRIAL ARCHAEOLOGY SOCIETY, The newsletter copies extracts from the Oxford Dictionary of National Biography the obituary of TRT, and adds a comment from Roy Irons who had been an operator on the LEO II.9 at Ilford Ltd. http://www.glias.org.uk/news/256news.html

- Byford, P,. (2019), **Message from our Chairman**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 1-2, Autumn.

- Byford, P., (2018), **New heritage partnership to unlock important IT archive,** ICL All Stars Magazine, Issue 58, Winter 2018, pp.25-26

- Byford, P., (2019), **Chairman's Review: October 2017 – March 2019,** report sent to all members of LEO Computer Society, www.leo-computers.org.uk

- Byford, P., (2020), **Lions on the Loose**, ICL All Stars Magazine, Issue 67, summer/autumn 2020, page 18. Report and photos of lunch in Melbourne of LEO

Australian veterans.
file:///C:/Users/Dell/AppData/Local/Microsoft/Windows/Temporary%20Internet%20Files/Content.Outlook/CVA422EG/ICLISP.%20Edition%2067%20Final.pdf

- Caldwell, J. (!962), **Review, Automatic Programming Languages for Business and Science**, a two-day conference held at Northampton College of Advanced Technology with the co-operation of the BCS.in April 1962. T.R. Thompson presented a paper on considering the fundamental principles for expressing a procedure for a computer application independently of any compiler or computer considerations. See review by Caldwell in Dropbox at: //www.dropbox.com/s/08ap89c8n26oxjs/J%20Caldwell%20Report%20Automatic%20Programming%20Conference%201962.docx?dl=0

-
  - Caminer, D.T., (1951), **Personal diaries**, David Caminer kept a personal diary for a few months in 1951, chronicling, both domestic and business events. Hilary Caminer his daughter, secretary of the LEO Computer Science has scanned them for collection in the in the LEO archive at the Cambridge Centre for Computer History.

- Caminer, D.T. (1956) **Experience of a General Purpose Computer**, in **The Electronic Office**, a bound collection of articles assembled by the Office Management Association following their conference in April 1956. Bound volume held by Hilary Caminer.

- Caminer, D.T. (1955) **The Application of Electronic Digital Computers and Calculators to Accountancy, Costing and Managerial Control**, Lecture to Northampton College of Advanced Technology (now City University, London). Lecture Notes held by Hilary Caminer. Also see https://www.jiscmail.ac.uk/cgi-bin/webadmin?A2=history-of-computing-uk;ca4a4c3.0012

- Caminer, D.T. (1958) **'….And How to Avoid Them'**, The Computer Journal, British Computer Society, Vol. 1, No 1, pp. 11-14.

- Caminer, D.T. (1997) **'LEO and its Applications: the Beginning of Business Computing'**, The Computer Journal, British Computer Society, Vol. 40, No 10, pp. 585-597.~~miner~~

- Caminer, D.T. (2000) **Back to Basics**, interview in Institute for the Management of Information Systems Journal, Vol. 10, Issue 1. Copy held by Hilary Caminer.

- Caminer, D.T. (2002) **'LEO and the Computer Revolution'**, 2nd annual Pinkerton Lecture, IEE Computing and Control Engineering Journal, Vol. 13.

- Caminer, D.T., (1997), **The Story of an Innovation,** in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, pp. 7 – 154.

- Caminer, D.T. (2003) **'Behind The Curtain at LEO'**, IEEE Annals of the History of Computing, Vol. 25, No. 2, pp. 3-13, April-June.

- Caminer, D.T., (2004), **Obituary John Gosden**, Resurrection, Issue 34, Spring, http://www.cs.man.ac.uk/CCS/res/res33.htm#f

- Caminer, Hilary, (2016). Editor, **LEO Remembered**, essays and reminiscences by LEO people compiled to Hilary Caminer. honour the role played by Peter Bird in bringing public attention to the history of LEO and of the Lyons Food Empire, Published by LEO Computers Society, 108 pages. Available from Hilary Caminer. http://www.leo-computers.org.uk/images/LeoBookWeb.pdf

- Caminer, H. and McGerty, L., Editors (2022), **LEO Remembered 2nd edition**. Book was launched September 28th 2022 by Zoom to an international audience and included presentations by Catherine Griffith of the AITT Trust, Peter Byford, Hilary Caminer, Lisa McGerty and Frank Land and included a question and answer session and comments by members of the audience. For a recording of the event and purchase of the book https://www.leo-computers.org.uk/launch-of-the-massively-revised-leo-remembered-on-28-september/

- Caminer, Hilary (2016) editor, **Unveiling the plaque, November 29th 2016**, edited version of presentation at the unveiling of the plaque commemorating 65 years of business computing at Lyons Walk, including presentations from Peter Byford, Frank Land, Dame Stephanie Shirley and Tony Morgan, https://www.dropbox.com/home/LEO%20Oral%20History%20project?preview=Unveiling+of+Plaque+aa+presentations.doc

- Caminer, H., (Editor), Behr, B., (Production), (2018), **Newsletter and Review**, Leo Computers Society Vol. 4, Spring 2018, pp. 1-22, http://www.leo-computers.org.uk/images/LeoNewsletterSpring2018.pdf
  The issue includes articles by Peter Byford, John Daines, Frank Land, Lisa McGerty, Elisabetta Mori, Phillip Bird, Mike Storey, Tony Morgan, Stan Holwill, Bill Forfar, WEJ Parry, Tony Davies, Bob Stevenson. The issue can be read or downloaded from the LEO Computers Website at http://www.leo-computers.org.uk/

- Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, Autumn. The issue includes articles by Peter Byford, Lisa McGerty, Jude Brimmer, John Daines, Tony Morgan, Frank Land, Neil Lamming, Lex Korngold, John Hoey Peter Hermon, John Aeberhard Carole Hyman and Neville Lyons. LEO Matters can be downloaded from the LEO Computers website.

- Caminer, H., (Editor), Behr, B., (Production), (2020), **Leo Matters,** , Leo Computers Society Vol. 8, Winter 2020, pp. 1-17. Accessing LEO Matters as of November 2020: Firstly the edition is embedded in LEO Computers Society new Website as a "Post" which means members will be able to comment or ask questions when they view it. To do this you members have to be logged in but if members click on "Leave a Comment" in the Post the system will ask them to log in. Login details are the email address used in this message and the password is teashops .
  Secondly the contents list in the document will take you directly to the article if you click on an item. There is also an external contents list which will take you to the page of each article. (However due to a small technical issue it only takes you to the page so you should scroll down if you don't see the article you expect)
  If you don't want to leave any comment you can see all the material without logging in, simply click on the document front page or contents item . If you do wish to make a comment without logging in please just reply to this email. as we would really like any feedback , ideas for topics for upcoming issues or ,indeed, any views that you may have on LEO coverage. To go to the Post Click Here

- Caminer, H., (Editor), Behr, B., (Production), (2021), **Leo Matters,** , Leo Computers Society Vol. 9, Spring 2021, pp. 1-16. This Issue - Index 1. Message from our Chairman Peter Byford, pp. 1 -2. Letter from HM Queen Editor pp. 2-3. Special Visit to Cadby Hall Neville Lyons pp. 3-4. NHLF Project Update Lisa McGerty, pp. 4-5. Zoom, Zoom, Zoom Hilary Caminer, pp. 5-6. Braille Computing Tom Brooks pp. 6-7. Sporting and Social Side Peter Byford p. 8. My Rugby Days Fred Whittaker pp. 9-10. LEO Bridge Teams Tom Brooks, Mike Lawson Dave Alterton p.10. LEO Strikes Oil Mike Hancock p.11. LEO Master Routine Michael Guy p.12. Our Latest Trustee Philip Cleary p.13. (Editor: Can anyone identify people on photos? p.14.) Dates for your diaries p.15.

- Caminer, H., Editor, (2021), **An edited transcript of the LEO Women's Forum held on Zoom by the LEO Computers Society** in celebration of World Women's day, March 8th, 2021. https://www.dropbox.com/scl/fi/mv115mrn11zy5mk323wy9/Women-s-Day-Zoom-8March-2021.docx?dl=0&rlkey=55962nhxf0tyftgsu1rlp000a

- Campbell-Kelly, M., (1995), **ICL and the evolution of the British Main Frame**, Computer Journal, Vol. 38, No. 5, pp 400-412.

- Campbell-Kelly, M., (2004), John Maurice McLean Pinkerton Obituary, Oxford Dictionary of National Biography, print, 25th September 2004, online 25th September 2004

- Campbell-Kelly, M., (2008, 2009), Wheeler, David John Obituary, Oxford Dictionary of National Biography, print 5th March 2009, online 3rd January 2008

- Campbell-Kelly, M., (2014), Wilkes, Sir Maurice Vincent Obituary, Oxford Dictionary of National Biography, online 9th January 2014

- Campbell=Kelly, M., (2021), Review: Conversation with Frank Land, Resurrection, Number 94, Summer 2021, page 26.

- Cane, A. (2008) **Teashop boffin who pioneered business computing**, Financial Times, 28th June, https://www.ft.com/content/3c7bdcf0-4475-11dd-b151-0000779fd2ac

- Cane, A. (2011) **Perspectives: Unlearnt lessons of Leo; British pioneers wrote the script on project management in the 1950s, but no one was listening,** Financial Times, 6th December, https://www.ft.com/content/7c7fc396-168d-11e1-be1d-00144feabdc0

- Cann, R., (1997), **The Royal Dockyards**, in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 24, pp. 274 – 286.
- Casey, F. (1954) **Lyons Electronic Office: How LEO Works**, in Business: The Journal of Management in Industry, April.
- Ceruzzi, P.E. (1996) **LEO: The First Business Computer, Review**, ACM Computing Reviews, February, http://www.computingreviews.com/review/Review_review.cfm?review_id=119311&listname=search Note: this review was rated the best review in Computing Reviews for 1996.
- Clarke, Gavin (2013) **The Big Battle with Blue**, The Register, March. A useful sketch of LEO history based on author's reading and interviews with Frank and Ralph Land.
- Clarke Gavin (2014) **How Brit computer maker beat IBM's S/360 - and Soviet spies**, The Register, April, http://www.theregister.co.uk/2014/04/09/how_english_electric_outsold_ibm_s360_cold_war/ The story of ICL and LEO success in selling computers in East Europe.
- Clarke Gavin, (2013) **Blighty's revolutionary Cold War teashop computer - and Nigella Lawson,** The Register, November, http://www.theregister.co.uk/2013/03/27/geeks_guide_leo/
- Cochrane, A. (2017), **LEO Operating Memories**, an account of working as an operator on the Stewarts and Lloyds LEO II/3. Copy available from Frank Land and Dropbox.
- Computer Conservation Society, (2019), **OBE for Frank Land of LEO fame**, http://www.computerconservationsociety.org/
- Computer History Museum, **From Cambridge to Café,** The LEO story including brief bibliography, **http://www.computerhistory.org/revolution/early-computer-companies/5/110**
- Coombs, M. (2003) **Review: 'A Computer called LEO'** (Ferry, G.), European Journal of Information Systems, Vol. 12, Issue 4, 241–24.
- **oombs, M. and Lanchin, M., (2019),** From cakes to computers**,** BBC Witness History Coombs recalls her work as an early computer programmer on LEO, the first electronic office system, pioneered by the Lyons catering company. In the early 1950s, the leading British catering firm, J Lyons & Co, pioneered the world's first automated office system. It was baptised LEO - the Lyons Electronic Office - and was used in stock-taking, food ordering and payrolls for the company. Soon it was being hired out to UK government ministries and other British businesses. Mary Coombs worked on the first LEO and was the first woman to become a commercial computer programmer. She tells Mike Lanchin about her memories of those heady days when computers were still in their infancy **https://www.bbc.co.uk/programmes/w3csyx55**

- Cooper, A., (2018), **A Virtual LEO III.** The story of LOLA the consortium of London local authorities who replaced their LEO III with an IBM 360/50 and for whom IBM produced a LEO III emulator to enable them to run legacy systems. LEO Matters, Vol. 5, Spring 2019, pp. 9– 10, Newsletter of the LEO Computers Society, https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf
- Cooper, G. (2016) **How Lyons Produced the World's First Large Business Computer,** Power Point Presentation to IET retired branch, https://www.dropbox.com/home/LEO%20Oral%20History%20project/Copied%20from%20old%20Leo%20interviews%20shared%20folder?preview=Cooper+IET+Lecture+2016.ppt
- Cooper, M., (2020) **From baking to business computing,** Martin Cooper interviews Peter Byford, Neville Lyons and Frank Land members of the LEO Computer Society tell Martin Cooper MBCS RITTech about their memories of a computer, created by a catering company, that revolutionised business computing. Published in ITNow magazine of British Computer Society May 2020 https://www.bcs.org/content-hub/from-baking-to-business-computing
- Cotterell, S. (2002) **The day LEO roared**, Project Manager Today, pp. 4-6, February.
- Cummings, J.G., (2012), **The Great Railway Caper: Big Data**, O'Reilly Strata Conference October 2012 on Big Data. The paper gives an account of the LEO railway distancing job. http://blog.jgc.org/2012/10/the-great-railway-caper-big-data-in-1955.html
- D'Agapeyeff, A., (1962), **Current Developments in Commercial Automatic Programming** The Computer Journal, Volume 5, Issue 2, August 1962, Pages 107–111, CLEO is the language of LEO Computers, designed for LEO III, and is almost certainly the most recent language to be specified. It is of particular interest due to its having a combined aim toward both mathematical and business purposes. Only a preliminary report on CLEO has so far been available, but this is impressive in so far as it goes. The language might be described as being akin to both FACT and ALGOL, in that there are features of the former in the file processing and of the latter in the other procedures. See: https://academic.oup.com/comjnl/article/5/2/107/340809
- Daines, J. (2017) **The LEO Computers Society Heritage Project**, presentation at October 2017 LEO Computers Society Reunion at HAC London. Copies can be obtained from John Daines and Frank Land.
- Daines, J. (2017) **LEO, Lyons Electronic Office: The World's first Business Computer**, presentation at Cambridge Centre for Computing History November 2017. Copies can be obtained from John Daines and Frank Land.
- Daines, J., (2019), collector. **LEO III Training Course**, including examples of CLEO, INTERCODE and LEO II coding. Held on loan at Cambridge Centre for Computer Research and in Dropbox at https://www.dropbox.com/s/2zooadee7pyxa4r/LEO%20III%20Training%20Course%20Coding%20Example.pdf?dl=0
- Daines, J., (2019**)**, collector, **GPO stuff from jd,** articles published in PO Telecomms Journal, reporting on in purchase and installation of LEO Computers by Post Office, including photographs, held in LEO Dropbox archive at https://www.dropbox.com/sh/np1gbf6xo06t9pz/AAA-WrhY-7hlrGJ3bs44AMs5a?dl=0

- Daines, J., (2019), **LEO Reunion April 2019: A Personal View,** in Caminer, H., (Editor), Behr, B., (Production), (2019). LEO Matters, LEO Computers Society, Vol 6, pages 4-5, Autumn.
- Daines, J., (2019), Lecture **"On the origins of LEO,** presented to Manchester branch of Computer Conservation Conservation Society. September 2019. An edited version of the talk is available from Frank Land John Daines.
- Daines, J., (2020), **Tony Morgan, an Appreciation**, in LEO Matters, Spring, 2020, pages 14-15 http://www.leo-computers.org.uk/images/LeoNewsletterSpring2020.pdf
- Daines, J., (2020), **The Evolution of LEO, the World's First Business Computer**, Lecture to members of Computer Conservation Society, October 29th 2020, talk given via Zoom to a large audience including Q and A session. https://youtu.be/pGx15K7RYDM
- Daines, J., (2021), **The History of LEO Computers**, Presentation given to Winsford U3A Science and Technology Group on January 20th and reported on in the Winsford U3A Science and Technology Newsletter in February 2021 at https://u3asites.org.uk/files/w/winsford/docs/february2021newsletter.pdf

  The editor provides a summary of the Power Point presentation and comments on its httpsaines://www.youtube.com/watch?v=pGx15K7RYDM&feature=youtu.be

  Daines, J., (2021), T**he UK not the USA produced the first ever business computer,** presentation Daines 30th April, attended by about 240, JW3 Presentations. JW3 is a Jewish news and debating society which pre going online via Zoom had an average attendance of 20 but using Zoom has increased the attendance 10 fold – see https://jewishnews.timesofisrael.com/jw3s-debating-series-sees-ten-fold-increase-in-participation-after-move-online/

- Daines, J., (2021), **The Story of LEO**, Presentation to LEO Computers Society Zoom Forum, 14th July 2021. The presentation, including the follow-up discussion is available at
  https://us02web.zoom.us/rec/share/aLJ0ORkKAs_kBVPdvRi0nzYpKWroGA1sPa3kzA5vo7OxDH1XOBg33PpSJLFEa1dz.kZEJfUhzeF7MxB0V
  Passcode: =9g=7D#N

Daines, J., (2022), **Collected CLEO material.** The material includes training manuals, and CLEO code. The collection can be viewed at:

https://1drv.ms/u/s!Am-Eh_3csbLuj0cw5DM4fiZJK_Vd?e=WqOJUb

- Daziel, Billy (2015) **Corby & The Electronic Brain: LEO II**, pamphlet describing exhibition at the Corby Heritage Centre July/August, in memory of the Stewarts and Lloyds' LEO II computer, the first LEO II delivered to a commercial customer, https://www.corby.gov.uk/sites/default/files/Corby%20%26%20The%20Electronic%20Brain%20exhibition.pdf

- Deane **J., (2004**), Timesharing History: An Update**, in Leatherdale, D., editor, Resurrection, Bulletin of Computer Conservation Society, Issue 32, New Year. The article updates an article in Issue 31 which had omitted LEO's role in the development of Timesharing and its implementation in early 1962 ahead of its rival, the Ferranti Orion, though Ferranti had first launched its timesharing plans. http://www.cs.man.ac.uk/CCS/res/res32.htm#f**
- Delve, J., Anderson, D. (2001) **The Pinkerton Lecture**, IEEE Annals of the History of Computing Vol. 23, Issue2, pp.68-73.
- Douce, C. (2017) **Academic Blog**, report and Reflections on IT History meetings attended by author, an OU academic. Includes references to LEO, but of more general interest. https://learn1.open.ac.uk/mod/oublog/view.php?user=42396&tag=history
- Duffy, J. (undated) **LEO I: The construction of the world's first Business Computer**, Tripod Website, http://james.duffy.tripod.com/Leo1.html. A good account of the LEO story with many photographs.
- Eadie, N., (1997), **The General Post Office**, in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 21, pp. 249 – 256.
- Enticknap, N. (1977) **The First Business Computer**, Computer Management, pp. 10-15, June.
- Espiner, T. (2011) *ZD Net.* **LEO Computers marks 60th anniversary**, http://www.zdnet.com/pictures/leo-computer-marks-60th-anniversary/
- Evans, C. (1983) **Conversation: J.M.M. Pinkerton**, IEEE Annals of the History of Computing,
  Vol. 5, Issue 1, pp. 64-72.
- Fantl, L. (1956**?**) **Application of Digital Computers to Chrystallography**, Lecture to Northampton College of Advanced Technology (now City University, London). Lecture Notes held by Hilary Caminer.
- Fantl, L., (1997), **The Early Days,** in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 2, chapter 14, pp.157 – 167.
- Fantl, L, (1997), **Into South Africa**, in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 4, Chapter 25, pp. 289 – 305.
- Ferry, G., (1969), **A look back at LEO**, Computer Weekly. https://www.computerweekly.com/feature/A-look-back-at-Leo
- Ferry, G. (2005) **Simmons, John Richardson Mainwaring (1902–1985)**, Oxford Dictionary of National Biography; http://www.oxforddnb.com/view/10.1093/ref:odnb/97801986 14128. 001.0001/odnb-9780198614128-e-57059
-
- Ferry, G. (2015) **Pioneer of Business Systems "Father of Office Computing**, Old Brightonians, Brighton College, http://www.oldbrightonians.com/notable-s/john--bc.-1916.html

- Ferry, G., (2012) **David Tresman Caminer (1915-2008),** Oxford Dictionary of National Biography, http://www.oxforddnb.com/view/article/99795?&docPos=27
- Forbes, J.M. (1965) **'An Introduction to Compiler Writing'**, The Computer Journal, British Computer Society, Vol. 8, No 2, pp. 98-102.
- Fox, M.L. (2015) **How technology can improve the UK**, presentation at WiredWorld2015, annual conference of Wired World October 15/16th 2015, London. Printed in Observer Newspaper 18th October 2015, main section pages 32.33 See http://www.theguardian.com/technology/2015/oct/18/martha-lane-fox-technology-women-computing
- Furey, C. (1975), **LEO III: a rave from grave,** *Computing***,** September 4th 1975, an article noting the retirement of the London Boroughs LEO III from Greenwich and lamenting the failure of any British Museum to take an interest in the machine. The lament is reinforced by the edition editorial "*A Maker from History"*
- Galliers, R. (ed.) (2003) **Journal of Strategic Information Systems**, Vol. 12, No. 4, December. The Issue is devoted to the 2001 conference at the London Guildhall celebrating the 50th anniversary of the rolling out of the world's first business application at the Cadby Hall headquarters of J Lyons and Company on their LEO I computer. URL http://www.citeulike.org/journal/els-09638687

  The contents of the issue are as follows:

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  Baskerville, R., **The LEO principle: perspectives on 50 years of business computing**, pp 255-263
  Cox, G., **Business computing 2001-the state of the art**, pp 285-294
  Mowery, D., **50 Years of business computing: LEO to Linux**, pp 295-308
  Yapp, C., **Conference sponsors' panel: what have we learnt in 50 years?** pp 309-320
  Shirley, S., **Panel: social and economic consequences of business computing and public policy**, pp 321-330
  Ashworth, J.M., **Knowledge and digital information**, pp 331-337
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  Amaravadi, C.S., **The world and business computing in 2051**, pp 373-386
  Schell, E.H., **The world and business computing at mid-century**, pp 387-395

Galliers, R., (2020/2021), **Strategic Issues in Information Technology: Challenges, Strategies and Innovation** in Managing Information Systems**,** Henry Stewart Talks Limited Lecture Series for Business Schools. The online Power Point presentation includes a photo of LEO I Galliers sets out to refute Carr's Harvard Business Review article (2001) **IT doesn't matter**. Galliers briefly refers to LEO and its pioneering role. https://hstalks.com/t/1962/challenges-strategies-and-innovation-in-managing-i/

- Garnsey, P., with added reflections from Neil Lamming, Mike Benton and Kent & Sheilagh Brooks and Peter Byford, (2013), **Vale Wallace Weaving: An Appreciation,** extracted from ICL ALL Stars Magazine, Issue 31, Autumn. See LEO Computers Society Dropbox https://www.dropbox.com/preview/LEO%20Oral%20History%20project/LEO%20Memoirs%2C%20Reminiscences%20and%20Anecdotes/Wallace%20Weaving%20Obituary.docx?role=personal

- Gibbs, G.R., (1965), **The LEO I**, Datamation, pages 40-41, an article describing LEO I on the date of its decommissioning, including two photos of the computer, download from http://www.bitsavers.org/magazines/Datamation/196505.pdf

- Gibson, A. (1991) **IAM – seventy five innovative years**, a short history of the IAM, 1915-1990, Modern Records Centre Warwick University, MSS.337/4/66/1.

- Gibson, A. (1995) **The next five years,** additional material to celebrate 80 years of the IAM, Modern Records Centre, Warwick University, MSS, 337/4/ 66/2.

- Gibson, A., (1991), **British Journal of Administrative Management** (1991), 75th Anniversary Issue: Copy held as manuscript text at John Rylands Library, Manchester University in box GB 133 NAHC/LEO/A6 http://archives.li.man.ac.uk/ead/html/gb133nahc-leo-p1.shtml *The contents include:* **Simmons, the visionary**, April 1991. **O&M and Simmons**, November 1991. The contents of the collection can be viewed by application to the librarian.

- Gibson, R.P. and Lenaerts, E.H. (1960) **Maintenance Procedures on a Computer**, proceedings of joint BCS/IEE Conference, January. The paper reflects both LEO I and LEO II experience.

- Glass, R. (200**T** of the ACM, Vol. 48, No. 3, pp 25-26. The paper refers to the first LEO applications.

- Gluckstein, I. M. (1959) **G.W. Booth, Obituary**, Lyons Mail, October.

- Godwin, C. (1986) **Landmarks: How the king of the jungle grew up on tea and cakes**, Computing, April 23rd.

- Gosden, J.A. (1960) **'Market Research Applications on LEO'**, The Computer Journal, British Computer Society, Vol. 3, No 3, pp. 142-143.

- Gosden, J.A. (1964) **"The Operations Control Center Multi-Computer Operating System."** Proceedings of the Association for Computing Machinery, E2.2-1-E2.2-9. New York: Association for Computing Machinery.

- Gosden, J.A., (1997), **Toward System Software,** in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 2, Chapter 16, pp. 185 – 206.

- Graham-Cumming, J. (2012) **The Great Railway Caper: Big Data in 1955**, presented at Strata Conference, London, October 2nd.

- Greening-Jackson, T. (2008) **LEO I and the BR. Job,** including transcript of interview with Roger Coleman, programmer in charge of railway distancing job, https://www.google.co.uk/search?q=%E2%80%A2%09Greening-Jackson,+T.+(2008)+LEO+I+and+the+BR.+Job&rls=com.microsoft:en-GB:IE-Address&dcr=0&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwj0yZHO5c3YAhWFGOwKHQhsDzoQsAQINA&biw=1600&bih=675#imgrc=vj9Ru_saGx8OgM:&spf=1515600989252

- Haigh, T. (2007) Chris Date: **Oral History, Computer History Museum**, Silicon Valley, California Available at: https://aisel.aisnet.org/cais/vol41/iss1/15

- **Hartley-Smith, A., (2030), editor, Marconi in Computers and Automation.** The account includes a graphic showing the various components involved in the evolution of the UK computer industry including the LEO enterprise. **http://marconiincomputers.pbworks.com/w/page/86849797/Marconi%20in%20Computers%20and%20Automation**

- Harvey, F. (2001) **The lion that failed to roar, LEO**, Financial Times, August 20th.

- Hassan, Nik R. (2017) "**Editorial: The History and Philosophy Department**," *Communications of the Association for Information Systems*: Vol. 41 , Article 15. Available at: **https://aisel.aisnet.org/cais/vol41/iss1/15**

- Hayes, J., (2018), **Reconstructions of early electronic computers are giving us new insights into how they worked and the software that ran on them**, E&T Magazine. An account of the various efforts to reconstruct early computers including a brief history of the role played by LEO in early business computing. https://eandt.theiet.org/content/articles/2018/04/reconstructing-the-early-electronic-computers/?utm_source=Adestra&utm_campaign=New%20EandT%20News%20-%20Automation%20FINAL%20-%20MEMBER&utm_medium=Newsletters%20-%20E%26T%20News&utm_content=E%26T%20News%20-%20Members&utm_term=https%3A%2F%2Feandt.theiet.org%2Fcontent%2Farticles%2F2018%2F04%2Freconstructing-the-early-electronic-computers%2F

- Hendry, J. (1986) **The Teashop Computer Manufacturer**, Business History, Vol. 29, No 8.

- Henin, S. (2003) **LEO: II computer in una tazza da tè**, La Altra Scienza, p. 102.

- Herbert, A,. (2019), **Grantchester**, Resurrection, Issue Number 85, Spring 2019, pp. 21-24. An account of the making of the ITV series Grantchester shown on 225th January, 2019, featuring the fictional computer 'UNIAC' based on the real EDSAC, and *inter alia*, noting that UNIAC included working for a teashop business.

- Hermon, P.M., (1997), **A Reminiscence**, in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 2, Chapter 17, PP. 207 – 220.

- Hermon, P., (2019), **The LEO Years**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 7-10, Autumn,

- Hicks, M., (2019), What makes a history hidden, blog by author of Programmed Inequality, tracing an advertisement featuring LEO computer operator

Cathy Gillespie dating back to 1965. https://mitpress.mit.edu/blog/what-makes-history-hidden,

- Hinds, M.K. (1981) **'Computer Story'**, Meteorological Magazine, Vol. 110, pp 69-80.
- Historian, (2020), **LEO – Lyons Electronic Office**, a well written account of the LEO/Lyons story, https://www.i-programmer.info/history/machines/670-leo-lyons-electonic-office.html
- Hoey, J., (2019), **Operating LEO in Australia**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, page 13, Autumn.
- Holdsworth, D. (2015) **A LEO III: 21st Century Hindsight**, in Leatherdale, D., editor, Resurrection Issue 70, pp. 21 – 30, Journal of Computer Conservation Society, A substantial account of the project to rediscover and emulate LEO III programming software. Under the heading **Software** in the **Society Activity section** two other items are reported by Holdsworth: **LEO III Rescue**, leo.settle.dtdns.net/LeoCode/impasse.htm. and **LEO III Documentation,** leo.settle.dtdns.net/LeoMan/LeoMR.htm The whole issue can be downloaded from http://www.computerconservationsociety.org/resurrection/res70.htm#e
- Holdsworth, D. (2015) **LEO III Software Rescue**, Resurrection, Issue 71, David notes "All of a sudden, it works", pp.8-9. http://www.computerconservationsociety.org/resurrection/res71.htm The software can be accessed at http://leo.settle.dtdns.net/LeoCode/LeoIIIdemo2.zip
- Holdsworth, D. (2015) **LEO III Intercode resurrection**, http://leo.settle.dtdns.net/LeoCode/ See also **LEO III Intercode Translator on the Web.** http://settle.ddns.net/LEOIT/6971576/LeoCode/runleoIT.htm
- Holdsworth, D. (2016) **Intercode and Master Routines**, Resurrection, Issue 73 pg.7.
  David has commented:
  "…it looks a lot like a real Leo, or so I am told by people who knew the real thing. What is more important than the replica is the software that we have, namely the Intercode Translator, the Master Routine and its accompanying generator programme. All three run successfully on our replica. There may be the odd malfunction, but that was common in computing in the 1960s."
- Holdsworth, D. *et al* (2017) **On-line Leo III User Manuals**, http://leo.settle.dtdns.net/LeoMan/Manuals.htm
- Holdsworth, D. (2015) **History of the Leo III Software Preservation Project: Blow by Blow Account**, http://sw.cc5 - 13s.bcs.org/leo/BlowByBlow.htm, Draft Account
- Holdsworth, D., (2019), **Software**, Further account of LEO III facilities and correspondence related to making facilities available, Resurrection, Spring 2019, number 87, page 10,. http://computerconservationsociety.org/resurrection/res87.htm#b
- Holdsworth, D., (2019), **Software Leo** III: I have been co-operating with Leo Society members in updating their LEOPEDIA, and it now contains links to our stuff both on sw.ccs.bcs.org and Resurrection. I am looking for information on early assembly language programming, in an attempt to comprehend the state-of-the-art at the time that Intercode was designed. My amazement at Intercode is documented in Blow By Blow. It may be that I was not properly aware of the programming conventions of an era that slightly pre-dates my own entry into the world of computing, Resurrection,

Winter/Spring, Number 88. See
http://www.computerconservationsociety.org/resurrection/res88.htm

- Holdsworth, D., (2020), **LEO III Software** Computer Conservation Society Activity, Resurrection, Issue 89 Spring 2020, Page5. Holdsworth reports that previous errors in LEOPEDIA links to his work have been corrected as well as reporting on the latest developments on the LEO III emulator and the availability of LEO III demo packages at settle.ddns.net/LeoIIIdemo3.zip Resurrection
online at http://www.computerconservationsociety.org/resurrection/res89.htm

- Holdsworth, D., (2020), **Software LEO III** in Leatherdale, Resurrection, Issue 91, Autumn. Pages 6 – 7. Reports on the trial by Ray Smith and Ken Kemp of their kit for running INTERCODE on Windows computer. The trial involved sending an invitation to LCS ex- programmer members to experiment in using the kit. The report by Ray Smith is summarised, and future actions proposed. The outcome was disappointing in the very small number of members who completed the trial. A larger number were prevented from completing the trial due to an inability to download the zipfiles comprising the kit. A start has been made by David Holdsworth in rationalising the LEO III presence on the new TNMoC server. The LEO III emulation facilities are operational and can be accessed at http://37.122.195.165//leo/emulate.htm

-

- Hudson, R.L. (2001) **David Caminer analyses what went wrong with one of the world's first computers, the LEO,** Convergence, the Wall Street Journal's magazine of Digital Business, Vol VII, No 3.

- Hyman, C., (2019), **Working at Wills as a 15 year old in the 1950s**, in Caminer, H., (Editor), **Behr**, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 10-11, Autumn.

- I Programmer (2010) **LEO – Lyons Electronic Office: World's first business machine** – a short but comprehensive account of the LEO story, http://www.i-programmer.info/history/machines/670-leo-lyons-electonic-office.html

- **1984** (Siemens – Data Processing, the history of the domain of Data Processing from 1954 to 1984), Siemens Aktiengesellschaft, Munich. The paper, in German, refers to the role played by LEO.

- Jack. W (1967) a report on LEO III/32 at Colvilles Ltd 1965-1974

LEO III/32 at Colvilles Ltd, Ravenscraig Works (Later part of BSC Strip Mills Division)

Date 1965 – 1974
Principal Uses

- Production Tracking and Control
- Payroll

Background

In 1963, a decision was taken by ColvillesLtd, the Scottish steel manufacturer, to acquire a LEO III computer and the machine was installed in a custom-built facility at their Ravenscraig works in 1965. The first two projects were to be computerisation ofproduction planning and control and the works payroll system.

Staff to man the facility were recruited from within the company, their suitability for a new career in computing being assessed using the LEO 'Aptitude test'. The newly formed team was sent off to Hartree House in early 1965 for training in CLEO programming. On their return two groups were formed – one for the Production Control project, the other for the Payroll project. The two development teams numbered around a dozen personnel in total.

Production Tracking and Control System

In the nineteen fifties / sixties, Colvilles Ltd., iron and steel manufacturers in the West of Scotland, had built a fully integrated steel strip mill on a green-field site in Motherwell. The product was coils of steel or cut sheet which were of many grades, sizes and weights.

Iron ore and coal was fed into blast furnaces which produced iron. This was passed in bulk form to a steel-making plant where the steel output was transformed into ingots of varying sizesand steel qualities These were then processed in a slab mill which reduced the ingots to long slabs which were then sub-divided. From this point, where many slabs were produced from each ingot, product tracking became complex.

Each slab was allocated a unique identity together with its dimensions, weight,steel grade and whether it had been allocated to a customer order or to stock. Slabs were then scheduled for the next process where they were reheated and processed through the strip mill,the output being coils of steel.

Further processing wasthen carried out, as necessary, to meet customer requirements. This could involve processes such as pickling, tandem rolling, annealing, slitting and cutting coils into individual bundles of sheets. Cold finishing processes were carried out at Gartcosh Works some 15 miles away from Ravenscraig.

Tracking of individual pieces of material was vital. Most orders were comprised of many coils or bundles of sheet. For scheduling reasons it was not possible to keep the material for any one order together through all the processes. In the early sixties production had beenmonitored by Hollerith card systems and wall-mounted adjustable displays of customer orders givingdetails of their progress through the plant. Periodic stock-checks of material ahead of each process disclosed significant discrepancies and it was decided that a better production management system was required.

Given the complex movement of material and orders through the many processes along with constant transfers into and out of inter-process stocks it was vital that the production controllers had up-to-date information to keep abreast of a rapidly moving and ever-changing situation. Thus it was a prime target for the LEO system to deliver to the Production Control Department information which was as current as possible. This was defined as having the production status as at 6amavailable to the production control staff when they arrived to start work at 8.30am.

We were confronted with a major problem. We had just over 2 hours to collect the production information from the shop floor operatives, prepare it for input to the computer and produce the reports. Data preparation at that time was considered to be a task for women and the personnel rules dictated that females could not work outside dayshift hours. In any case the time required to prepare the data for input to the LEO using conventional data prep. methods was too long to meet our targets. So we turned our attention to Lector and optical mark sensing.

A body of opinion held that filling forms with marks was too complex for shop-floor operatives. However, the Ravenscraig development team felt that this was unjustified, and so it proved. With the elimination of data preparation delays we were able to meet our system performance targets. Clerks could now start their work at 8.30am and have on their desks the complete production details as at 6am that same morning. This allowed them to achievemuch tighter control. Inter-process stockswere reduced and delivery performance improved.

Appendix 1 gives some further information on how and why Lector OMR documents were used

Payroll System

In 1965 Ravenscraig and Gartcosh steel works employed around 5,500 personnel, a number which eventually rose to around 7,500. The pay structure was complex with around 900 differing pay rates and many local adjustments. Employees could be engaged in several different activities in any week, each attracting different pay rates. The majority of the employees were paid weekly, in cash.

It was considered that to be of real value the computer system should undertake not just the gross to net pay calculation but the considerably more complex calculation of gross pay from the pay rates and time worked for each individual. The main time-sheet information was input weekly using **Lector**. Again it was considered that getting the pay clerks used to completing Lector documents would be a ‘hard sell’ but with training it was successfully achieved.

At start up, employee payroll data, previously stored on a Hollerith Punch card system was input via a LEO installation in Birmingham which was equipped with a card reader. The system successfully went live in October 1965 - some 8 months after the implementation team had returned from their first programming course!

Some reflections

A principal feature of the Ravenscraig LEO III installation was the extensive use made of **Lector**. The somewhat contrived method of creating digits from a series of marks was easily mastered by plant and administrative personnel, contrary to general opinion. As noted above the benefit of directly inputting the collected data to the computer without the delays imposed by data preparation was key to the success of the system. We were greatly assisted by the printing industry in Edinburgh who had a reputation for high quality printing and rose to the challenge of producing Lector documents to the tight tolerances required. During the lifetime of the installation at least two dozen

different document formats were employed. Sadly no copies of these have been kept for the archives.

In hindsight, the speed with which the systems were implemented by an inexperienced team is astonishing. We were a young, enthusiastic and highly motivated team eager to prove ourselves in this new field of technology. Perhaps we were too naïve to appreciate the implications of trying to deliver large complex systems using somewhat experimental technologies in such a short timescale.

Finally a word of homage to CLEO. In the course of a long career in computing and exposure to many programming languages my admiration for the CLEO programming language has not diminished. Its blend of the best features of Cobol and Fortran rendered it a powerful, flexible and easy to master tool. I take my hat off to the pioneers who were responsible for creating such superb technology so far ahead of its time!.

Appendix 1 – Use of Lector OMR documents in the Production Planning & Control system (PPC)

The PPC system would require to be fed with all information as regards material movement and change of status from the slab mill output to despatch. Once updated, its output reports would provide schedulers with an accurate picture of what material was available for them to schedule to the next process. The system could only provide these reports once it had been run and it would be designed to present the updated information as at 6am – the end of the night shift. However, the data processing team was all female and females were not permitted to work outside the daytime working hours. When they started each morning, they would have to input at least half of the previous day's back shift (2 to 10) and the night shift (10 to 6) before the computer system could be updated. For the remainder of their day, they would input that day's day shift (6 to 2) and as much of that day's back shift as possible. This meant that it was unlikely that the system could be updated and output records produced before 2pm – a full 8 hours beyond the system updating point of 6am. It was felt that this was an unacceptable position.

This was in the days before the advent of on-line terminals but effective OMR machines were now becoming available. LEO Computers had recently merged with the English Electric company and the combined firm was now offering an OMR reader called Lector. Adoption of this technique could solve the delays caused by data preparation.

Trial OMR documents were printed and tested out on shop-floor production recorders. Most of the data to be collected was numeric; items such as material identity, any changes to dimensions, weight, grade or anything else that could change at any specific production unit. The test documents had the particular processing unit identity pre-printed on them. As most of the date to be collected was numeric, each character of a particular parameter to be input was represented by four, what we called, soup-bowls labelled 1, 2, 3 and 6. Thus, by filling in no more than 2 of these soup-bowls by pencil, any digit from 0 to 9 could be represented. Thus recording a material identity of 5 numeric characters would be represented on the pre-printed form by 5 groups of these 4 soup-bowls. We were advised that shop-floor personnel would not understand this. We argued that anyone who knew how to fill in a pools coupon would soon master it. Trials showed that we were right.Subsequently, once the system was implemented, we only had one failure – a person who was dyslexic.

When first implemented, we only had one machine and it was installed in the computer room at Ravenscraig Works. However, the daily operational run was still held up because there was no similar OMR facility at Gartcosh Works. Its data had to be collected by car after 6am and transported to Ravenscraig to go through data preparation from 8.30am. Nevertheless, the system provided its output mid morning. A second Lector reader was acquired for GartcoshWorks and a paper-tape to paper-tape link provided between the two Works. The system now produced all the output reports as at 6am ready for the schedulers when they started at 8.30am.

Instead of the predicted 8 hour delay in providing up to date information, this had reduced to two and a half hours. Routine stock-checks confirmed that the new system was extremely accurate compared to the old manual one. Any corrective updates to the computer stock database were minimal compared to the old system. Additionally, stock checks were completed considerably faster as checkers were provided with lists of material to check against the material in the various stock areas.

- Jackson, M.J., (1966), **A Computer in the Mail Order Business**, Data Processing, September-October, pp. 1-9.
- Jackson, M.J., (1970), **Freemans (London, SW9)**, paper presented at Computer for Profit Conference, 6 pages, sponsored by British Institute of Management, Confederation of British Industries and ICL, at Queen Elizabeth Hall, London, January 22nd 1970
- Jackson, M,J., (1997), **Freemans Mail Order**, in Caminer, D.T., *et al, editors,* LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 23, pp, 274 -286.
- Jon, Post Office LEO 326, a series of extracts from Post Office publications on the history of computing at the Post Office and its LEO 326. Details listed in LEOPEDIA Annex under donation from Jon. Copies held by Frank Land. **Development of DPE,** pages 1 and 2, **Farewell Old Friend**, pages 1,2 and 3, on the retirement of LEO from the Derby computer centre.
- Jones, S., (2011), **How Lyons Teashops Powered Computers,** The Guardian, 26th August. The article recapitulates the story of LEO origins and finishes with an extract from the New Scientist a decade earlier: "In today's terms it would be like hearing that Pizza Hut had developed a new generation of microprocessor, or McDonald's had invented the internet." https://www.theguardian.com/technology/2011/aug/26/how-lyons-teashops-powered-computers
- Johnson, H.J.W. (2016) **LEO I – Recreating the Word's First Business Computer**, Middlesex University Mauritius Campus, Business Information Studies, Information Studies, Dropbox archive: https://www.dropbox.com/home/LEO%20Oral%20History%20project – *links to Dropbox 'LEO Oral History project', not to this specific item.*
- Kaye, E.J. and Gibbs G.R. (1954) **'LEO – A Checking Device for Punched Paper Tape'**, Electronic Engineering, Vol. 29, pp. 386-392. Reprinted as part of '**LEO –Lyons Electronic Office'** in Electronic Engineering, pp 18-24 http://www.bbc.co.uk/blogs/outriders/2011/11/leo_making_history.shtml
- Kemp, K. (2014) **Early Commercial Computing**, Bristol Industrial Archaeological Society Journal (BAIS), No. 47, pages 21-33.
- Kemp, K., **LEO Software Demonstration**, The full set of demonstrations developed by a team headed by David Holdsworth of the CCS are held at http://sw.ccs.bcs.org/leo/ITdemo.zip.
- Kemp, K., (editor), LEO III and PROGRAMMING TECHNIQUES, this document has been produced by people who programmed the LEO III computer in the 1960s to describe some of the techniques and methods which were in use at the time. The objective is to provide information to help people understand how the LEO III was used for data processing using the hardware and software available at the time. These

techniques and methods are now obsolete and hence are probably not understood by those who did not experience computing in the 1960s. See http://sw.ccs.bcs.org/leo/KenK.htm This document is part of the project to emulate and run programs written for LEO III. Original reference manuals are available and should be consulted for technical information on the hardware and software. They came in 5 volumes:- See Volumes I, III, IV and part of V are available in digital form at http://sw.ccs.bcs.org/leo/Manuals.htm

- Korngold, L., (2019), M**emories of working with LEO in Australia**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 13-14, Autumn.
- Lamming, N. (2017) **LEO in OZ**, ICL All Stars Magazine, Issue 53, Winter, pp 25-27.
- Lamming, N., (2018), **Peter Gyngell: Obituary,** ICL All Stars Magazine, Issue 58, Winter. pp. 25-26, LEO Computers Dropbox archive at https://www.dropbox.com/preview/LEO%20Oral%20History%20project/LEO%20Memoirs%2C%20Reminiscences%20and%20Anecdotes/PETER%20GYNGELL%20Obituary.doc?role=personal
- Lamming, N., (2019), **Two Faces of Note**, in ICL AllStars Magazine, Issue 61, Summer 2019, pp 16-17, a sketch of the contribution made to the story of LEO by David Caminer and John Pinkerton.
- Lamming, N., (2019), **History of LEO in Australia,** https://www.dropbox.com/s/nr1ytjmd6rjmpli/LEO%20in%20Australia%20by%20Neil%20Lamming.doc?dl=0
- Lamming, N., (2019), **History of LEO in Australia**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 11-12, Autumn.
- Land, F.F. (1960) **'Computers in Purchasing and Stores Departments: LEO at the Ford Motor Company Spares Depot'**, Computers in Purchasing and Stores Departments, Purchasing Officers Association, pp 27 – 33.
- Land, F.F. (1994) **`LEO, A personal memoir'**, in INGENUITY, the ICL Technical Journal, Vol 9, No. 2, pp. 355 – 361, https://www.fujitsu.com/uk/Images/ICL-Technical-Journal-v09i02.pdf
- Land, F.F. (1996) **Information Revolution**, in Malcolm Warner (ed.), **International Encyclopaedia of** published in LSE Working Paper Series, Number 95. http://www.worldcat.org/title/informationrevolution/oclc/500306458&referer=brief_results
- Land, F.F. (1996) **'Systems Analysis for Business Applications'**, Resurrection, Journal of the Computer Conservation Society, Summer.
- Land, F.F. (1997) **'Information Technology Implementation: The Case of the World's First Business Computer: The Initiation Phase'**, in McMaster, T., Mumford, E., Swanson, E.B., Warboys, B., and Wastell, D. (eds.) *Facilitating Technology Transfer through Partnership: Learning from Practice and Research*, pp. 3-19, Chapman & Hall: London.

- Land, F.F., (1997), **The Widening Field**. in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 2, Chapter 15, pp. 168 -184.

- Land, F.F. (1998) **'LEO, The First Business Computer: A Personal Experience'**, in Glass, R.L. (ed.), *In the Beginning. Personal Recollections of Software Pioneers*, IEEE Computer Society, Los Alamitos, CA., pages 134 – 154. Republished in Glass, R.L., (2020), **In the Beginning: Personal Recollections of Software Pioneers 2**, published by Developer Books, Hogansville, Chapter 5: **LEO the First Business Computer: A personal recollection, Frank Land**, pp 249 – 288 and brief biography of Frank Land, pp 611 – 613.

- Land, F.F. (1998) **The Fist Business Computer: A case Study in User Driven Innovation**, Proceedings of Conference Computers in Europe, Past Present and Future, Kyiv, pp. 108 -120, October.

- Land, F.F. (1999) **A Historical Analysis of Implementing IS at J. Lyons**, in Currie, W.L. and Galliers, R.D. (eds.) Rethinking Management Information Systems, Oxford: Oxford University Press. pp 310 - 325.

- Land, F.F. (2000) **'The First Business Computer: A Case Study in User-Driven Innovation'**, IEEE Annals of the History of Computing, Vol. 22, No. 3, pp. 16-26.

- Land, F.F. (2003) **A Computer Called LEO: Review:** ACM Computing Reviews, June 24th, http://www.computingreviews.com/review/Review_review.cfm?review_id=127849&listname=search - *link takes to the login page only – need to be a member of ACM to access.*

- Land, F.F. (2006) **LEO II and the Model T Ford**, British Computer Society Journal, Vol. 49, No. 6, pp. 650 – 656.

- Land, F.F. and Powers, D., (2008), **Reflections on Decision Support Pioneers,** http://dssresources.com/reflections/land/land03162008.html

- Land, F.F. (2009) **Appreciation of Professor Colin Tully (1936 – 2007):** Professor of Software Practice, Middlesex University, British Computer Society, Vol. 52, Issue 3, May, pp. 388 – 391. **http://dssresources.com/reflections/land/land03162008.html**

- Land, F.F., (2010), **The use of history in IS research: an opportunity missed?**, Journal of Information Technology, Vol 25, pp. 365 – 394 Reprinted 2016 in Enacting Research Methods in Information Systems: Volume 1, pp 213-234, editors Wilcocks, L., Lacity, M., Sauer, C., Springer International Publishers. https://link.springer.com/chapter/10.1007/978-3-319-29266-3_9

  Reprinted as a selected paper in Schlagwein, D. (Editor, December 2020, **Thirty-Five Years of the Journal of Information Technology.** To celebrate this, the editors have selected and made open access JIT sample papers across the years via a special collection: https://journals.sagepub.com/page/jin/35yearsjit

- Land, F.F. (2012) **Remembering LEO**, pp. 22-42 in Tatnall, A. (ed.) **Reflections on the History of Computing: Preserving Memories and Sharing Stories, IFIP Advances in Information and Communication Technologies,** Springer.

- Land, F.F. (2013) **The story of LEO the World's First Business Computer**, in Developing LEO:
  The world's first business computer, Warwick University Library Modern Records Centre,
  Simmons Archive,
  https://warwick.ac.uk/services/library/mrc/explorefurther/digital/leo/story/
  Reprinted in The Software Practitioner, Vol 24, no.4, July 2014, p.5.
- Land, F.F., (2014), **U3A: Remembering LEO**, lecture presentation to Ivybridge U3A Science and Technology Group. The presentation material can be obtained from Frank Land on request. F.land@lse.ac.uk
- Land, F.F. (2015) **Early History of the Information Systems Discipline in the UK: An account based on living through the period**, Communications of the Association for Information Systems: Vol. 36, Article 26. The article includes a short Appendix recounting the LEO story.
- Land, F.F. (2017) **Teleprocessing and LEO,** Letter to Editor, Resurrection, Vol. 88, http://www.computerconservationsociety.org/resurrection/res78.htm
- Land, F.F. (2017) **Review: Programmed Inequality: How Britain Discarded Women Technologists and Lost its Edge in Computing,** ACM Computing Reviews, June 27th,
  http://www.computingreviews.com/review/review_review.cfm?review_id=145394 - *link takes to the login page only – need to be a member of ACM to access.*
- Land, F.F. (2017) **Peter Bird Obituary**, Other Lives, Guardian Newspaper website, 10th September, https://www.theguardian.com/technology/2017/sep/10/peter-bird-obituary
- Land F. F., (2019), **Book Review: Legacy by Thomas Harding**, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 6-7, Autumn.
- Land, F.F., (2020). **Tony Morgan Obituary, in** Other Lives, Guardian newspaper, B
- Land, F.F., (2020), **Recollections of TRT**, in Caminer, H., (Editor), LEO Matter, LEO Computers Society, Vol 7, pages 10-11, Spring 2020
- Land, F.F., (2021), Book Review: IT Girl, Ann Moffatt, Resurection, Number 93, Spring 2021
- Land, R.R., (1997), **Lyons Teashops**, in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 18, pp223 – 228.
- Land, R.R., (1979), **Behind the Iron Curtain**, in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 4, Chapter 26, pp. 306 -320.
- Land, R.R., (2018), **Mysterious Death of Dennis Skinner**, commentary on report of death of LEO Moscow Office Manager. Commentary held by Frank Land and in Dropbox at
  https://www.dropbox.com/home/LEO%20Oral%20History%20project/LEO%20Memoirs%2C%20Reminiscences%20and%20Anecdotes?preview=Dennis+Skinner+mysterious+death.docx. Also see Monica Porter below.

- Land, R.R. (2016) **LEO in East Europe**, Communications of the Association for Information Systems, Vol. 38, Article 34, http://aisel.aisnet.org/cais/vol38/iss1/34
- Lawson, Dominic (2016) **65 years ago the age of the computer began …. to sell a better tea cake**, Sunday Times, 4th December, pg. 24, http://www.thetimes.co.uk/edition/comment/65-years-ago-the-age-of-the-computer-began-to-sell-a-better-tea-cake-zzpPx63qx6
- Laver, M., (1956-1958), **Electronic Computers in the Office,** PO Telecomms Journal, Vol. 9,10. Laver's introduction to computers and what they might be used for. Including photos of a LEO III installation.
- Laver, M., (1997), **The General post Office**, in Caminer, D.T., *et al*, *editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, Chapter 22, pp. 257 – 260.
- Lavington, S.H. (1980) **'LEO and English Electric'** in *Early British Computers: The story of vintage Computers and the people who built them*, Chapter 13, pp. 68 – 77, London: Butterworth-Heinemann.
- Lavington, S.H. (2015) **A Brief History of Early British Computers**, ETHW, A Brief History of Early British Computers, http://ethw.org/A_Brief_History_of_Early_British_Computers
- Lawson, D., (2019), **My family's firm dished up tea to Britain and death to the Nazis,** August 25 2019, The Sunday Times; Dominic Lawson, provides an interesting addendum in his weekly column to the book Legacy by Thomas Harding (reviewed in LEO MATTERS by Frank Land). Both Harding and Lawson belong to the family which established J. Lyons & Co. https://www.thetimes.co.uk/article/my-familys-firm-dished-up-tea-to-britain-and-death-to-the-nazis-wfbpzjcgw
- Lawson, D., (2019), **My family's firm dished up tea to Britain and death to the Nazis**, article in Sunday Times 25th August 2019, triggered by Thomas Harding's book Legacy, the story of the family that created J. Lyons & Co. Lawson, like Harding a descendant of the family, comments in the article on the initiative taken by the Company in developing the World's first business computer. https://www.thetimes.co.uk/article/my-familys-firm-dished-up-tea-to-britain-and-death-to-the-nazis-wfbpzjcgw and at https://www.dropbox.com/s/a3nv8s2tr6acdlk/DomiminLawsonSundayTimes25Aug2019.eml?dl=0
- Lean, T. (2010) **Mary Coombs: Oral History,** National Life Stories: An Oral History of British Science, Transcript: http://sounds.bl.uk/related-content/TRANSCRIPTS/021T-C1379X0016XX-0000A0.pdf
- Lean, T. (2010) **Frank Land: Oral History,** National Life Stories: An Oral History of British Science, Transcript: http://sounds.bl.uk/related-content/TRANSCRIPTS/021T-C1379X0017XX-0000A0.pdf
- Lee, J. (ed.) (1998) Biographies, **John Maurice McClean Pinkerton,** IEEE Annals of the History of Computing, Vol. 20, Issue 3, pp. 69 – 71.
- Lenaerts, E.H. (1950-1967) **Note Books**, a set of 48 manuscript diaries covering the work of LEO engineer Ernest Lenaerts from LEO I to LEO III. www.billp.org/LEO The note books are held at the Cambridge Centre for Computer History and being professionally archived and made available for exhibition. See also

https://www.dropbox.com/search/personal?path=%2F&preview=Ernest+Lenaerts+and+his+diaries.doc&qsid=435821106312509275222391511615 52&query=ernest+diaries&search_token=maaZCi5EZfs9ghMHde3MaOmE5gIkeIs7mVlUbNhfSkQ%3D

- Lenaerts, E.H. (1951) **Visual Presentation of Binary Numbers,** Electronic Engineering, Vol. 23, pp. 140-141.
- Lenaerts, E.H. (1954) **'LEO - Operations and Maintenance'**, Electronic Engineering, Vol. 29, pp. 335-341. Reprinted as part of '**LEO –Lyons Electronic Office'** in Electronic Engineering, pp. 11-17.
- Lenaerts, E.H., (1955), **Automatic Square-Rooting on a Computer**, Electronic Engineering, July 1955
- Lenaerts, E.H., (1966), **Study of Static Charge on Paper Tape**, Journal of Science Institute, June 1966
- Lenaerts, E.H., (1967), **Acoustic Noise in the Computer Room,** for GPO, November 1967
- Lenaerts, E.H., (1969), **Talking to the Computer**, New Scientist, December 1969
- Lewis, J.W. (1963) **'Time Sharing on LEO III'**, The Computer Journal, British Computer Society, Vol. 6, No. 1, pp. 24-28.
- Lewis, J.W. (1964) **'The Management of a Large Commercial Computer Bureau'**, The Computer Journal, British Computer Society, Vol. 7, No. 4, pp. 255-261.
- Lewis, J.W., (1997), **Glyn Mills Bank and Army and Air Force Officers Payroll**, in Caminer, D.T., *et al, editors*, LEO: The Incredible Story of the World's First Business Computer, McGraw-Hill, New York, Part 3, chapter 19, pp. 229 – 242.
- Logan RS et al Ravenscraig use of LECTOR V3 (2022)

Colvilles Ltd., Ravenscraig Steelworks - Use of Lector OMR in LEO III systems

Introduction

Colvilles Ltd. Steelmakers installed a LEO III (No.32) in its Ravenscraig Works in Motherwell in 1965. In 2021, Dr. William (Bill) Jack, leader of the systems development team described in a paper to the LEO Computers Society the systems developed and run on this computer. I was one of the lead analysts and was asked by the Society if I could provide further detail on how Lector OMR techniques were used. This request was made nearly 60 years after we had acquired the LEO and all documentation had long since been destroyed. We clearly did not have the foresight to realise that what we were developing could be regarded as pioneering. Appendix 1 is a timeline of significant events.

The development team

The team, with the help of the LEO aptitude test, was selected from existing Works staff. It was built up to about a dozen in 1964 and started work on system design. It received training in the CLEO high-level language in early 1965. Thereafter, it was split into two sections; one for the Production Planning and Control system and the other for the Payroll one.

Production Planning & control system

Perhaps a word is in order as to how I managed to get a little more detail. In 1967 I had just got married and was working on draft drawings of a house I planned to build. By pure chance, I recently found (in 2021) that one of these drawings had, on its reverse, most of a flow chart of the Production Planning & Control system that we had implemented. I think it is probably just missing 1 or 2 operations down one edge so it gives a good picture of the scope of the system. It is unfortunately very faded and not really suitable for adding to the LEO archives in its present state. However, I traced a copy of a Colvilles Ltd. Technical Offices progress report on the use of the LEO at Ravenscraig Works. It is undated but I estimate that it was probably produced in Spring 1967. It is held in the Peter Bird material at the Manchester University archives. The pages were poorly scanned with data missing or very difficult to read. However, I have managed to retype almost all of it. I was able to pick up additional detail of the use of Lector documents from it and it does contain Xerox copies of some of the Lector documents..

The primary requirement of the system was to provide information on orders and the location and present state of every piece of material across the works whether or not it was allocated to an order. This information allowed clerical staff to create production schedules for further processing. This information was required as at 6am by staff who started work at 8.30am and for production meetings at 9am. This was not possible to achieve using conventional data preparation staff who also started work at 8.30 and on-line terminals had yet to appear. English Electric LEO Computers had recently introduced its Lector Optical Mark Reading device. It was determined that this was the only feasible way of collecting the large amount of feedback in the short time available each morning .

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Lector documents were used to collect data on new orders, order amendments, order cancellations and order completions. These documents were completed by sales personnel in an office environment in normal

office hours. This information was input to the system run shortly after 6am daily thus providing an updated order file.

As Dr. Jack explained in his paper, for process scheduling reasons, it was not possible, unless an order was very small, to move all of the material for it through the plant together. However, by tracking the movement of every piece of material, whether or not allocated to an order, the system could provide the requirements of every order and the present progress towards order completion including whether there was a shortfall of material for it. Unlike order processing, material movement was a 24 hour, 7 days a week, operation. There was, therefore, a constant flow of Lector documents being collected from the shop-floor and processed to paper-tape by a Lector machine. This meant that, at the end of the night-shift at 6am, there was very little material still to be processed before the system could be run. Trials showed that there would be a delay whilst the final documents from Gartcosh Works, 15 miles away, were conveyed to Ravenscraig and processed. It proved necessary to install a second Lector reader at Gartcosh together with a paper-tape reader to paper-tape punch link to Ravenscraig.

Lector documents collected information on the creation of each steel slab, including dimensions, weight, grade or quality and allocation to an order. Thereafter, Lector documents were used to record every movement and change of status of the coils produced from the slabs. In later processing, a coil could be cut along its length into two or more narrower ones. Coils could also be cut into bundles of sheets and further processed. Lector documents were also used to track material through these processes. Where a coil was despatched by train to Gartcosh Works finishing processes, the tracking continued until despatch from there as either coils or bundles of sheets. The data recorded on each coil or bundle as it passed through the processes included a code for the process, any change to dimensions, weight or grade (which resulted in it being removed from its allocated order). A lector document was also used to collect information on surplus stock being allocated to suitable orders. The tracking of coil and sheet bundles movement thus covered all processes until the material was despatched. The Lector documents were completed by recorders on the shop floor (see Appendix 2). The data was collected through a 24 hour period and input to the Lector machines at Ravenscraig and Gartcosh.

The system produced production reports for morning progress and planning meetings at 9am. Additionally, order file reports were produced showing the present status of each order so that remedial action could be taken if it

was running late or short of material. Lists were produced of the stock ahead of each production unit to assist schedulers with their work and to greatly simplify periodic stock checks. Subsequent stock-checks showed the system to be highly accurate.

Analysis of the recovered flow chart indicates that there were 52 CLEO routines providing vetting and files updating together with about 50 printed reports. There were upwards of 30 sort routines. I do not have actual figures but there must have been many hundreds of order and stock changes every 24 hours.

Payroll System

The payroll system required much alpha information such as names and addresses. As the payroll was only run once a week there was plenty of time to collect this type of data using conventional data preparation. However, there was limited time between the end of the working week and the running of the payroll system. This would have required a large team of data preparation staff for a limited period each week. As it had already been decided to use Lector for the production system, this same facility was selected to collect the clock-card data. The complex nature of the payroll system would be handled by the system leaving the pay-clerks to fill in Lector documents from the clock-cards.

Further development

After the steel industry was nationalised, Ravenscraig and Gartcosh Works became part of the Strip Products Group of British Steel. The predominant computer supplier to this Group was IBM. The Group decided to adopt a policy of standard computer system as far as possible and it was decreed that the LEO III at Ravenscraig be replaced by an IBM360/40. It indicates how highly the LEO systems were regarded that both were rewritten almost unchanged in PL1 to run on the IBM machine. The rewritten systems which were implemented in 1973 still used Lector documents for several years until replaced by on-line terminals. The LEO III was decommissioned in 1974.

Acknowledgements

It was fortunate that 6 senior members of the original team were still available and the detail in this report would not have been possible without the help of Eric Halkett, Bill Jack, Stewart Logan, Bill Service, Allan

Watson and John Wolseley. I very much appreciate the encouragement of Frank Land to add to the LEO history.

Stewart Logan

June 2022

Appendix 1 – Ravenscraig LEO3/32 and Lector Timeline

Colvilles Ltd. selects a LEO3 computer
1963

Development team selected & system design started
1964

LEO3 computer delivered and commissioned 1965

Development team trained in CLEO
Feb. 1965

Production Planning & Control system implemented at Gartcosh Oct. 1965

Payroll system implemented
Oct. 1965

Production Planning & Control system implemented at Ravenscraig
Apr. 1967

Ravenscraig/Gartcosh moved to British Steel Strip Products Group
July 1967

IBM360/40 delivered
c1969

PP&C system operational in PL/1 on IBM360/40 using Lector Docs.
c1973

Payroll system operational in PL/1on IBM360/40 using Lector Docs.
c1973

LEO3/32 decommissioned
Sept. 1974

IBM360/40 systems inputs moved from Lector to on-line terminals
c1975

Lector readers decommissioned c1975

Over 50 years after the IBM360/40 was brought in to replace the LEO3/32, we could not trace anyone who could be definite about the dates in the latter period when systems were converted to run on the IBM machine. However, these converted systems continued to use Lector documents for some years until replaced by on-line terminals..

Appendix 2 – Design of Lector forms

Trial OMR documents were printed and tested out on shop-floor production recorders. Most of the data to be collected was numeric; items such as material identity, any changes to dimensions, weight, grade or anything else that could change at any specific production unit. Alpha data was very limited and normally restricted to one of a small range of characters. The test documents had the particular processing unit identity pre-printed on them. As most of the date to be collected was numeric, each character of a particular parameter to be input was represented by four, what we called, soup-bowls labelled 1, 2, 3 and 6. By filling in no more than 2 of these soup-bowls by pencil, any digit from 0 to 9 could be represented. Thus recording a material identity of 6 numeric characters would be represented on the pre-printed form by 6 groups of these 4 soup-bowls. The choices of the limited acceptable alpha characters were all represented by individual soup-bowls. We were advised that shop-floor personnel would not understand this. We argued that anyone who knew how to fill in a pools coupon would soon master it. Trials showed that we were right. Subsequently, once the system was implemented, we only had one failure – a person who was dyslexic!

Logan R.S 1967 Colvilles Technical Office Report on Systems development on the LEO III/32

Ravenscraig Reports

Items in red are inferred from historic documents but not actually readable

Ito

This is the transcript of a Colvilles Ltd Technical Offices report on the development of systems on the LEO3/32 computer installed at Ravenscraig Works in Motherwell. The original copy is held in Peter Bird's material in the Manchester University Archives. It is undated but, based on the contents, must have been produced round about March 1967. It is a very poor copy of an original document with the bottom line missing on some pages and examples of print-outs being distorted and very faint. I have managed to retype the complete document with the exception of those lines that were missing from Peter Bird's copy. I have inserted in red the likely content of those missing lines. Despite the missing flow-chart, this report gives much detail of the computer's actual and planned workload. Due to the subsequent nationalisation of the steel industry, which resulted in the LEO computer being replaced by an IBM 360/40, much of the future plans to enhance the LEO systems were not implemented on that machine.
Stewart Logan (Chief Systems Analyst at that time)
June 2022

LEO III COMPUTER SYSTEMS
PRESENT DEVELOPMENT

Technical Offices
Motherwell
Mach 1967 (estimated)

1. INTRODUCTION

This report briefly outlines the projects at present being undertaken by the LEO III Computer. It indicates how far these systems have been developed and the form the ultimate systems will take. Wherever possible the savings and advantages of the computer systems are enumerated. Appendix 1 shows the information flow in the computer production control system and includes samples of the main reports.

The flow-chart is not in Peter Bird's material and cannot be traced.

2. PRODUCTION SYSTEMS

The Production System is being undertaken in three stages.

Phase 1 Production Recording

This involves the establishment of an effective recording and feedback system.

Phase 2 Computer assisted production control system

At this stage the Computer produces reports which enable the manual system to operate more effectively and with much reduced manpower.

Phase 3 Computer controlled production control sysyem

At this stage the computer will automatically control all aspects of production with manual interventions permitted for exceptions and emergencies.

Phases 1 and 2 are complete at Gartcosh and are in an advanced stage of implementation at Ravenscraig.

2.1. PRODUCTION RECORDING

Present

The object of this part of this project was to set up an effective method of recording the status of orders and coils as material moves through the Mills and the Finishing Units.

Accurate and speedy retrieval of data is the foundation of any computer system and most computer projects which have failed, (and there are many of these), have done so because this problem had not been adequately solved. Data retrieval is a special problem in steelworks where the area covered is large, conditions do not always favour clerical work and the quality of recording personnel is often poor. It was, therefore, thought that production recording should be tackled first as a project in its own right. The solution adopted was:

1. Use of Lector documents for direct retrieval of data from source.

2. Use of data links to transmit data rapidly between Ravenscraig and Gartcosh.
3. Adoption of 'exception' principle to limit the volume of recording.

The system has been in operation at Gartcosh for eighteen months and an effective recording system has been established there. The quality of recording by the Gartcosh Production Personnel is acceptable for the degree of control being sought. Data is collected at 2pm and 10pm and processing commences on the Computer within half an hour of the final collection of data at 6am.

Future

The recording system is being extended to the Ravenscraig Hot Strip Mill and Hot Sheet Finishing Department.

Because of the ease with which Production Personnel are coping with Lector recording, the 'exception' principle is being relaxed and the document is being extended to handle more information. All recording on production units will be done on Lector and the Computer will produce all relevant reports. The Lector documents have been redesigned and have been presented to the Production Management for approval.

2.2 SCHEDULING

Present

The Computer produces, daily, lists of material ready for processing ahead of each production unit at Gartcosh. These lists are in the schedule order dictated by the requirements of each unit (eg light, medium and heavy gauge rounds, in descending width order at Tandem Mill etc.). Most of the difficulties have now been overcome and all major production units at Gartcosh are scheduled from these listings.

Advantages

1. Clerical functions are simplified and the work load reduced.
2. When the correct criteria are established, the scheduling is more accurate and more efficient.
3. Delays between processes are reduced.

Future

The computer will produce schedules for direct use on the production units. These schedules will be manually scrutinised, minor adjustments made

and then issued directly to the units. The schedules could be in the form of Lector documents pre-printed by the computer. The unit personnel will record on these documents and return them to the Computer for further processing. Sufficient information will also be supplied so that emergency schedules can be prepared manually in the event of a breakdown or an occurrence outwith the scope of the Computer System, (eg roll breaking). An attempt will be made to move away from scheduling the next manufacturing unit to several production units. The Computer would reschedule continually as actual performance fell short of this plan,

2.3. PROGRESSING

Present

The Computer produces a summarised statement of the progress of each order, listing the tonnages ahead of each unit and the balance still to be despatched. It also indicates when an order is falling behind schedule and when insufficient material is in process to give a reasonable likelihood of completing the order. A further set of listings is produced giving details of the individual coils being processed against each order.

The progress report is available to Sales Department and to the Progressing and Expediting Departments.

Advantages

1. Considerable reduction in clerical effort.
2. Potential backlogs and shortfalls are highlighted much earlier, giving more time to take corrective action.
3. Sales Department can give customers accurate and up to date information on the status of their orders without reference to Production Departments.

Future

When confidence in the computer controlled system Has developed it is anticipated that the Computer will Report only on these orders that are not running to plan. This should have the effect of focussing the attention of the Progress Department on those orders where manual expediting is necessary

A statistics file will be set up on the Computer and development will be done into a method of accurately determining production overages and lead times. These Investigations will be continued and more sophisticated techniques developed for planning and evaluating progress.

Advantages

1. Reduction in clerical effort.
2. Better control of backlogs and shortfalls.
3. More accurate production plans and progress reports.

2.4. STOCK CONTROL

Present

The Computer produces daily lists of unallocated material with all relevant parameters and, where applicable, the reason why the material was put to stock. This material appears in gauge/width order and is grouped according to the stock areas. This report is used in conjunction with a daily list of orders requiring tonnage to be allocated to them. It is a simple task to match the two listings and reapply stock to orders.

Advantages

1. Reduced clerical effort.
2. More effective reallocation of stock to orders leading to reduced stock levels and the utilisation of a larger percentage of stock for prime orders.

Future

A system has been specified for automatic reapplication of stock to orders by the Computer.

Advantages

1. No clerical effort.
2. Reduced stocks.
3. More economic use made of stocks by considering the costs involved.

2.5. ORDER HANDLING SYSTEM

Present

The Sales Department return to the Computer selected information about each order received. This is stored on an order file in the Computer and used to progress the orders through the plant. The computer order book can be listed in any form required, giving details of order parameters and balance of tonnages

to be met. The amount of data recorded is not sufficient to set up an effective computer control in this area at present.

Future

Phase 1 – A Lector document has been designed to record additional information for each order. This information will permit the Computer to carry out the analysis required by the Market Research Department and produce all the B.I.S.F. statistics. The additional information will also enable the Computer to perform all the calculations at present done by the Figuring Section.

Advantages

1. Considerable reduction in clerical effort.
2. Better and more extensive market research analysis.
3. Reduction in the loading of the De La Rue Bull Punch Card installation.

Phase 2 – This involves the complete computer control of the order handling system through Sales, Quality Control to Scheduling and Planning. A detailed feasibility study has been carried out and the findings passed to Sales, Quality Control and Production Planning. (unable to suggest next missing words) and Quality Control details are typed on these machines and the paper tape produced is fed to the Computer.

As 70% of all orders handled are completely or in some part standard, the Computer will add this standard information, figure the order, produce the master order form, calculate the plant loading and produce the Melting Shop Schedules completely automatically.

Advantages

1. Greatly reduced clerical effort.
2. More accurate and speedy handling of the order.
3. More legible Mill documentation would be produced, thus reducing the chance of mistakes in processing.

2.6. MANAGEMENT REPORTING

Present

The computer produces daily, reports of plant performance and stock tonnages, weekly summaries of performance and monthly tabulations of stock values. Plant loading summaries are produced on the basis of the order book.

Future

As the Computer extends its control into the various aspects of the production system the reports produced for Management will increase in scope. The setting up of a statistics file will enable Management to have statistical information about the production system in any form they request.

A major extension envisaged will be the Incorporation of costing information into the system. This would mean that Management would be supplied with costing reports as a by-product of the computer production control system and thus the effects of policy decisions could more easily be evaluated in terms of these costs.

3. PAYROLL SYSTEM

Present

Each week the Computer processes the pay- roll of weekly paid employees at Ravenscraig and Gartcosh. From the input data of gross hours and jobs worked for each employee it produces the following information:-

Payroll

Pay Envelopes

Schedules of Deductions

Cash Dissections

B.I.S.F. Statistical Returns

National Insurance Schedules.

Advantages

1. The payroll is produced 24 hours earlier.
2. Much less manual preparation of input data is required.
3. Many of the clerical functions of the Pay Department have been taken over.

Future

A Collectadata time and attendance record- Ing system is being introduced to record directly to the Computer, the clocking in and out times of each employee at Ravenscraig and Gartcosh.

Used in conjunction with Lector documents for recording the various jobs worked on by each

employee. This will permit the preparation of the payroll to be completely automatic.

Advantages

1. Greatly reduced manpower.
2. A very closely controlled payroll system.

Possibly another advantage missed at bottom of page

4. INVENTORY CONTROL SYSTEM

Present

The Computer produces a monthly statement of all issues from the Ravenscraig and Gartcosh Stores. These are tabulated against bin numbers, account numbers and job numbers for the Cost Department and Plant Maintenance Department.

Advantages

1. Gartcosh Hollerith equipment abolished.
2. Operating staff for this equipment freed.

Future

A Collectadata recording system is being introduced into the Ravenscraig and Gartcosh Stores. This system will record all stores receipts and issue quantities. The Computer will eventually:-

Produce cost reports

Maintain stock records

Control perpetual inventory system

Control stock levels

Prepare purchase requisitions

Produce order progress reports

Produce financial returns

Advantages

1. Considerable saving in clerical effort.
2. Reduction in levels of consumable stocks.
3. More accurate control of stores system.
4. Prompt financial returns.

5. OTHER SYSTEMS

In addition to the main systems discussed , the Computer is also used for work of a scientific and statistical nature. The computer has also been used to analyse the

performance of coils through the production processes to set up more accurate tables of production overages and lead times.

Scientific

The Computer is being used to assist research into heat transfer in the slab reheat furnaces and in the evaluation of titration values for the Central Research Laboratories.

Critical Path Methods

Computer time has been sold to local building firms to do critical path analysis of large building projects. The Computer Department has liaised closely with the planning engineers of these companies in order to gain a working familiarity with this technique as it has some very definite applications in the steel industry, eg building and development projects, implementation of computer systems, shutdown maintenance projects, roll changing etc.

Process Control

A set of programs has been written for the LEO Computer to handle directly, data logged by the KDF7 which is linked on-line to the Hot Strip Mill. From this data mathematical models are being constructed in preparation for computer control of the Hot Strip Mill.

Budgetary Control

Linear programming techniques are being used on the Computer to develop an accurate economic model for the Ravenscraig and Gartcosh Works.

Appendix 1

This appendix contains samples of the major items of documentation in the production system. These documents should be studied in conjunction with the diagrammatic illustration of the production system.

Diagrammatic illustration not included and could not be traced.

BALANCE OF ORDERS TO DESPATCH – COLD REDUCED

MOTOR TRADE	GEN. HOME	EXPORT	PICKLE & OIL	GALVANISED	TOTAL BACKLOG
862	386	**335**	185	11	**1779**
197	711	280	114	14	1316
377	97	219	184	26	903
126	55	841	122	31	1175
125	103	8	22	4	262
187	47	91	12	3	340
15	676	163	182	381	1417
1889	2075	1937	821	470	**7192**

TONNAGE AHEAD OF DESPATCH

MOTOR TRADE	827 TONS
GENERAL HOME	1307 TONS
EXPORT	3458 TONS
PICKLE & OIL	336 TONS
GALV. – HOME	55 TONS
EXPORT	6 TONS
TOTAL	5983 TONS

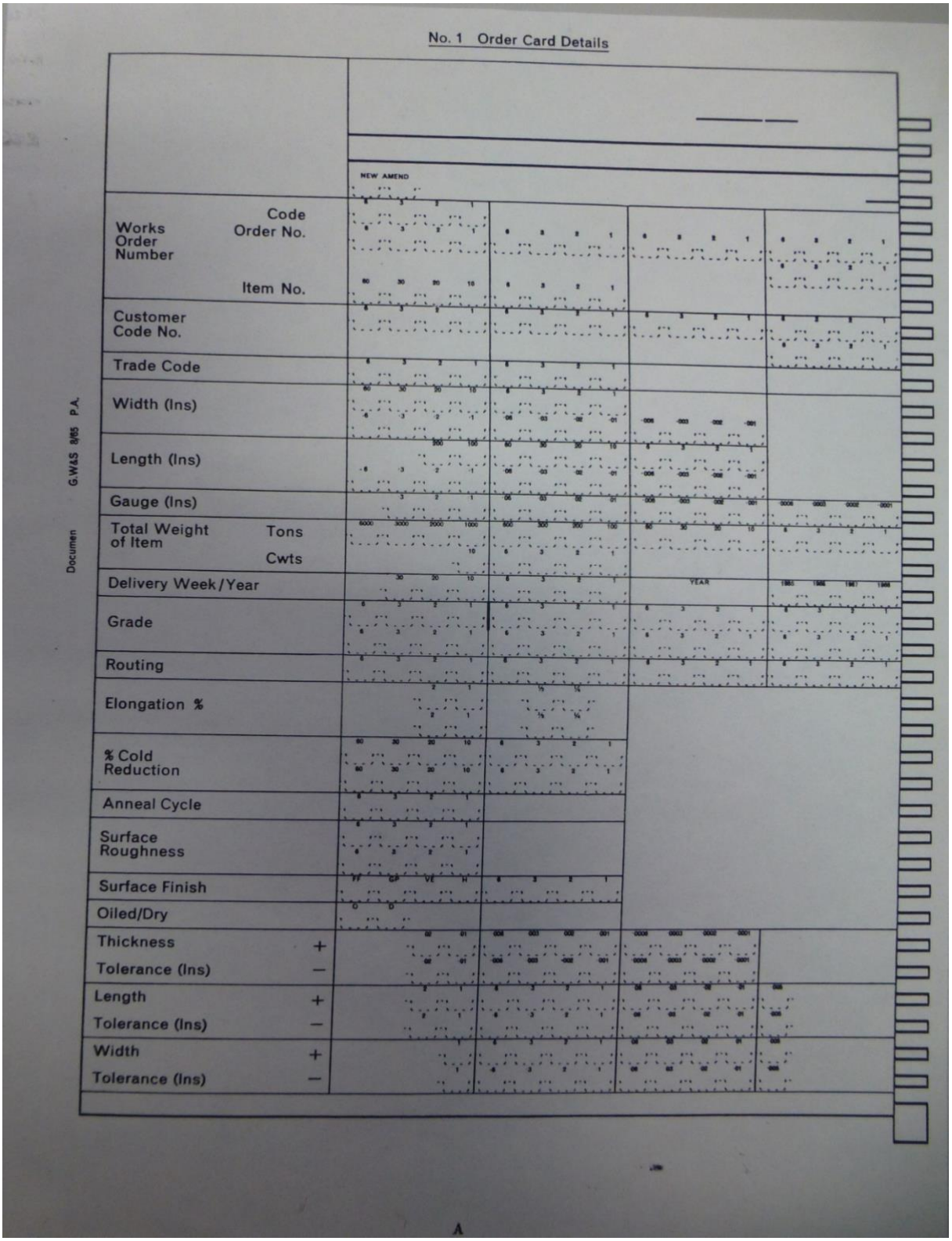
GARTCOSH SHIFT PRODUCTION REPORT FOR 24 HOURS ENDING AT 10PM ON FRIDAY 17/03/67

	10 – 6			6 – 2			2 - 10		
PROCESS	TONNAGE IN	TONNAGE OUT	YIELD	TONNAGE IN	TONNAGE OUT	YIELD	TONNAGE IN	TONNAGE OUT	YIELD
STRIP MILL	0.00	0.00	0.00%	0.00	0.00	0.00%	0.00	0.00	0.00%
PICKLE TRIM & OIL	14.11	11.72	78.57%	0.00	0.00	0.00%	0.00	0.00	0.00%
PICKLE LINE	228.75	208.57	91.23%	357.59	336.16	94.12%	475.33	442.23	93.05%
TANDEM MILL	733.10	732.88	99.86%	905.25	904.42	99.89%	612.86	621.65	101.47%
ANNEALERS	0.00	0.00	0.00%	343.37	485.40	141 40%	370.20	180.56	48.65%
NO 1 TEMPER MILL	307.88	302.23	98.37%	452.68	452.05	100.00%	321.50	311.31	96.88%
NO 2 TEMPER MILL	0.00	0.00	0.00%	0.00	0.00	0.00%	0.00	0.00	0.00%
SLITTER LINE	0.00	0.00	0.00%	94.59	79.28	84.04%	211.96	195.83	92.42%
NO 1 SHEAR LINE	0.00	0.00	0.00%	100.89	98.14	98.00%	164.78	161.67	95.17%
NO 2 SHEAR LINE	0.00	0.00	0.00%	76.47	63.00	82.89%	64.72	62.29	96.88%
RESHEAR	0.00	0.00	0.00%	4.71	4.71	100.00%	5.36	5.36	100.00%
ROLLER LEVELLER	0.00	0.00	0.00%	0.00	0.00	0.00%	0.00	0.00	0.00%
HAND INSPECTION	0.00	0.00	0.00%	11.10	11.10	100.00%	0.00	0.00	0.00%
SHEET PACKING	33.98	33.98	100.00%	76.82	76.82	100.00%	9.19	9.19	0.00%
COIL PACKING	119.75	120.20	100.84%	216.42	225.00	104.17%	332.05	334.13	100.60%
DESPATCH	0,00	0.00	0.00%	0.00	350.83	0.00%	0.00	303.83	0.00%

DAILY STOCK REPORT FOR GARTCOSH AS AT 10PM ON SATURDAY 18/03/67

STOCK AREA	COIL BACK LOGS	COIL CURR ORDS	COIL ADV ORDS	COIL AWAIT ORDS	COIL TOTAL	SHEET BACK LOGS	SHEET CURR ORDS	SHEET ADV ORDS	SHEET AWAIT ORDS	SHEET TOTAL	N.T.R CURR	RESERVE ADV	STOCK TOTAL
PRIME													
A/H PICKLE (Rav & Gart)		467	1605	6156	434 (8662)						562	9224	
A/H TANDEM		139	1077	409	113						187	1925	
A/H ANNEAL		1522	3488	217	71						735	6033	
IN ANNEAL	690	1662	29	11	(2392)	666	77	406	6	(1155)	230	3777	
A/H OF COOLING	21	316	1094	46	(1477)	115	249	586	30	(980)	90 323 178	3047	
TEMPER – READY ROLL		2244	3932	1345	392 (7913)		918	193	488	214 (1813)	402 120	672	10920
A/H SLITTER	254	953	672	132	(2011)	40	15	7	13	(75)	22	2108	
A/H CUT UP LINES		2	23	210	(235)	152	198	151	250	(751)	8	994	
A/H FINISH & PACK			HOME					EXPORT					
AT SHEET STOCK	51	14	4	408	(477)	85		4	90	(179)		656	
AT ROLLER LEVEL	2			2	(4)							4	
AT RESHEAR		44			(44)		-1			1			44
AT HAND INSPECTION		31	-6	4	31 (58)		-4			-1 5			58
AT SHEET PACKING		32	61	-2	6 (97)		271		3	13 (287)		11	395
H/R PICKLE & OIL AT SHEET DESPATCH		298	320	278	145 (1041)		792			4 (796)		25	1862
H/R PICKLE & OIL AT COIL PACKING		162	108	215	234 (719)		419	485	410	46 (1360)		4	2083
H/R PICKLE & OIL	17												
AT COIL DESPATCH		708	427	149	210 (1494)		1649	677	276	4 (2606)			4100
H/R PICKLE & OIL	87												
GALVANISED A/H DESP.	75	10	26								111		
NON-PRIME											47341		
RAVENSCRAIG COBBLE										PLATE			
GARTCOSH PICKLE										TANDEM 28			28

No. 1 Order Card Details Lector document



PROGRESS REPORTS – ALLOCATED STOCK

DEPARTMENT 1 ROUTES PRESSINGS 14/11/66

ORDER NO. GAUGE G/C TONS BAL	A/H	A/H PCLE	A/H TAND	A/H ANEL	IN ANEL	IN COOL	A/H TEMP	COIL PACK	A/H SLIT	A/H CUL	A/H RLV	A/H RHO	A/H CINN	A/H INSP	A/H SPAK	A/H DESP	IN PROC	ORD DESP
2/32827/1 0048 0 0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	17	0	10 `10
		L <-																
2/32826/1 0048 0 0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	11	0	10 10
		L <-																
2/32839/1 0048 0 0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	16	0	12 12
		L <-																
2/32840/1 0048 0 0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	13	0	10 10
						L <-												
2/32841/1 0048 0 0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	9	0	10 10
		L <-																
2/32842/1 0048 0 0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	22	0	20 20
		L <-																
2/33210/1 0048 0 0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	8	0	5 5
						L <-												
2/33211/1 0048 0 0	0	0	29	10	0	0	0	0	0	0	0	0	0	0	0	39	0	29 29
						L <-												
2/33462/1 0048 0 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10 10
		L <-																
2/29970/4 0048 0 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	15 15
		L <-																
2/29977/1 0048 0 0	0	0	0	0	0	59	0	0	0	0	0	0	0	0	0	58	0	94 94
		L <-																
2/32732/1 0048 0 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	10 10
		L <-																

TOTALS FOR DELIVERY WEEK 601

	ORDDBAL	TEMPR	ROLLD	NON T	ROLD	PRESS	FISH	FORD
	VAUX	OTHER						
	TONS	26	26	26	26	STEEL	LUD	HALL
COIL ORDERS	721	721	578	0	143	0	646	0	0	0	0

	ORDDBAL	UNDER	OVER	FLAT R&RDOILED	PRESS	FISH	FORD
	VAUX	OTHER					
	TONS	020	0 20		STEEL	LUD	HALL
SHEET ORDERS	314	314	11	303	0	1	254	215	0	0	0	0

	ORDDBAL	PLATE	MPLTE	SHEET	PRESS	FISH	FORD
	VAUX	OTHER					
	TONS				STEEL	LUD	HALL
PICKLE & OIL ORDERS	32	32	0	17	15	0	0	0	0	0

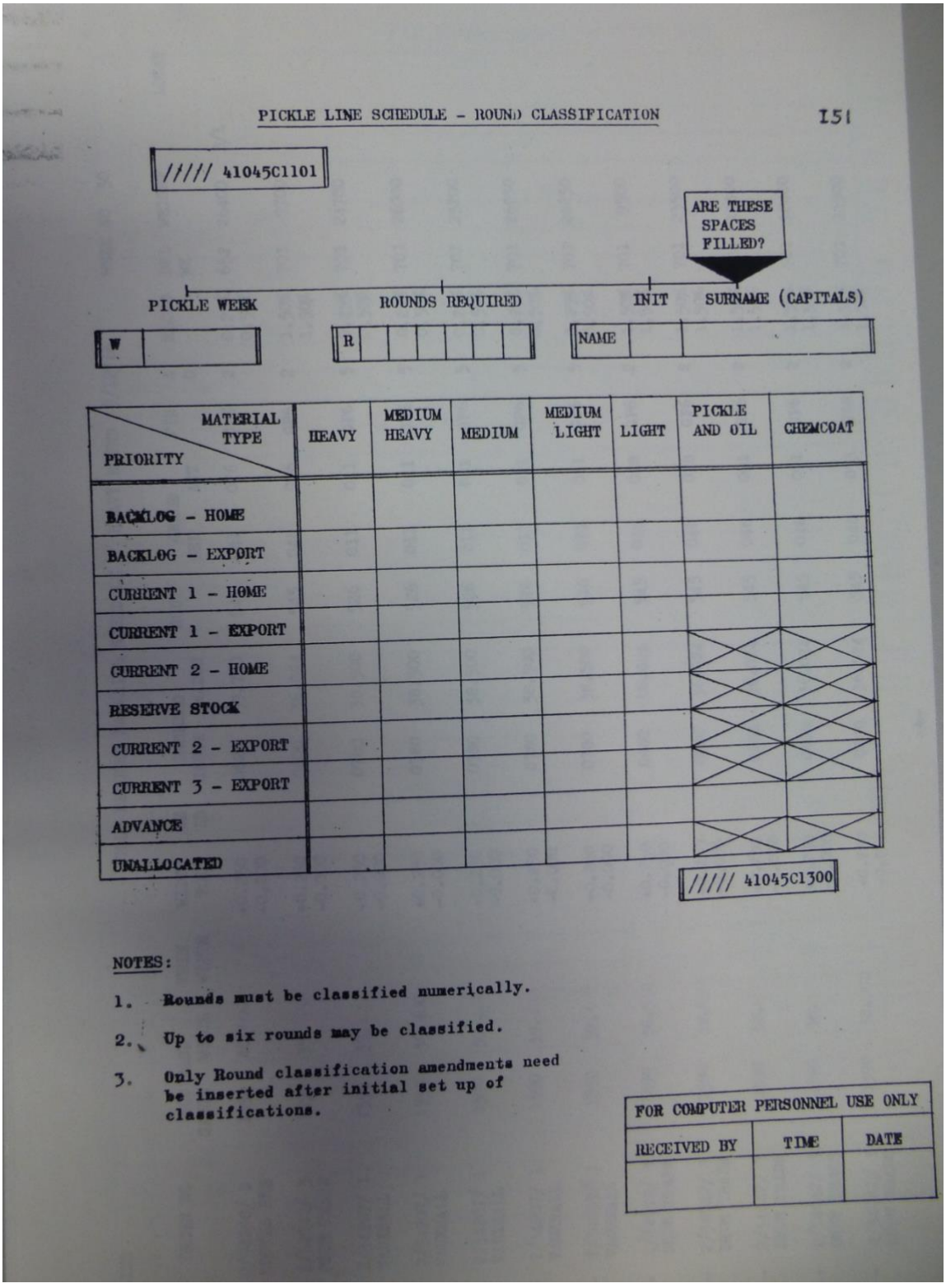
TOTALS FOR DELIVERY WEEK 602

	ORDDBAL	TEMPR	ROLLD	NON T	ROLD	PRESS	FISH	FORD
	VAUX	OTHER						
	TONS 26	26	26	26	26	STEEL	LUD	HALL
COIL ORDERS	2800	2800	1550	420	830	0	689	823	268	0	20

	ORDDBAL	UNDER	OVER	FLAT R&RDOILED	PRESS	FISH	FORD
	VAUX	OTHER					
	TONS	020	0 20		STEEL	LUD	HALL
SHEET ORDERS	2926	2926	119	2807	13	43	2374	265	0	93	205	691

		ORDD	BAL	PLATE		MPLTE		SHEET					PRESS		FISH		FORD		
		VAUX		OTHER															
		TONS										STEEL		LUD				HALL	
PICKLE & OIL ORDERS		515	515		100	202	2	13					42	0		0		0	5 0

PICKLE LINE SCHEDULE ROUND CLASSIFICATION



PICKLE LINE SCHEDULE - ROUND CLASSIFICATION 151

///// 41045C1101

ARE THESE SPACES FILLED?

PICKLE WEEK W | ROUNDS REQUIRED R | INIT NAME | SURNAME (CAPITALS)

PRIORITY \ MATERIAL TYPE	HEAVY	MEDIUM HEAVY	MEDIUM	MEDIUM LIGHT	LIGHT	PICKLE AND OIL	CHEMCOAT
BACKLOG - HOME							
BACKLOG - EXPORT							
CURRENT 1 - HOME							
CURRENT 1 - EXPORT							
CURRENT 2 - HOME							
RESERVE STOCK							
CURRENT 2 - EXPORT							
CURRENT 3 - EXPORT							
ADVANCE							
UNALLOCATED							

///// 41045C1300

NOTES:

1. Rounds must be classified numerically.
2. Up to six rounds may be classified.
3. Only Round classification amendments need be inserted after initial set up of classifications.

FOR COMPUTER PERSONNEL USE ONLY		
RECEIVED BY	TIME	DATE

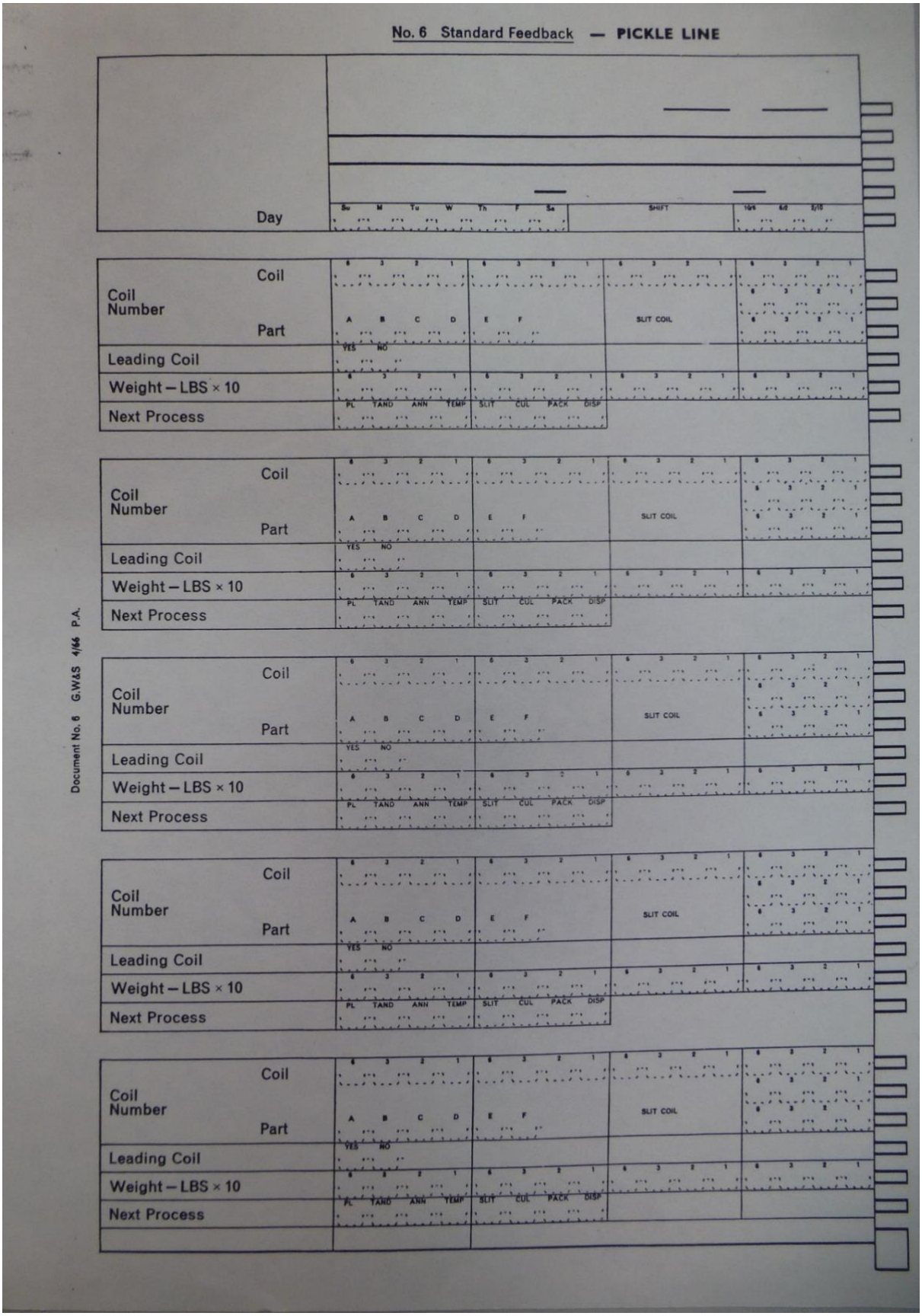
PICKLE LINE **COLD REDUCED MATERIAL SCHEDULE** **HEAVY ROUND** **9/12/66**

WEEK NO 50

ORDER NO	HOT BAND WEIGHT	GAUGE	WIDTH	TRIM WIDTH	WE TOL	ORDERED LD	GAUGE	WIDTH	ROUT	GRADE	FIN ORD	A ACT	ELONG C	DEL WK
2/34280/1	1590	40.60		+0.250	0620	39.750	846	041	026	GP6	2	0.25%	652	26400 b/l
ROOTES PRE				-0.000								0.50%		
2/34042/3	1590	39.00		+0.250	0600	36.024	545	048	036	GP6	2	1.50%	701	9700
DRUM TRADE				-0.000								1.50%		
2/34207/1	1590	39.40		+0.250	0780	38.500	526	011	011	GP6	5	0.25%	701	24700
VAUXHALL				-0.000								0.50%		
2/34207/1	1590	39.40		+0.250	0780	38.500	526	011	011	GP6	5	0.25%	701	26000
VAUXHALL				-0.000								0.50%		
2/34207/1	1590	39.40		+0.250	0780	38.500	526	011	011	GP6	5	0.25%	701	25200
VAUXHALL				-0.000								0.50%		
2/34207/1	1590	39.40		+0.250	0780	38.500	526	011	011	GP6	5	0.25%	701	26950
VAUXHALL				-0.000								0.50%		
2/34207/1	1590	39.40		+0.250	0780	38.500	526	011	011	GP6	5	0.25%	701	26250
VAUXHALL				-0.000								0.50%		
2/34042/3	1590	38.50		+0.250	0600	36.024	545	048	048	GP6	2	1.50%	701	9500
DRUM TRADE				-0.000								1.50%		
2/34042/3	1590	38.00		+0.250	0600	36.024	545	048	028	GP6	2	1.50%	701	23500
DRUM TRADE				-0.000								1.50%		
2/34042/3	1590	38.00		+0.250	0600	36.024	545	048	001	GP6	2	1.50%	701	13300
DRUM TRADE				-0.000								1.50%		
2/34042/3	1590	38.00		+0.250	0600	36.024	545	048	001	GP6	2	1.50%	701	12400

DRUM TRADE			**-0.000**								**1.50%**			
2/34042/3	**1590**	**38.00**	**+0.250**	**0600**	**36.024**	**545**	**048**	**053**	**GP6**	**2**	**1.50%**	**701**	**24900**	
DRUM TRADE			**-0.000**								**1.5**			

PICKLE LINE LECTOR DOCUMENT



No. 6 Standard Feedback — PICKLE LINE

Day

Su M Tu W Th F Sa SHIFT

Coil Number — Coil / Part

A B C D E F SLIT COIL

Leading Coil — YES NO

Weight – LBS × 10

Next Process — PL TAND ANN TEMP SLIT CUL PACK DISP

Document No. 6 G.W&S 4/66 P.A.

RUN 286 PROGRESS REPORTS IN ORDER NUMBER ORDER 4/ 5/67

DEL WEEK	ORDER NO	GAUGE	G/C	A/H PCLE	A/H TAND	A/H ANEL	A/H COOL	A/H COOL	AN & TEMP	DATE PACK	A/H SLIT	COIL CUL	A/H RLV	A/H R&CS	A/H INSP	A/H SPAK	A/H DESP	A/H PROC	A/H DESP	IN TONS	BAL
720	2/38237/1	0490	0	0	0	0	12	10/05 L<-	0	0	0	0	0	0	0	0	0	12	0	10	10
720	2/38237/2 25	0360		9	0	0	22	28	7/05	0	0	0	0	0	0	0	0	0	50	0	25
720	2/38237/3	0360	0	0	34	0	0	L<-	0	0	0	0	0	0	0	0	0	34	0	30	30
720	2/38237/4	0390	0	0	0	24	0	L<-	0	0	0	0	0	0	0	0	0	24	0	35	35
720	2/35238/1 10	0395		0	0	0	0	15 L<-	10/05	7	0	0	0	0	0	0	0	0	22	0	10
720	2/35238/2	0360	0	0	0	18	0	L<-	0	0	0	0	0	0	0	0	0	18	0	10	10
720	2/35239/1	0360	0	0	0	0	38	30/05 L<-	0	0	0	0	0	0	0	0	0	38	0	31	31
720	2/38210/1	0360	0	0	0	0	0	L<-	31	0	23	0	0	0	0	0	0	54	0	25	25
720	2/38210/2	0360	0	0	0	0	56	10/05 L<-	0	0	0	0	0	0	0	0	0	56	0	56	56
720	2/38211/1	0360	0	0	0	54	0	L<-	0	0	0	0	0	0	0	0	0	54	0	50	50
720	2/38212/1	0360	0	0	0	10	5	6/05 L<-	11	0	0	0	0	0	0	0	0	27	0	25	25
721	2/38213/1	0360	0	1	0	0	0	L<-	0	0	0	0	0	0	0	0	0	1	0	14	14
721	2/28214/1	0390	0	0	0	0	0	L<-	0	0	0	0	0	0	0	0	0	0	0	10	10
721	2/38214/2	0360	0	0	0	0	13	09/05	16	0	0	0	0	0	0	0	30	59	0	25	25

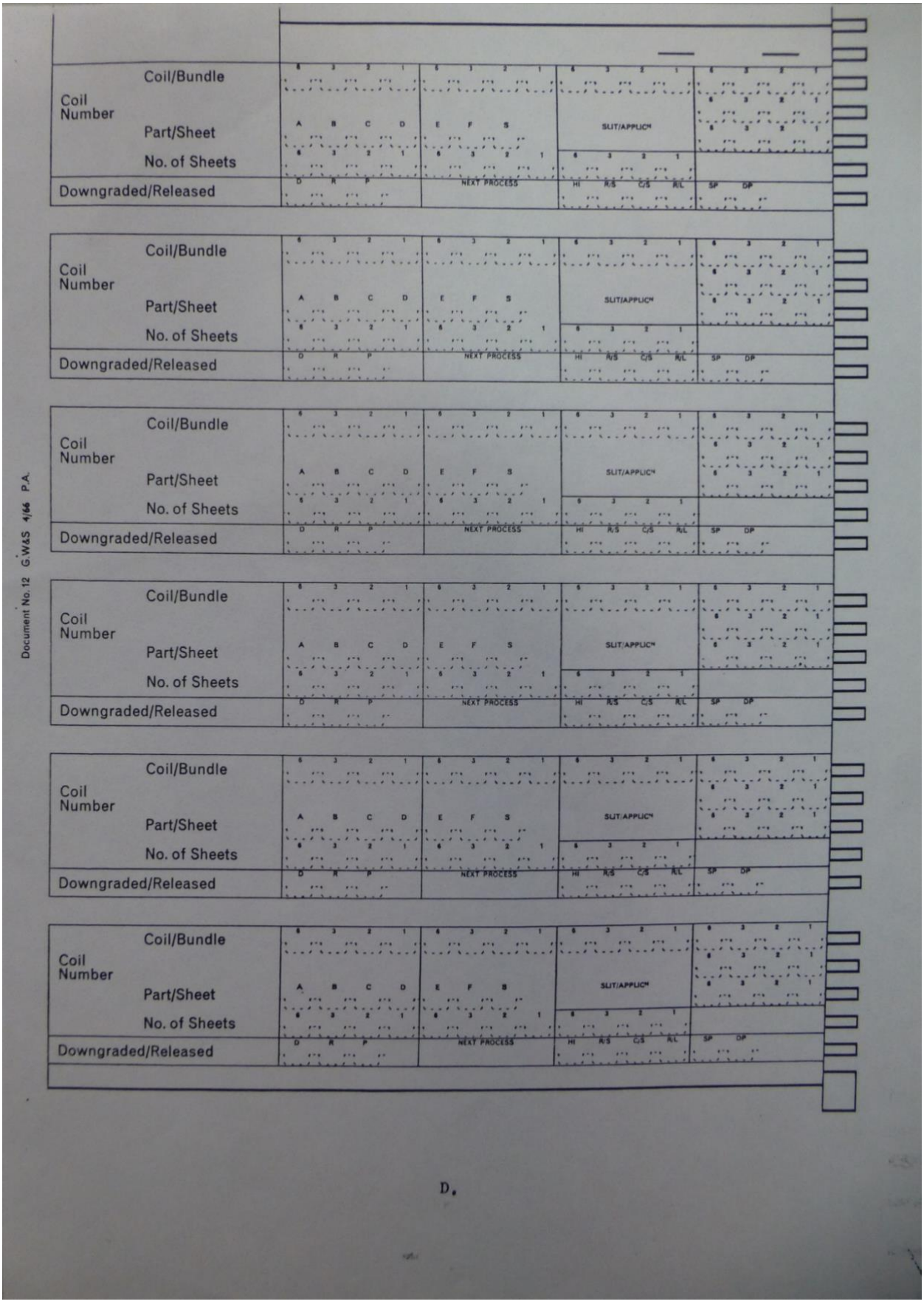
721	2/38214/3	0490	0	14	0	L<- 0 L<-	0		0	0	0	0	0	0	0	0	0	14	0	10	10

STOCK LIST (COILS AGAINST EACH ORDER) SHEET 93 RUN 185 6/01/66

ORDER NO	T/C	DEL WK	GAUGE	WIDTH	LENGTH	GRADE	ORDERED TONS	BALANCE CW	BALANCE TONS	ROUT CW	SUR	O	%	A	S	TOLERANCES FIN	D	CR	C	R
2/34356/2	8	652	.0625	27.250	67.500	048	5	5	2 12	540	GP5	*	45	2	3	+0020	0.125	0.500		
GNRL-LONDON															65	6	-0080	0.000	0.000	
49943/-/			.0625	27.230		048	3860		364	SHEET DESP					MOVED		32/12			
54588/-/			.0625	27.250		078	11860		183	ROLL/LEVEL					MOVED		22/12			
2/34356/3	8	652	.0625	46.025	76.000	048	10	0	6 0	540	GP5	*	45	2	3	+0020	0.250	0.500		
GNRL-LONDON															65	6	-0080	0.000	0.000	
36847/A/			.0000	00.000		008	15100	(1)		TEMPER					MOVED		29/12			
54186/A/			.0625	46.625		021	13540		218	ROLL/LEVEL					MOVED		28/12			
2/34356/4	8	652	.0247	28.250	90.750	048	6	5	6 5	540	GP5	*	45	2	3	+0020	0.125	0.500		
GNRL-LONDON															68	6	-0080	0.000	0.000	
37931/-/			.0780	29.529		048	16700	(1)		TANDEM					MOVED		8/12			
55100/-/			.0247	28.230		034	13800		760	ROLL/LEVEL					MOVED		5/01			
2/34356/5	8	652	.0313	36.750	72.500	048	42	0	1 14	540	GP5	*	45	2	3	+0010	0.250	0.500		
GNRL-LONDON															65	6	-0080	0.000	0.000	
55299/-/			.0313	36.750		041	250		-1	SPEC PACK					MOVED		6/01			
							8531		400	SHEET DESP										
2/34357/1	17	705	.0394	32.290	0.000	111	22	13		816	GP6	*	45	6	3	+0030	0.125	0.000		
EXPORT ORDER															55	6	-0030	0.000	0.000	
58630/-/			.0394	32.290		111	29050	(1)		A/H ANNEAL					MOVED		5/01			
58632/-/			.0394	32.290		111	27900	(1)		A/H ANNEAL					MOVED		5/01			
58638/-/			.0394	32.290		111	28400	(1)		A/H ANNEAL					MOVED		5/01			
2/34357/2	17	705	.0394	33.560	0.000	111	66	3		816	GP6	*	45	6	3	+0030	0.125	0.000		
EXPORT ORDER															55	6	-0030	0.000	0.000	
58630/-/			.0394	33.560		111	28100	(1)		A/H ANNEAL					MOVED		4/01			
58632/-/			.0394	33.560		111	28950	(1)		A/H ANNEAL					MOVED		4/01			

58641/-/	.0394	33.560		111	21200	(1)		A/H ANNEAL	MOVED 4/01

CUT UP LINE LECTOR DOCUMENT



D.

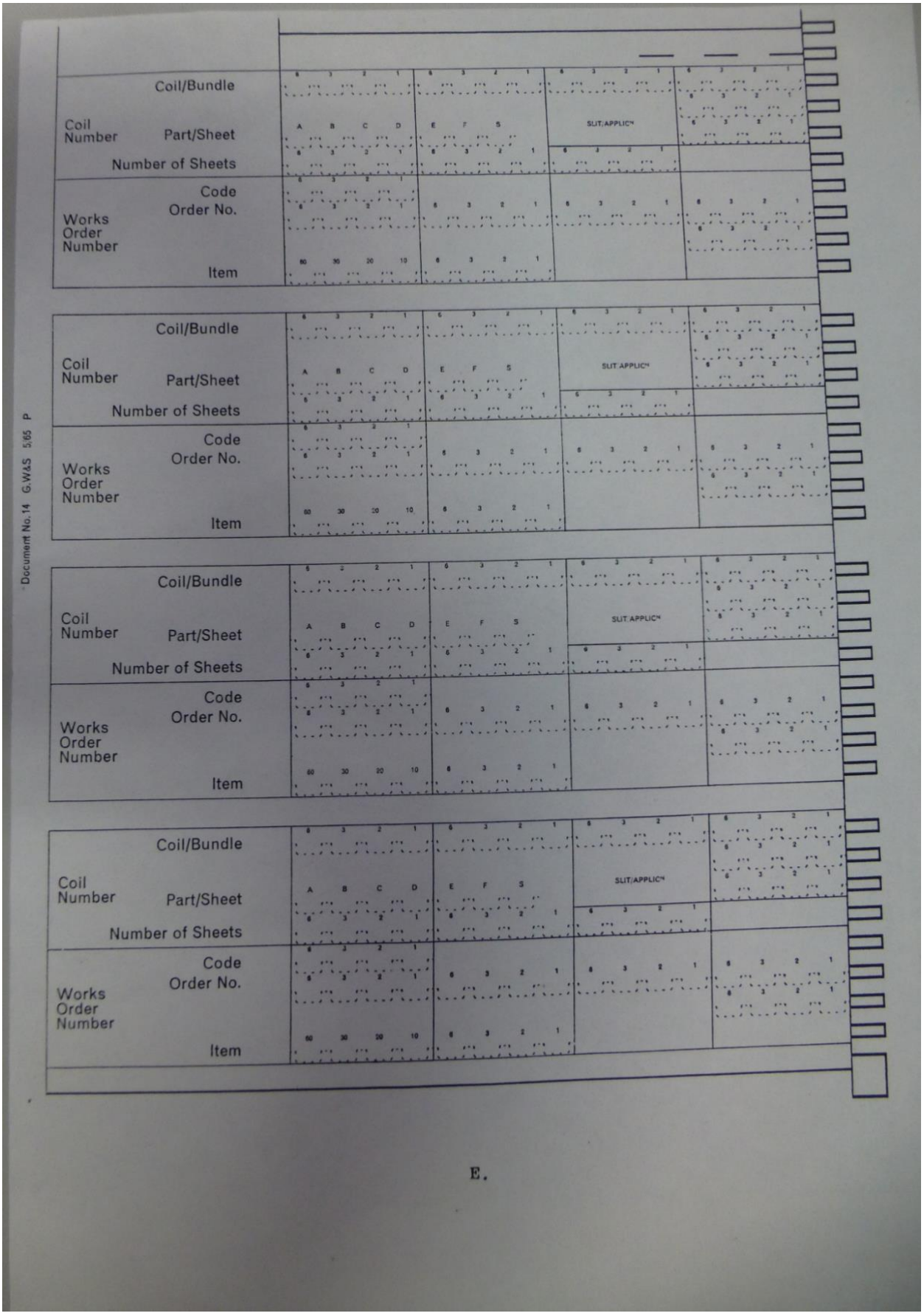
UNALLOCATED STOCK LISTS RUN 135

A/H CUT UP LINES

IDENTITY HELD	LOCN	GAUGE	WIDTH		LENGTH	FIN GRADE	DRY	ANN ISH	OIL	NO OF CYC	WEIGHT	ELONGATION SHTS	MIN	MAX	P/NP
B 37728/-/	0 74	0490	36.250	Coil	048	GP6	OIL	2	22900		0.00	0.00			
A 35177/-/	0 74	0480	31.890	Coil	048	GP6	OIL	2	17000		1.50	1.50			
A 39659/-/	0 74	0480	47.187	Coil	028	GP6	OIL	3	10360		0.00	0.00			
B 29682/-/	0 74	0490	48.000	Coil	048	GP5	OIL	2	28140		1.50	1.50		M4742	SKD
B 42642/-/	0 74	0490	30.000	Coil	028	GP6	OIL	3	10000		0.00	0.00			
S 40157/B/	0 74	0490	48.000	Coil	048	GP6	OIL	2	19780		1.50	1.50			
B 34271/-/	0 74	0495	36.000	Coil	048	GP6	OIL	2	20160		1.50	1.50			
A 39007/-/	1 74	0567	56.600	Coil	115	FF4	OIL	6	6300		0.25	0.50			
A 40673/-/	0 74	0520	33.000	Coil	038	GP6	OIL	2	7100		1.50	1.50			
A 37979/-/	0 74	0620	31.625	Coil	038	GP6	OIL	6	12750		0.75	0.75			
B 41418/B/	0 74	0625	48.000	Coil	048	GP6	OIL	2	12300		1.50	1.50			
A 88764/-/	0 74	0440	30.250	Coil	000		DRY	0	17920		0.00	0.00			
A 14618/-/	0 74	0600	48.000	Coil	000		DRY	0	15456		0.00	0.00			
B 37882/B/	0 74	0600	48.000	Coil	031	FF2	OIL	2	13000		1.50	1.50			
AN 662/-/	0 74	1040	37.500	Coil	048	GP6	OIL	0	9000		0.00	0.00	NP		
2587/-/	0 74	2500	55.000	Coil	048	H6	OIL	0	12320		0.00	0.00			

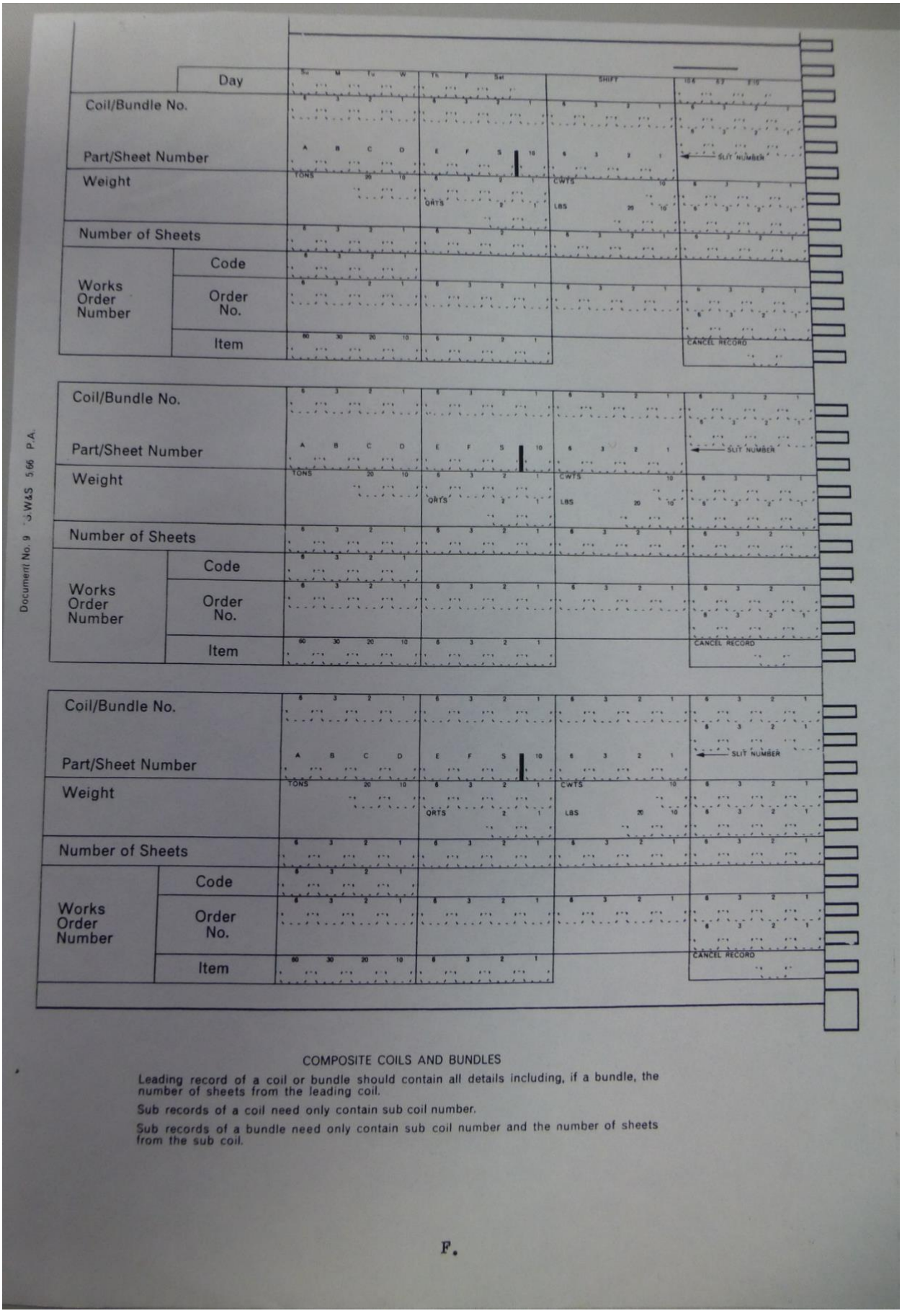
WIDTH	LENGTH	GAUGE	SURFACE	ORT	GRADE		ELONGATION	FINISH		---------TOLERANCES---------- %			ORDERED GAUGE		BALANCE LENGTH		DEL WIDTH	TONS CWTS
TONS CWTS	WK	WORKS	O/NO															
19.095	126.000	.0590	0480		GP5	*	546	1.50 1.50	2	23`	+0050 -0050	+0.625	+0.030 -0.000	-0.000	5	0	5	0	646	2/32920/1
19.095	126.000	.0590	0480		GP5	*	546	1.00 1.00	2	23`	+0050 -0050	+0.625	+0.030 -0.000	-0.000	8	0	8	0	702	2/32920/2
19.095	126.000	.0590	0480		GP5		546	1.50 1.50	2	23`	+0050 -0050	+0.625	+0.030 -0.000	-0.000	8	0	8	0	710	2/32920/3
20.500	44.500	.0170	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.500	+0.125 -0.000	-0.000	5	0	5	0	649	2/33370/4
20.750	89.000	0185	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.500	+0.125 -0.000	-0.000	10	0	10	0	649	2/33187/2
20.699	117.008	.0196	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.530	+0.125 -0.000	-0.000	0	12	6	4	702	2/17130/2
20.669	103.543	.0197	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.530	+0.125 -0.000	-0.000	6	0	6	0	702	2/17130/4
20.669	103.543	.0197	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.565	+0.125 -0.000	-0.000	0	6	0	6	714	2/17131/4
20.669	103.543	.0197	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.535	+0.125 -0.000	-0.000	0	6	0	6	702	2/17132/4
20.669	103.543	.0197	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.535	+0.125 -0.000	-0.000	0	6	0	6	714	2/17133/4
20.669	108.976	.0197	0480		GP6		545	1.00 1.00	2	23`	+0020 -0020	+0.535	+0.125 -0.000	-0.000	8	17	85	17	714	2/1713131

LECTOR TO ALLOCATE SHEET MATERIAL TO AN ORDER


Coil/Bundle
Coil Number
Part/Sheet
Number of Sheets
Code
Order No.
Works Order Number
Item
A B C D
E F S
SLIT APPLIC^N
60 30 20 10
Document No. 14 G.W&S 5.65 P

E.

LECTOR TO ALLOCATE SHEET BUNDLES TO AN ORDER



Document No. 9 W&S 566 P.A.

COMPOSITE COILS AND BUNDLES

Leading record of a coil or bundle should contain all details including, if a bundle, the number of sheets from the leading coil.

Sub records of a coil need only contain sub coil number.

Sub records of a bundle need only contain sub coil number and the number of sheets from the sub coil.

F.

- Lyons, N. (2015) LEO: The Lyons Electronic Office. The story of the First Business Computer, Journal of the Royal Signals Institution, Vol. 33, Issue 1, pp. 32-37. An abridged version was published in Kai Kai Baluch Jouryonsnal September 17th 2017, pp. 29-32.
- Lyons, N. (2016) LEO, the First Business Computer, Resurrection, No. 75, Autumn, pp. 19 - 30 http://www.computerconservationsociety.org/resurrection/res75.htm#top
- Lyons, N. (2006-2018) Correspondence, Research items gifted to London Metropolitan Archives, City of London: Accession reference: Lyons Neville The material includes history of J Lyons and Company Limited and its achievements (presentations includes images mainly sourced from Peter Bird, historian) and media interview recordings. Details here https://www.leo-computers.org.uk/london-metropolitan-archives-lyons-neville-lma-4803/
- Lyons, N, (2017), Sir Joseph Lyons: A double anniversary, an article commemorating Joe Lyons, chairman of J.& Co from its inception to his death in 1917, by his nephew and member of LEO Computers Society.. https://leo-computers.org.uk/images/JosephLyons.pdf
- Lyons, N. (2018), The Joe Lyons Story –Food for Thought, Computer Conservation Society, talk presented at meeting of CCS in May 2017 tells the story of the company which produced the World's First "electronic office". Available at You Tube: https://www.youtube.com/watch?v=VrwGDC8Bdow
- Lyons, N., (2019), LEO: the World's first Business Computer, letter in Shell-Mex and BP's pensioners association magazine, Brigs, Paddy, editor 44Club News, pp 13-14. file:///C:/Users/Dell/AppData/Local/Microsoft/Windows/Temporary%20Internet%20Files/Content.IE5/PSKR5ALW/165.pdf
- Lyons, N., (2019), LEO: Publicising and preserving the World's first business computer, Probus Magazine, page 36, Winter edition. https://probus83.org.uk/neville-lyons-probus-magazine-article and https://www.dropbox.com/s/varqdycgsghexpi/Neville%20Lyons%20PROBUS%20Article.docx?dl=0
- Lyons, N., (2020), **Byting the Biscuit** in the U3A Third Age Matters journal, Feb, pages 159-161, **U3A** member Neville Lyons tells how LEO, the first ever business computer, was developed by cakes company J Lyons &Co.
- Lyons, N., (2021), LEO the worlds first business computer presentation to Hawker Association on July 14th 2021 at the invitation of Colin Wilson, President There were 33 attendees including John Tritton invited by Neville Lyons. John Tritton subsequently writes "Dear Neville, Your presentation was most interesting and informative, and so well researched. I'm glad that it was recorded so that I can watch it again, or recommend to friends. The same applies to your talk on LEO itself.
  I bought a copy of Peter Bird's book from the man himself when he gave a talk some thirty years ago. I must read it again.
  Once again, thank you." The edited recording, including questions/comments at the end: https://youtu.be/Xh_eWjsh3sw

- Margolis, J, (2018) **Review: 'Electronic Dreams' by Tom Lean,** Financial Times, March 12th, 2018, https://www.ft.com/content/e1afa168-ef79-11e5-9f20-c3a047354386 ,

  "Another remarkable fact from Electronic Dreams: which UK company would you imagine was, by 1951, the world's first to use a computer for business, and started making computers for other companies? It was J. Lyons and Co, the teashop chain. Its computer business, LEO, kept going until 1963. Lyons' role as a computer manufacturing pioneer is the more astonishing — at least to anyone old enough to remember the ostensibly low-tech J. Lyons cafés — in that there was stiff competition from within the UK; companies such as Ferranti, Elliott Brothers, English Electric and British Tabulating Machinery were all selling British boffin-made computers globally."

- Martin, D. (2008) **David Caminer, a Pioneer of Computing Dies at 92**, New York Times, http://www.nytimes.com/2008/06/29/technology/29caminer.html

- Mason, R.O. (2004) **'The Legacy of LEO:** Lessons learned from an English Tea and Cakes Company: Pioneering efforts in Information Systems', Journal of the Association for Information Systems, Vol. 5, No. 5, May, pp. 183 – 219.

- Mason, R. O. (2009) **AIS, LEO and the Pursuit of Good Work**, Communications of the Association for Information Systems, Vol. 25, Article 37, pp. 452 – 464.

- May, J. (2012) **Review of a Computer Called LEO**, Amazon Reviews, http://www.amazon.co.uk/review/R3MSJ7IMMOLZRU/ref=cm_cr_pr_viewpnt#R3MSJ7IMMOLZRU

- McGerty, L., (2019), **Update on the HLF Project**, in LEO Matters, Vol. 5, page 7, Spring 2019, https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf

- McGerty, L., (2019), **Heritage Lottery Fund, Project Update,** in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, pages 2-3, Autumn.

- McGerty, L., (2021), **Visit of HRH Princes Elisabeth to Cadby Hall, Feb 15th 1951.** An account of the visit in Cambridge Centre for Computer History Website at 2021: An Anniversary Year - Blog Post - Computing History

- McGerty, L., (2021), **Structure of CCH LEOPEDIA and the LEO Archive**, download PDF depicting graphically the difference between the CCH and LCS version of LEOPEDIA. 

Diagram - LEOPEDIA and THE LEO ARCHIVI/

- Merriman, J.H.H., Caminer, D.T., and others, (1957) **A Discussion on the Use of Electronic Processing Equipment**, Journal of Royal Statistical Society, Vol. 120, No.3, pp. 291-307. Proof copy held by Hilary Caminer.

- MICROSERVIOS, (2011) LEO 1, el primer ordenador comercial de la historia, cumple 60 años, a Spanish version of the 60th LEO anniversary including the video of the event at the London Science Museum.

- Middlesex University, (2019), **OBE for Frank Land**, History and Philosophy of Computing, http://ta.mdx.ac.uk/leo/?s=
- Mills, G., (1937), **Clerical Research** Paper presented to OMA Conference and refers to his work for
  J. Lyons in its systematic approach to improving efficiency.
- Mills., G. (1938), follow up to above given to Conference in Canada
- Moller, M. and Hoey, J., (2018), **QUIS** the aptitude test devised by TRT for applicants for programming or operator jobs with LEO and its client users. The documentation was collected and digitised by Mike Moller and John Hoey. QUIS was widely used by the LEO community and regarded by many as better than the IBM aptitude test for identifying programming talent.
-
- Monk, C., (2019), **LEO I Virtual Reality Project.** The project is part of the Heritage Lottery funded LEO project. For more information click on: http://www.computinghistory.org.uk/leodev/photos/
- Monk, C., and Monk, R., (2020), **LEO I Virtual Reality Project.** Presentation at steering group meeting of NHLF project, September 3rd 2020. **http://www.signalvr.co.uk/files/design_pres_sept03.pdf**
- Morgan, A. B. (Tony), (2007), **Report on visit of inspection to LEO III/ in Edinburgh Museum,** see Dropbox https://www.dropbox.com/s/hncodrv7krf2zi6/LEO%20III-33%20by%20Tony%20Morgan.doc?dl=0
- Morgan, A. B. (Tony),, **Commissioning LEOs — a Memoir**, Newsletter and Review ISSUE Spring 2018,Vol. 4, section 9, page 12, editor Hilary Caminer, layout, Bernaqrd Behr.
- Morgan, A. B. (Tony), **LEO Lives: LEO DME, Another story……,** in LEO Matters, Newsletter of LEO Computers Society, editor Vince Bodsworth, Vol.5, Spring 2019, pp. 10 – 12, https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf
- Morgan, A., (2019), **III/33 – Phoenix Assurance Company**, summery of a report by Tony Morgan of his inspection of the relics of LEO III/33 in Edinburgh Museum, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, page 16, Autumn.
- Morgan, A. B,, (2019), **III/33 – Phoenix Assurance Company**, summery of a report by Tony Morgan of his inspection of the relics of LEO III/33 in Edinburgh Museum, in Caminer, H., (Editor), Behr, B., (Production), (2019). **LEO Matters**, LEO Computers Society, Vol 6, page 16, Autumn.
- Mori, E. (2016) **LEO Plaque Unveiling in London**, Blog http://ta.mdx.ac.uk/leo/leo-plaque-unveiling-in-london/
- Mori, E. (2016-2021), **Presentations**, list of presentations: **Elisabetta's presentations - to be added to cumulative listing**
- 2017

- **October 3rd-7th**: paper presented at 4th Conference on the History and Philosophy of Computing in Brno, Czech Republic.
  http://ta.mdx.ac.uk/leo/coping-with-the-american-giants/
- **October 11th**: presentation about Validity and Correctness in LEO I and II at the Alan Turing Institute.
  https://www.eventbrite.com/e/history-and-philosophy-of-programming-meeting-tickets-37255156175?
- **October 20th,** presentation of paper about LEO at PROGRAMme: roundtable CNAM - Conservatoire national des arts et métiers, Paris
  http://ta.mdx.ac.uk/leo/validity-and-correctness-in-leo-i-and-ii/
- 2018
- **May 16th,** 2018: Seminaire HEPI: University of Lille, on the history and philosophy of computing.
  I presented a talk "From Academia to Business: LEO computers and Olivetti. Two case studies in the early European Computer Industry". The other lecturer of the seminar was Pierre Mounier-Kuhn.
  https://calcul.hypotheses.org/435#more-435
- 2019
- **21 February**, 2019 **Computer Conservation Society seminar**
- *Olivetti and the early Italian computers*
- http://www.computerconservationsociety.org/lectures/2018-19/20190221.htm
- ??EM is going to Lille tomorrow for a seminar. Her paper may be seen here: https://programme.hypotheses.org/spring-workshop-i-machines . It is part of a 4 year planned programme and will be published in 2022.
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2021

4 February 2021 Talk on LEO at the Conservatoire Nationale des Arts et Materiels (CNAM) in Paris. 2.5 hour workshop conducted with a French historian. 'Les Debuts de l'Informatique de gestion en Italie et Angleterre.'

Mori, E., (2022), **My LEO history PhD**, presentation with discussion, via Zoom, of Dr Mori's PhD – both its main content and aspects of her journey to completion, highlighting publications, conference presentations and related work such as taking Oral Histories for LEO Computer Society. The presentation was followed by a lively discussion on her work and what it suggested for future work and projects. A recording of the presentation and discussion can be found at:

Elisabetta Mori PhD

- Murgia, M. (2016) **End of Moore's Law? What's next might be more exciting,** Daily Telegraph, 26th February. The article has photo of LEO to indicate size of early computers, http://www.telegraph.co.uk/technology/2016/02/25/end-of-moores-law-whats-next-could-be-more-exciting/

- Niewlsdomski, S. (2016) **British transistor manufacturers in the 1950s**, British Vintage Wireless Society Bulletin, Vol. 41, No. 4, pp. 10-22. The paper includes a section on LEO III, and displays a job advert dated 1957 for Computer Engineers from LEO Computers Limited. It may be referenced and read but not copied. See http://www.bvws.org.uk/publications/bulletins.php/volume41number4

- Page, C.A. (2010) **LEO Computer Reunion 2010,** Anna C Page's Blog, WorldPress.com weblog. An account of the 2010 reunion by the daughter of a LEO programmer, including photos of LEO artefacts. https://annacpage.wordpress.com/2010/04/18/leo-computer-re 60, Springunion-2010/

- Paine, R.M., (1965), **The gradual acceptance of a variety of commercial English languages**, The Computer Journal, Volume 8, Pages 208- 215. The paper provides a comprehensive review of UK high-level languages and includes an analysis of CLEO. See https://academic.oup.com/comjnl/article-pdf/8/3/208/961522/080208.pdf

- Parry, W.E.J., (2018), **How information was stored and processed in the LEOII computer,** presented at **Living Legends Hidden Histories Exhibition,** Corby, May 3rd 2018. Copy of presentation can be obtained from Frank Land (f.land@lse.ac.uk) and Wej Parry, (wej@theparrys.co.uk).

- Parry, W.E.J., (2018), **John's (John Parry) Story,** Living Legends Hidden Histories Exhibition**,** Corby, May 3rd 2018. Copy of presentation can be obtained from Frank Land (f.land@lse.ac.uk) and Wej Parry, (wej@theparrys.co.uk).

- Pasquali, V.. (2019) **The Formation of ICL and the New Range,** an interesting account of the merger forming ICL and the discussions involving ex Leo managers, including john Pinkerton, David Caminer and John Aris in defining the New Range to succeed the ICT 1900 range and EELM System 4 range, written by one of the key members of the New Range team. Resurrection, Spring 2019, Number 87, pages 23 – 25. http://computerconservationsociety.org/resurrection/res87.htm#b

- Pearson, I., (ed) (2017) **ICL AllStars Magazine**, Issue 50, Autumn. The newsletter of ICL Australian veterans includes a number of references to the history of LEO. Pages14 and 15 refer to the collaboration between John Pinkerton and Conway Berners-Lee, ex Ferranti.

- Pearson, I., (ed) (2019), **ICL AllStars Magazine,** Issue 61, Summer, the Newsletter of ICL Australian veterans, includes a number of references with a LEO theme: Report on Heritage Lottery Fund to LEO Computers Society and CCCH, page 4-5; an article entitled 'Two Faces of note' by Neil Lamming providing a sketch of the roles played by David Caminer and John Pinkerton in the LEO story, pages 16-17; and a personal history of David Llewellyn Jones, who joined LEO in Australia in 1964, page18.

- Pearson, I., (ed) (2019), **ICL AllStars Magazine**, Issue 62, Autumn, the Newlsetter of ICL Australian veterans, includes a number of references and photographs with a LEO theme, including on pages 6 – 9 a report on the visits to Australia of Peter Byford and Hilary Caminer in the very hot summer of 2019, and includes a photo on page 27 of the Shell Data Centre LEO III with Alan Sercombe, Peter Gyngell, Wallace Weaving and Gary Driver.

- Pearson, I., (ed) (2019), **ICL AllStars Magazine**, Issue 63, Winter, the Newlsetter of ICL Australian veterans, includes a number of references and photographs with a LEO

theme: a very full report on the LEO Reunion, 2019, pages 11-12, and a report on Frank Land's OBE awarded June 2019.

- Pelling, N. (2002) **The Case For The First Business Computer**, http://www.nickpelling.com/Leo1.html The business cases behind the five proposals made to the board of J. Lyons & Co. by Thompson and Standingford in 1947 - which led to the construction of the first business computer - are analysed, but found to be strategically lacking. Both an alternate reading of the case and some contemporary implications are then developed. **XXX002**

- **Pearcey, T. (1948), Australian Journal of Science,February**

- Pearcey wrote;

- In the non-mathematical field there is wide scope for the use of the techniques in such things as filing systems. It is not inconceivable that an automatic encyclopaedic service operated through the national teleprinter or telephone system, will one day exist."

- The article by Piercey who may is honoured as father of Australian computing may be considered prescient much as the LEO project at that time.

- Pinkerton, J.M.M., (1949), **Use of EDSAC on the Wages Problem**, manuscript typescript of a paper prepared by John Pinkerton with the help of Derek Hemy one month after John joined Lyons. The paper attempts to provide an analysis of how long it would take to prepare a payslip under various assumptions about input/facilities. A copy of the transcribed document is held in Dropbox in Word and PDP format.
https://www.dropbox.com/s/hr062jv7rnabnh1/John%20Pinkerton%20EDSAC%20payroll%20paper_1949.docx?dl=0
https://www.dropbox.com/s/cbji9iikgtjm3ge/John%20Pinkerton%20EDSAC%20payroll%20paper_1949.pdf?dl=0

- Pinkerton, J.M.M. (1951) **Automatic Frequency Control**, Electronic Engineering, Vol. 23., pp. 147-148.

- Pinkerton, J.M.M., (1951), **A Short Description of the EDSAC Type Calculator Circuits used in LEO**, Copy No 1' of a 63 page report on the LEO computer for J Lyons & Company Ltd. including text and 'small block schematic diagrams' for submission to the Patent Office. The report has the handwritten and stamped mark '88147 Presented 27 July 1951' as well as being stamped 'Patent Office Library, 27 July 1951'. Listed in the report and included with it are 65 larger diagrams all stamped 'Patent Office Library, 27 July 1951'. BL Explore Archives and Manuscripts catalogue. The catalogue number is **Add MS 89294**
http://searcharchives.bl.uk/IAMS_VU2:IAMS032-003391654

- Pinkerton, J.M.M. (1952) **Patent Application:** GB000000767192A 29.05.1952 30.01.1957 JOHN MAURICE MCLEAN PINKERTON; LYONS & CO LTD J
Improvements in and relating to data transfer apparatus. Complete Specification published January 1957. See
https://worldwide.espacenet.com/publicationDetails/originalDocument?CC=GB&NR=767192A&KC=A&FT=D&ND=4&date=19570130&DB=EPODOC&locale=en_EP#

- Pinkerton, J.M.M. (1954) **Operating and Engineering Experience Gained with LEO**, in **Automatic Digital Computing**, Proceedings of a Symposium held at National Physical Laboratory, March 1953, pp. 21-30, published by HMSO. Key points from the article include:

  - in building the "calculator" (i.e. LEO) Lyons' intention was to get it into operation as quickly as possible because they felt that until it had actually been in use over a period of time for clerical purposes, "the optimum form of such equipment could not be decided".
  - **Pinkerton states that modifications and "additional features" were required to the EDSAC design that the LEO is based on "to** make the installation effective on clerical work" and that this included a "larger store, means for introducing data into and extracting results from the calculator much faster than was possible with the EDSAC, and a foolproof method of checking data recorded to the machine".
  - Pinkerton suggests that although LEO has been in use for over 18 months, it is "not yet as reliable as would be necessary for carrying out a regular and intensive programme of clerical work". http://www.chilton-computing.org.uk/acl/pdfs/Automatic_Digital_Computation_Symposium_Mar53_text.pdf

- , page32, see

- Pinkerton, J.M.M. and Kaye, E.J. (1954) **LEO: History and Technical Description**, Electronic Engineering, Vol. 29, pp. 284-291. Reprinted as part of **'LEO –Lyons Electronic Office'** in Electronic Engineering, pp. 3-10.

- Pinkerton, J.M.M. (1959) **Features of the LEO IIC Computer,** Automatic Data Processing, December.

- Pinkerton, J.M.M. (1961) **'The Evolution of Design in a Series of Computers'**, The Computer Journal, British Computer Society, Vol. 4, No. 1, pp. 42-46.

- Pinkerton, J.M.M., (1965), **Hardware in Europe**. Datamation, short article outlining the range of computers produced in Europe including the LEO III produced by English Electric LEO Marconi, page 32, download from http://www.bitsavers.org/magazines/Datamation/196505.pdf

- Pinkerton, J.M.M. (1966) **'Large-Scale Computing in the Seventies'**, The Computer Journal, British Computer Society, Vol. 10, No. 2, September.

- Pinkerton, J.M.M. (1974) **'Performance Problems with LEO I'**, Presented at the Colloquium on the 25th Anniversary of the Stored Program Computer, held at the Royal Society, London, on 12th November 1974

- Pinkerton, J.M.M. (1975) **'Performance Problems with LEO I'**, The Radio and Electronic Engineer, Vol. 45, No. 8, pp. 411-414, August.

- Pinkerton, J.M.M. (1983) **Tape 6 in Christopher Evans's 'Pioneers of Computing'**, IEEE Annals of the History of Computing, Vol. 5, No 1, pp. 64-72, January-March.

- Pinkerton, J.M.M. (1987/88) **'The Early History of LEO: The First Data Processing Computer',** The Computer Museum Report, Vol. 21, Winter, https://archive.org/stream/computermuswin198788comp/computermuswin198788comp_djvu.txt

- Pinkerton, J.M.M. (1988) **ORAL History – self interview**, Charles Babbage Institute, University of Minnesota, Minneapolis, 54 pages, http://conservancy.umn.edu/bitstream/handle/11299/107600/oh149jmp.pdf?sequence=1&isAllowed=y
- Pinkerton, J.M.M., (1990), Designing a computer for data processing, Resurrection, Vol. 1 Number 2. https://www.computerconservationsociety.org/resurrection/res02.htm#d
- Pinkerton, J.M.M (1991) **Taming LEO – Overcoming the Inherent Unreliability of LEO I**, IEE Review, Vol. 37, pp. 13-17.
- Pinkerton, J.M.M., Hemy, D., Lenaerts, E.H., (1992), **The Influence of the Cambridge Mathematical Laboratory on the LEO Projec**t, IEEE Annals of the History of Computing, Vol. 14, No. 4, pp. 41-48.
- Pinkerton, J.M.M, (1997), **'Evolution of Constructional Methods from Radios to Computers'.** This is a 25 page illustrated booklet containing a reprint of a talk by John Pinkerton 'read at a joint meeting with the Computer Conservation Society at the Science Museum on 8 -9 April, including references to and photos of LEO. Published in Transactions of the Newcomen Society for the study of Engineering and Technology, Volume 68, 1996-9
- Pollock, N.C. (1955) **Electronic Computers and their possible applications**, Report to the Board, Stewart and Lloyds, Document stored at the National Museum of Computing, Bletchley. Thanks to Corby Borough Collection for making the Report available. See http://www.corby.gov.uk/sites/default/files/Electronic%20Computers.pdf
- Porter, Monica, (1979). **Mysterious Death of Dennis Skinner,** Coffee Break: 2, 15 Years Ago. Report of death of manager of LEO Moscow Office in 1964. Copy of report held by Frank Land. Donated by Frank Skinner (no relation). See also blog by Ralph Land with more information, held by Frank Land and in Dropbox at https://www.dropbox.com/home/LEO%20Oral%20History%20project/LEO%20Memoirs%2C%20Reminiscences%20and%20Anecdotes?preview=Dennis+Skinner+mysterious+death.docx.
- Quest, M. (1962) **Living with Computers**, The Journal of the Hotel and Catering Institute, Vol. 9, No. 4. The article recounts the LEO story and includes an interview with Ralph Land about computers and the hotel business.
- Randall, G.A. (1959) The Potentialities of a Computer in the Smaller Office, The Accountant, September 19th.
-
- Reynolds, C. (1990) CODIL: **The Architecture of an Information Language**, The Computer Journal, Vol. 33, pp. 155-163. Note: CODIL was a LEO project.
- Reynolds, C. (2015) **Algorithms aren't everything**, IT NOW, September, pp. 60-61.
- Richardson, D.J. (1974) **LEO Computers, a draft account based on interviews** with Anthony Salmon, John Simmons and John Stevens, NAHC/LEO, A7 see http://archives.li.man.ac.uk/ead/html/gb133nahc-leo-p1.shtml
- Richardson, M. (1964), **User's experience of CLEO.** An analysis carried out by Richardson of the Board of Trade, Central Office, Lime Grove, Eastcote, Ruislip, Middlesex, of the use of CLEO. The analysis refers to an article in Volume 5, Issue 3, November 1962 of the Computer

Journal by T.R. Thompson entitled **Fundamental Principles for expressing a procedure for a computer application.**

User's experience of CLEO - By M. Richardson*

The Board of Trade Census Office has used CLEO for preparing Annual Inquiry registers, and issuing and processing the 1963 returns. We have also used CLEO for a register of new companies and are now in course of applying it to all new jobs. Comments made here relate to the first seven programs written, which were analysed in some detail.
The first CLEO compiler did not become available until the end of 1963 and is still not on general release

1. General comments

(a) Adequacy

So far CLEO has covered all our programming requirements since these needed only integer arithmetic. It has not been found necessary to enter the lower language, i.e. Intercode.

The major extension of facilities to floating-point values, etc., will cover all future requirements; there will be no need to know Intercode.

Facilities are to be extended to cover function calls and floating-point working within the next three months. In general, most of the features mentioned in T. R. Thompson's paper in this Journal have been included in the system or will be included very shortly. At present the major limitation is on editing values for printing; this has been covered by a CLEO subroutine.

(b) Ease of learning, etc.

The CLEO conversion course provided for the first team of Intercode programmers occupied one and half days. There is no doubt that CLEO is easy to learn and with the compiler checks provided it is easy to use correctly.

(c) Debugging

Amendments are very simple to make in CLEO. The trials data system now being provided is even simpler than the Intercode system. It was difficult to locate logical errors in Intercode, but it is easy to do this in CLEO. Desk checking becomes more effective.

(d) Compiler problems

Only one minor imperfection appeared in the first version; this is now being put right.

2. Satisfactory features

The following table gives some idea of the reduction in programming time

made possible by CLEO.

RELATIVE PROGRAMMING EFFORT (TIME UNITS)

INTERCODE	CLEO

low charting	10	0
Coding time	55	10
Data description	10	2
Checking	10	2
Proving	15	2

Board of Trade, Census Office, Lime Grove, Eastcote, Ruislip, Middlesex

- Rooney, B. (2011) **World's First Business Computer Celebrates 60th Anniversary**, *Wall Street* Journal. Available at: http://blogs.wsj.com/tech-europe/2011/11/14/worlds-first-business-computer-celebrates-60th-anniversary

- Runciman, B. (ed.) (2017) **The Second Part of our Celebration of 60 years of BCS and the Member Magazine** – 1987 – 2016, IT Now, Autumn, entry for year 2001, notes 50th anniversary of first LEO job with picture of John Pinkerton and picture of W.D.& H.O. Wills LEO II installation.

- Ryder, A., (2019), **Lyons: Pride before a fall**, Waitrose Weekend, page 7, October 31st issue. From penniless immigrants to industrial titans, the story of the family behind the famous teashops is told by one of their descendants, Thomas Harding, in his new book 'Legacy'. The article documents the company's highs and lows in 5 thumb-nail texts with photographs illustration episodes in Lyons history. The 1947 episode tells the LEO story and includes a photo of LEO I with a female operator. file:///C:/Users/Dell/AppData/Local/Microsoft/Windows/Temporary%20Internet%20Files/Content.Outlook/CVA422EG/Waitrose%20News%20Thomas%20Harding.pdf

- Sabbagh, D. (1999) **When Lyons roared**, Computing, September 30th.

- Salmon, Sam, Chairman, (1965), **J. Lyons & Co: Annual General Meeting Report**, The Times Newspaper, Chairman's report notes sale of all of the Lyons LEO Computers shares to English Electric and formation of English Electric LEO Marconi, June 14th

- Sant, W., (2015), **The Early Days of Customs & Excise Computing**, LEO Computers Society, editor Bernard Behr, Newsletter and Review, Summer 2015, Vol. 2, pp. 16-17. Apply to Frank Land or Bernard Behr for copy if required.

- Saran, C. (2016) **The heyday of computing: How the Brits ruled IT**, Celebrating 50 years of British Technology Innovation, Computer Weekly, April 5-11, pp. 23-29. http://www.bitpipe.com/fulfillment/1459781780_511

- Saran, C., (2019), **Computer scientist Frank Land receives OBE**, Computer Weekly, June 13th. https://www.computerweekly.com/news/252465041/Computer-Scienist-Frank-land-receives-an-OBE

- Saran, C., (2021), **LEO: Office Automation is still going strong**

- Cliff Sarans Enterprise Blog, Cliff Saran tells the story of Bakery Valuations the world's first business application in November 1951, Computer Weekly, https://www.computerweekly.com/blog/Cliff-Sarans-Enterprise-blog/LEO-Office-automation-is-still-going-strong

- Schmidt, E. (2016) **From LEO to Deep Mind: Britain's computing pioneers**, presentation at the London School of Economics on 14th October 2016. The presentation took the form of a conversation between the speaker, the Executive Chair of Alphabet, the Google parent company, and Professor Chrisanthi Avgerou of the LSE and the audience. The presentation can be heard on the LSE podcast at http://www.lse.ac.uk/newsAndMedia/videoAndAudio/channels/publicLecturesAndEvents/player.aspx?id=3612 The event was jointly sponsored by LSE's Department of Management and the LEO Computers Society. It was intended to be the first of an annual LEO lecture.
- Sercombe, A., (2019), **A Life in Computing**, Resurrection, Issue Number 85, Spring 2019, pp. 27-28. Alan notes his appointment in 1960 as senior programmer at Standard Triumph working on their LEO II/8 following a programming career in aero-space industry.
- Simmons, J.R.M., (1949), **Development of the Electronic Calculating Machine**, Report No. 2, April 9th 1949,reporting on a visit by John Pinkerton and John Simmons to Cambridge University on 17th March 1949 to see a demonstration of EDSAC's first working, leading directly to the decision for Lyons to commence the LEO project. Modern Records Centre, Warwick University, 3 pages, MSS.363/S4/2/1/61support the EDSAC project.
- Simmons, J.R.M., (1950), **Circular relating to demonstration of LEO 2nd March 1950,** an invitation to members of the Lyons Board and other senior executives to see LEO performing some elemental operations. Including a briefing on LEO, Modern Records Centre, Simmons archive, 5 pages, Warwick University, https://mrc-catalogue.warwick.ac.uk/records/SIS/4/6/11
- Simmons, J.R.M. (1957) **Priniples of Security**, Reprinted Paper held in Simmons collected archive at Modern Records Centre, Warwick University as 363-51-6a, pdf
- Simons, P., (2019), **Why Lyon's Leo was the Met Office's cup of tea**, article in The Times, December 30th 2019. https://www.thetimes.co.uk/article/why-lyons-leo-was-the-met-offices-cup-of-tea-jf58blg63?shareToken=efb7dea08dc31511009d3b490ceaba57 and for more information on Met Office initiatives including reference to its pioneering use of LEO see https://www.metoffice.gov.uk/weather/learn-about/how-forecasts-are-made/computer-models/history-of-numerical-weather-prediction
- Simpson, I, **LEO III (13)**, from HigherSystems summarises the computers the author worked on starting with the British Oxygen LEO III – 1962 – 1965. See http://www.highersystems.co.uk/Leo_3.html
- Skinner, Frank, collection of photographs and copies of articles referring to LEO made available to LEO Computers Society by Frank Skinner. Available from Frank Land f.land@lse.ac.uk and in Dropbox at https://www.dropbox.com/home/LEO%20Oral%20History%20project/LEO%20Memoirs%2C%20Reminiscences%20and%20Anecdotes?preview=FrankSkinnerCollection.eml
- Smith, D (2011) **Innovation in a tea shop, whatever next?**, Fujitsu UK & Ireland CTO Blog, http://blogs.ts.fujitsu.com/uk-ie/cto/2011/11/innovation-in-a-tea-shop-whatever-next https://davidmsmith.net/tag/innovation/

- Spicer, D., (2019), **Update from USA**, in LEO Matters, Vol. 5, Spring 2019, pp,12 – 13. https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf
- Spicer, D, From Cambridge to Café, a brief account of Lyons and LEO and pictures of the holdings of LEO artefacts at the Computer History Museum, Mountain View, CA – click From Cambridge to Café - CHM Revolution (computerhistory.org)
- Spooner, P. (1957) **Electronics in the Office**, Business Magazine, November Issue. manufacturers also were offering for business. The Decca twin magnetic tape drive of which a photo appears was available with LEO II
- Standingford, O. and Thompson, T.R. (1947) **Report on a fact-finding trip leading to the development of the LEO computer**. A copy of this report which led to the decision by Lyons to build LEO is held in the London Science Museum, LEO exhibit in the Information Age Gallery. - The URL for the report is: https://collection.sciencemuseum.org.uk/documents/aa110067359/report-on-a-fact-finding-trip-leading-to-the-development-of-the-leo-computer
- Standingford, O. (1956) **Using a Computer Service** and **Multum in Parvo**, Standingford's summary of papers and discussions at the conference in **The Electronic Office**, a bound collection of articles assembled by the Office Management Association following their conference in April 1956. Bound volume held by Hilary Caminer.
- Studebaker, D. (2000) **The First Business Computer**: A Case Study in User-Driven Innovation Review, ACM Computing Reviews, June 1st. http://www.computingreviews.com/review/Review_review.cfm?review_id=123033&listname=search – *link only takes you to the login page as need to be a member of ACM to see.*
- Sumner, J. (2015), **Defiance to Compliance: Vision of the computer in post-war Britain**, History and Technology, an International Open Access Journal, Volume 30, 2014, Issue 4, pages 309-333 | Published online: 24 Feb 2015. An interesting analysis of Britain's changing role from apparent leadership in innovation and scholarship to a diminished role dominated by USA technology. The place of Lyons and LEO is outlined on page 311 amongst other notable technological achievements unmatched by American technology. See also in extract from the paper in the section.
- In 1947, J. Lyons and Company, Britain's leading catering firm, sent two senior managers to the USA to investigate American systems of office management. Their bald conclusion was that established practice could teach them nothing: 'We did not find any firm which has developed on so broad a front as Lyons, most offices only having tackled a limited number of office problems without having surveyed the whole field'. Physical layouts – notably including that of the

Pentagon – were poor, and development plans conservative, tending blindly to ignore the potential of rapid electronic processing. Far more exciting was the extensive American work on digital computing, but this was still largely uncommercialised.[11] Learning that there were British efforts in the same direction, the Lyons managers fostered a partnership with researchers at the University of Cambridge to develop the Lyons Electronic Office (LEO), which automated the bulk of the firm's payroll, stock control and valuation tasks across 1951–54, placing it at the forefront of international developments in this field. Lyons then formed a subsidiary to market LEO equipment to other businesses, stressing its business context as a unique guarantee of user-focused design.[12]

- A similar story played out in parallel at Ferranti, the commercial electrical and defence contracting group, which in 1948 sent a representative, Dietrich Prinz, to the USA to assess the state of the art in digital computing. Prinz's American hosts, according to company legend, wondered 'why he had come there, since the most advanced work was being done on Ferranti's doorstep at Manchester University', where the cathode ray tube storage system had become the basis for a prototype computer.

- Sylvan, A.C. (2007), editor, **Mr. Thomas Raymond Thompson: Bio/Description**, IT History Society, a compilation of biographical information and recollections of TRT from a number of sources including Peter Bird, Frank Land and Ralph Land. http://www.ithistory.org/honor-roll/mr-thomas-raymond-thompson and in Dropbox at https://www.dropbox.com/s/zyqe4p2qltrrcbb/T.R.T.%20Bio%20IT%20History%20Society.docx?dl=0

- Thomas, Edd, (2006) **Historic Archive of Early English Computing 1955-early 1970s**. A collection of LEO material including schematics and manuals. The collection is offered for sale for £10,000. This consists of 50 schematics and waveforms for the LEO II some of which have been annotated (One of the schematics looks to be from LEO I). Developmental notes, notebooks, waveforms, schematics, draft manuals, photos and publicity all for the LECTOR Auto reader. Booklets, leaflets and notes related to other English Electric Leo Computers including the KDF9 and LEO III. One or two of the manuals are the draft provisional copies. See https://historictech.com/product/historically-important-archive-of-early-english-computing-1955-70s/

- Thomas, E., (2019). **The Lector & Auto-Lector Optical Mark Machines,** in Bodsworth, V., (Editor), LEO Matters, Spring 2019, vol. 5. pages 5-6. including photos of Autolector and Lector. https://www.leo-computers.org.uk/images/Leo%20Newsletter%20Spring%202019.pdf

- Thompson, T.R., and Standford, O. W., (1947), **Report of visit to USA May/June 1947.** Extract published in Caminer, D.T., Aris, J.B., Hermon, P.M., Lanf, F.F. (editors and contributors) **LEO The Incredible Story of the Wold's first Business Computer,** McGraw Hill, New York, Appendix A, pages 337-359.

- Thompson, T,R**,,** (1947-1962), LEO Chronicles, account of events related to LEO maintained by TRT.
- Thompson, T.R., (1954), **Special Requirements for Commercial or Administrative Applications**, , Proceedings of s Symposium held at National Physical Laboratory, March 1953, pp. 85 – 101, published by HMSO. A copy of the proceedings are held by the Cambridge Centre for Computer History and The Charles Babbage Institute in Minnesota.
- Thompson, T.R. (1955) **The Scope for Electronic Computers in the Office**, presented to the Office Management Association's Conference in May.
- Thompson, T.R. (1955) **Diminishing Returns**, Engineering, December 23rd. The paper reflects Thompsons impressions following a tour of computer installations in the USA.
- Thompson, T.R. (1958) **'Four Years of Automatic Office Work'**, The Computer Journal, British Computer Society, Vol. 1, No. 1, pp. 106-112.
- Thompson, T.R. (1960) **'Problems of Auditing Computing Data: Internal Audit Practice and External Audit Theory'**, The Computer Journal, British Computer Society, Vol. 3, No 1, pp. 10-11.
- Thompson, T.R. (1962) **'Fundamental Principles of Expressing a Procedure for a Computer Application'**, The Computer Journal, British Computer Society, Vol. 5, No. 3, pp. 164-169, paper presented at Automatic Programming Languages for Business and Science held at Northampton College of Advanced Technology, April 1962. See Caldwell review in Dropbox at: //www.dropbox.com/s/08ap89c8n26oxjs/J%20Caldwell%20Report%20Automatic%20Programming%20Conference%201962.docx?dl=0

  http://www.computinghistory.org.uk/det/54559/Fundamental-Principles-of-Expressing-a-Procedure-for-a-Computer-Application/:
-
- Thompson, T.R. and others **'The LEO Chronicle, Major Events from 1947 to 1962'**, Leo Archive, National Archive for the History of Computing, Manchester, **LEO Computers,** see https://archiveshub.jisc.ac.uk/search/archives/367f3633-3a28-3fa9-837c-039693dcf8ee for listing of items held at John Rylands Library. As part of the library's special collections, the Archive is located in the main building of John Rylands University Library of Manchester, Burlington Street (building 18 in the campus map*). Note the collection is not digitised and can be viewed by application to the librarian.*
- Thomson. A., (2004), Timesharing History: the UK Story, in Leatherdale, D., editor, Resurrection, Bulletin of Computer Conservation Society, Issue 32, New Year. Leo Computers developed the Leo III as a medium size commercial computer, and included timesharing after several members of John Pinkerton's development team attended the colloquium on the design for Orion timesharing presented by George Felton at the Cambridge Maths Lab. Timesharing was demonstrated on Leo III in January 1962, and on Orion in April 1962. The Leo systems were first delivered to customers in April 1962. Orion, having been delayed by hardware problems, was not delivered to a customer till March 1963. English Electric announced the KDF9 in 1960 as a small scientific computer, with timesharing as an optional extra [Ref: 2] involving additional hardware and a specific version of the 'director' software. That was done independently of the Orion and Leo developments. http://www.cs.man.ac.uk/CCS/res/res32.htm#e

- Turtle, L., (1990), Office Manager and later Partner of Wedd Durlacher Mordaunt, owners of LEO III/45, **Oral History**. Turtle was responsible for setting out the specification for the LEO system and managing its implementation. His oral history recorded for the London Stock Exchange includes a brief account of that experience. https://sas-space.sas.ac.uk/2784/
- Vegter, I. (2007) **The curse of the monitor**, Brainstorm, 3 pages. History of LEO as object lesson in operating systems. http://www.brainstormmag.co.za/index.php?option=com_content&view=article&id=553%3Athe-curse-of-the-monitor&Itemid=124
- Wagner, F. and Wolstenholme, P. (2003) **'A Modern Real-Time Design Tool; Applying Lessons from LEO'**, IEE Computing and Control Engineering Journal, Vol 14.
- Walden, E., (2022), Private Correspondence. Eric Walden; Director of the Texas Tech Neuroimaging Institute Rawls Endowed Chair of Information Systems and Quantitative Sciences Rawls College of Business, writes 'when I teach intro to IS, I have a whole thing on LEO, and I know you (ed. Frank Land) worked on it.'
- Note: Eric Walden
- Director of the Texas Tech Neuroimaging Institute Rawls Endowed Chair of Information Systems and Quantitative Sciences Rawls College of Business
- 703 Flint Avenue
- Walton, Mark, editor,(2018): **A Celebration of Life in the 40s, 50s and 60s**, includes an account of the leading role played by the UK in the development of computers, with a mention of the role played by LEO with photos of LEO I, published in September as part of Goodwood Revival, an annual 3 day festival celebrating Goodwood Racecourse.
- Ware, G, (2019), **IT pioneer is awarded OBE**, Totnes Times, page 7, June 14th 2019
- Weetch, R. (2016) **Middlesex University Scholarships and Awards 2016**, Systematic Marketing, notes the award of the David Tresman Caminer Scholarship to Elisabetta Mori, https://smxi.com/blogs/russell.weetch/?cat=149
- Weik, M.H. (1961) **A Third Survey of Domestic Digital Computing Systems**, Ballistic Research Report No. 1115, March, Ballistic Research Laboratories. Does not mention LEO but shows developments in USA. BRL Report 1961 http://ed-thelen.org/comp-hist/BRL61.html#TOC
- West, L.., (2021), **Reunion Interviews – Ray Shaw, Roger Hemsley, Cyril Lanch**, edited version of mini interviews to create one short video by , and archived at CCH at entre for Computer History volunteer at: https://youtu.be/x1rM98UDfYQ. It.
- Whitley, P. (2005) **Computerised payroll's Golden anniversary**, Sage Accounting Web http://www.accountingweb.co.uk/topic/tax/computerised-payrolls-golden-anniversary
- Wikipedia, **LEO (Computers)** **http://en.wikipedia.org/wiki/LEO_%28computer%29#References**

- Wilcock, J. (2010) **The Staffordshire University Computing Futures Museum LEO Page**, available at https://archive.is/SHAKK - a good account of the Lyons and LEO story.
- Wilcock, J., (2019), **English Electric and its successors at Kidsgrove**, in Resurrection, the Journal of the Computer Conservation Society, Number 86, pages 25-26 Spring. The article summarises the history of Kidsgrove including the period following the merger of English Electric and LEO Computers, resulting in the production of the System 4 range at Kidsgrove. See http://www.computerconservationsociety.org/resurrection/res86.htm
- Wilkes, M.V., (1990). **The Thinking Behind EDSAC**, Resurrection, Vol. 1 Number 2. https://www.computerconservationsociety.org/resurrection/res02.htm#d
- Wilkes, M.V. (2001) **'John Pinkerton and Lyons Electronic Office'**, IET Computing and Control Engineering Journal, Vol. 12, Issue 3, pp. 130-144.
- Wilkes, M.V. (2001) **'John Pinkerton and Lyons Electronic Office'**, IET Engineering and Education Journal, Vol. 10, Issue 5, pp. 183-188.
- Wilkes, M.V. (2000) **'Business Innovation: Introduction of new methods into business operations'** IEE Inaugural Pinkerton Lecture, unpublished, copy of text with F. Land.
- Williams, C. (2001) **How a chain of tea shops kickstarted the computer age**, Daily Telegraph, **http://www.telegraph.co.uk/technology/news/8879727/How-a-chain-of-tea-shops-kickstarted-the-computer-age.html**
- Williams, C. (2015) **Of Bunkers, Bytes, and Cakes** http://softbox.co.uk/pub/Of_Bunkers,_Bytes_and_Cakes_Web.pdf An abridged version is printed in March 2014 issue of Cyber Talk Magazine, Issue 4.
- Williams, J.E. (1967) **The Brains Behind The Buttons**, Coventry Standard, p. 21, January 5th. The article refers to LEO/28 sold to Coventry Corporation.
- Williams, R. (1976) **Early Computers in Europe**, AFIPS National Computer Conference and Exposition, June, Proceedings, pp. 21-29, New York. http://dl.acm.org/citation.cfm?doid=1499799.1499804 and to download paper https://www.computer.org/csdl/proceedings/afips/1976/5084/00/50840021.pdf The paper includes a long section on the Lyons/LEO story. From the abstract: "the paper also includes a detailed description of the birth and foundation of the most successful first British commercial computer company - Leo Computers Limited, and this gives an insight into the thinking which lay behind British early computer development".
- Woods. M.J. (2002) **History of the Kidsgrove Works**, **http://www.members.optusnet.com.au/jaxbar/kidsgroveworkspt1.pdf** A detailed account of the Kidsgrove works, including its role with English Electric LEO Marconi (EELM) and the part Kidsgrove played in the evolution of the UK computer industry.
- **Yost, J.,** (2019), Director of Charles Babbage Institute, University of Minnesota Letter of Support for LEO Computers Society bid to become a charitable institution. Copy available from Frank Land and Dropbox. https://www.dropbox.com/s/q3cjgblu388037a/Charles%20Babbage%20Instutute%20Support%20letter.docx?dl=0