# Business Computing: the Second 50 Years

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# Conference Proceedings

# LEO and the Computer Revolution


# David Caminer


The 2001 IEE Pinkerton Lecture

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## Introduction

My theme in this second Pinkerton lecture is LEO and the Computer Revolution.

It is a revolution analogous to the Industrial Revolution that started about two hundred years before. The Industrial Revolution changed the whole mode of production and transportation. The generality of workers no longer made objects by hand, they tended machines and the machines were driven not by human muscle but by steam.

In the Computer Revolution the changes have been different but potentially they are as sweeping. Computers have altered the way in which information is accessed and made available. The links between person and person and organisation and organisation have been radically changed.

One striking outcome is that the Computer Revolution might effectively reverse the pull to the towns of the earlier revolution. Years ago now, Steve Shirley showed that it was just as possible to produce good computer programs in a room at home as it was in an office in town. Today, call-centres are springing up miles from nowhere. The outflow goes on.

## The two Revolutions

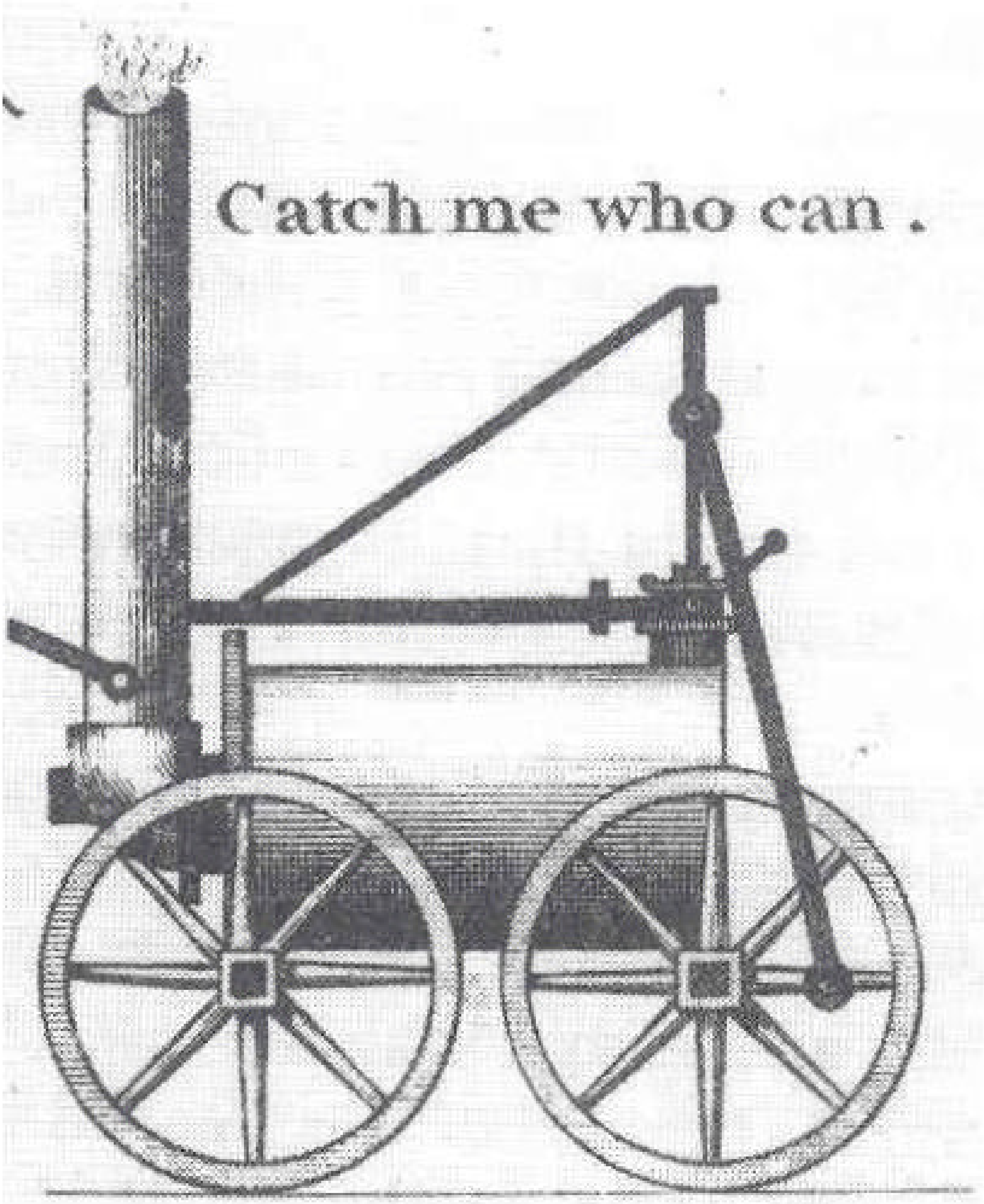
I like to think of LEO at the time of the first regular, ongoing productive, business job as being at something like the stage reached in the Industrial Revolution by George Stephenson's 'Locomotive' .

Ten years before Locomotive started its regular haul from the West Durham coalfield to the estuary at Stockton in 1824, Richard Trevithick had demonstrated that a steam locomotive could, indeed, work. His engine ran on a tramway from the steelworks at Merthyr to the national canal network. It pulled a load of twenty tons faster than a horse could manage.

Trevithick's problem, though, was that the load cracked the rails.
A topical complaint with which we can all sympathise. So, though he had proved the principle, he couldn't claim to have produced a regular, ongoing service.
George Stephenson went that one decisive step further and translated the principle into a service that became part of the economy of North East England.

And that is what LEO accomplished in 1951. From its inception in November of that year, the Bakery Valuations job made a regular contribution to the management accounts of J. Lyons & Co for several years.

Here is a picture of a railway engine of the early years.
I am bound to say that it is much better looking than LEO and a lot smaller. It probably also gave off a lower heat dissipation.


Catch me who can .

## Synopsis

I will now say a few words about LEO's ancestors, J. Lyons in West Kensington, ENIAC on the other side of the Atlantic and EDSAC in Cambridge.

Then I want to look at the first business job executed in the 'Computer Revolution'.

Then I will review some of the most significant early steps as the Revolution gathered pace.

Finally, I want to anticipate the question that is bound to come: Why, if LEO was so far ahead of the field, did it disappear from sight after a relatively short time? Why did Britain lose its lead?

## Joe Lyons

First, Joe Lyons, as it was familiarly known by everyone fifty or sixty years ago.

Founded in 1894, the company catered for some of the largest gatherings ever known, and then went on to build a chain of teashops. These became the favourite watering holes for shop workers and clerks for their lunches. And they provided a comfortable place for housewives to have a cup of tea after they'd done their shopping.

Here is a typical city teashop as it was, not far from here.

The next phase in the development of the company came when advanced bakery machinery was installed at the Cadby Hall estate in West Kensington. To make the powerful equipment fully economic it was necessary to produce a bigger output than that required by the catering activities alone. Within a few years every corner shop in the country was stocking Lyons packeted goods.

The expansion brought its own problems in its wake. It was one thing to expand production and to organise nationwide distribution. It was another to control all the movements of goods that arose and to keep account of all the thousands and thousands of small transactions.

And so, the ruling family decided to bring in some new blood. It was all a question of adding and multiplying, they argued. So they went to where the best adders and multipliers could be found. They recruited a senior wrangler from Cambridge University. His name was John Simmons.

## John Simmons

John Simmons is a name to remember when thinking about the Computer Revolution.

When he arrived at Lyons in1923, there was still a Dickensian atmosphere of clerks standing at tall mahogany desks. If they wanted a rest, they perched on tall stools. Long before the second world war, he had transformed the situation.


20
J. LYONS & Co Ltd
Burgoynes
Tintara

From the outset he saw it as his job to provide management with information upon which they could take sound forward-looking decisions. He moved Lyons from a position where the offices were just bean-counting, as they remain in many places to this day, to one where they guided all levels of management on positive action to improve the bottom line.

Lyons became a leader in the field of office mechanisation. Along the way a key step was taken with the establishment of a back-room function that became known as Systems Research, later Organisation and Methods. Its function was to look at all office activity from the viewpoint of its contribution to business needs.

When more advanced office machinery became available, the Systems Research responsibility was not merely to speed up what was being done already. Its job was to examine whether the business needs could now be met in new ways, yielding more help to management along the way.

When the idea of building a computer of our own came along, I had the good fortune to be Manager of Systems Research.

## ENIAC

So much for Joe Lyons for the moment. Now for the transatlantic ancestor, ENIAC. I won't say much about it because it was dealt with so authoritatively by Sir Maurice Wilkes in the first Pinkerton Lecture last year.

To remind you, ENIAC was built during the last war to meet the needs of the US army. The US army had its own mini-army of women mathematicians carrying out endless calculations to construct ballistic tables for all manner of projectiles in all manner of circumstances.

ENIAC failed to be ready in time to make a contribution to the war effort but it did prove that an electronic computer could deliver productive results.

It had a basic weakness. It was wired up to perform only one program. True, it could be rewired to suit other compatible programs, but there was no question of being able to switch quickly from one program to another.

To rectify this shortcoming, what became known as the Von Neumann architecture was devised. It was too late for ENIAC but it lit a beacon which stimulated computer development every where.

## LYONS meets ENIAC

The coming together of Lyons and ENIAC took place in 1947, when two senior executives of the Lyons offices visited the United States on a fact- finding mission after the war. Europe had been cut off from the United States for almost ten years, and Lyons was anxious not to be left behind in the field of business methods. The leader of the Lyons party was Raymond Thompson, another Cambridge mathematician.

In the event the party never actually saw ENIAC. They had an appointment to see it but it was cancelled. With its thousands of radio valves and high heat dissipation, it is little wonder that ENIAC was down from time to time. There is much less excuse now.

However, Thompson and his colleague, Oliver Standingford, did learn that two Cambridge, England academics had spent time at the site and would be well equipped to advise Lyons if they wanted to go further with the idea of obtaining a computer of their own. They were Professor Douglas Hartree and Dr Maurice Wilkes

The report of the tour and the subsequent visit to Cambridge was presented to Simmons. It contained a remarkably perceptive account of how a computer might be used for ordinary office work. It included a firm recommendation that the company should go ahead and acquire one.

Several possibilities were seen.

> One was to buy a machine from America.
>
> Another was to encourage British office machine manufacturers to build one.
>
> Another was to persuade the UK government to take a hand.
>
> A fourth possibility was to ask Cambridge to build a business version.
>
> Finally there was the proposition that Lyons should build a system of its own, drawing on assistance from Cambridge.

For one reason or another, all the options but the last were discarded as impractical.

## LYONS and EDSAC

The offer was made that Lyons would donate £3000 and the services of a technician for a year if Wilkes would make his work available as a model. The offer was accepted and no one could have been more generous in his help and advice than Maurice Wilkes was over the ensuing period.

The Lyons Board decision was that they would proceed with the building of a computer so long as and as soon as EDSAC could be demonstrated performing a live job.

It is worth commenting that at that time, Lyons had no electronic personnel at all.

In anticipation of EDSAC passing its test, an immediate step was to recruit a Chief Engineer. The young man appointed was John Pinkerton, in whose memory these lectures are named. This is his picture.

By training, Pinkerton was a Cambridge physicist. In the war he had worked as a boffin in TRE, the Government research establishment. His area was air defence. When Maurice Wilkes was asked to vet this applicant, he answered that he knew him well and that he was just the man for the job.

And so Pinkerton proved to be. When the aged Company Secretary asked him, ‘Do you think you can build this machine, young man?’ he paused for a moment and replied, ‘Yes, I think I can, but it might not be very reliable.’

He had rapidly absorbed the fact that an essential characteristic of business work was that it had to be done to time. In most scientific calculations of the period the fact that something was a day or two late would not be a disaster. Business work did not leave that latitude.

In parallel with this appointment, work began on preparing for the utilisation of a computer for the Lyons business. In due course this work was moved out of Systems Research to form a unit of its own. Programming techniques were developed. Applications were planned.

That was our format. Pinkerton was responsible for designing and building the equipment and I was responsible for putting it to productive work as soon as it was ready.

## Building the System

There were two main engineering tasks now. One was to build an engineered version of EDSAC to serve as the base. The other was to attach ancillary electronics to cope with the special requirements of business work.

At the heart of the difference between scientific computing and office work was the volume of input and output. In scientific work there is generally an enormous amount of calculating, most of it repetitive. This is based on very little data and produces only a small output of results.

In business work, on the other hand, the calculations are simple but the amount of data and results is enormous. So, unless provision were made to feed the data into the machine quickly and get the results away quickly, the benefit of the high calculation speed would be squandered.

The initial response was to use magnetic tape, even though this was still in its infancy. A leading firm of electrical engineers was enlisted to bring a magnetic tape ancillary system into being. Unfortunately, their approach was too ambitious and the scheme never reached a fully working state.

On the other hand Pinkerton was well on the way to delivering his part of the system in good order and to time. He commented wryly afterward that

> The philosophy we had was that we would not change anything if we didn’t understand why it was done the way it was.
>
> So, to start with, since we didn’t understand very well why it was done the way it was, we didn’t make very many changes at all.

This is an overmodest resume of what Pinkerton and his tiny team achieved but it conveys the spirit of the operation. Like Wilkes, Pinkerton was not trying to cross new thresholds in physics but to get a system into working order as soon as possible.

## The first business application

It was on Pinkerton's equipment alone that the first business application was carried out. It incorporated only minor additions to the EDSAC facilities but a great deal had been done to raise the level of reliability.

The application we prepared for this basic system was simple as compared with the integrated applications that we were working toward. But it was still testing in that it would be an integral part of the company's management accounting system. It would have to be completed to time each week if it were to serve that purpose.

The application was based on two management techniques that Simmons had introduced over the years.

The first was the internal market. Lyons was made up of several different trading divisions or units. Each had its own cost centre or profit centre. When they transferred goods to each other a charge was raised just as if the goods had gone outside.

The second technique was standard costing. There was a standard price for everything. There was a standard price for materials received from outside suppliers and every product was costed. There was a standard factory prime cost at which goods were transferred from the factories to the distribution centres. There were standard selling prices for each item for each of the different channels of sale.

In the Bakery Valuations job the total quantity for each item for each type of transaction for the week was calculated at the appropriate standard prices. The resultant amounts were then passed to the Statistical Office where they were compared with the actual costs incurred and turnover achieved.

For example, the aggregated standard labour costs for a Bakery could be compared with the wages actually paid. If the actual cost exceeded the standard cost then it indicated that too many staff might be being employed to produce the output achieved or that the grading might be too high for the work required… … or, of course, the sales price might be too low.

The whole objective was to enable management at all levels to take action without having to go searching for needles in the haystack of the Lyons Profit and Loss accounts. So may companies, even now, don't know where their profits are draining away.

I must stress that even though this job was carried out in November 1951, it was in no sense an experiment.

We knew when the equipment was due to be ready for use and it was our remit to have a job ready to run on it. We had innumerable test programs to try out different aspects of the system, but we instinctively knew that only live programs and live data could really give the equipment and our programming techniques the examination that they needed.

We had no doubt that our programs and hardware together would pass that examination. It is hard to convey the sense of confidence that was running at that time. We saw it as no great achievement to pass the test. We simply didn't entertain the possibility of failure.

And that is how it turned out. On completion fifty years ago, the system delivered the results every week and in good time for years afterward.

## The business computer

Two years after this world-first business application the full-scale LEO business machine was completed. The LEO team had produced an input-output system of its own Here is a schematic.

It was a system with three input channels and two output channels all working concurrently with the computer's calculating operations. Magnetic tape had been put aside for the time being and the input transports were punched card readers and electronically sensed paper tape readers. The output was to a line printer and a card punch. Data were read into buffer stores so as to be ready immediately they were wanted by the calculating unit in the main frame. Similarly, results were flashed out to the output buffers ready for printing or punching.

It was all like a three ring circus, except that there were many more than three things happening at once.

It was an enormous triumph for John Pinkerton and his team that the full system was completed to schedule and worked sufficiently reliably to be entrusted almost at once with a time-critical, externally visible job. His team, in modern terms, was still laughably small.

## The first full-scale integrated application

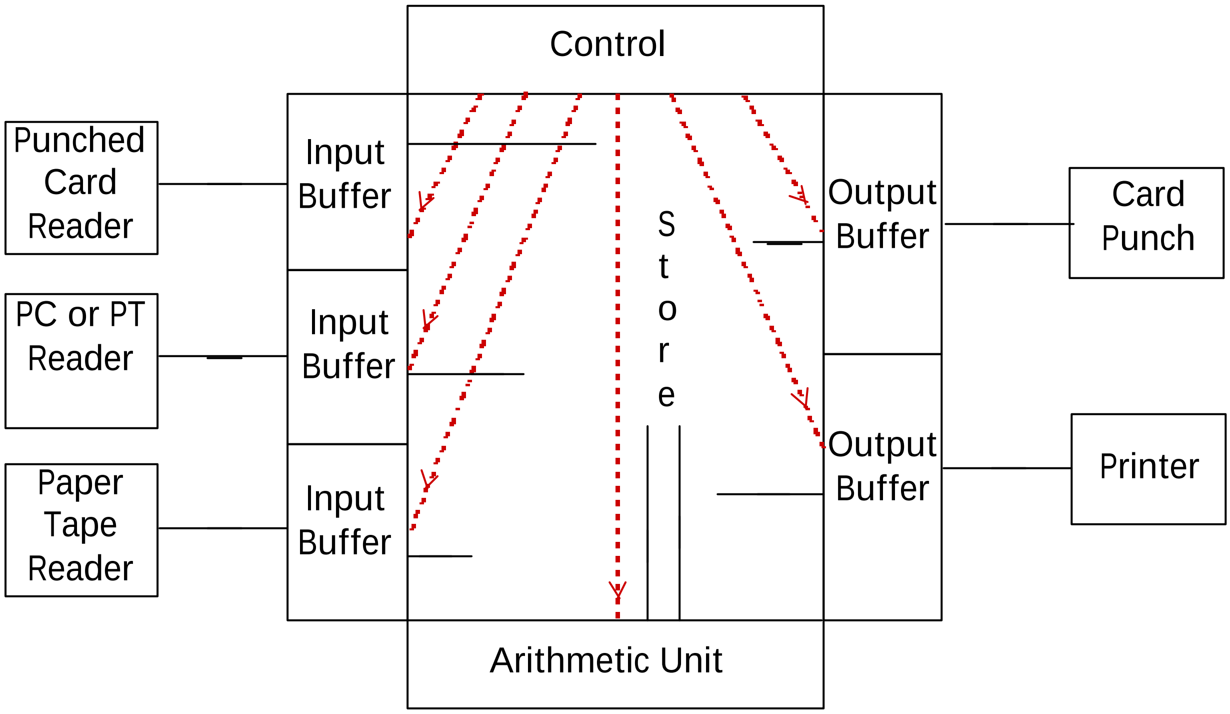
The completion of LEO l was the second major step in the Computer Revolution.

It had been intended from the outset that the first full-scale integrated application would be payroll. The payroll system that emerged led the world for many years.
This is a chart of the process.

The payroll job operated on the lines of one employee having his pay calculated while the data for the next employee were being read in from three separate channels and the payslip for the previous employee was being printed.

In the calculating phase everything down to updating the state of the employee's loan account was included. PAYE was deducted with special provision for holidays. If the extent of deductions meant that the take-home pay would have sunk below a set level, then only statutory deductions would be taken. To reduce the time for making up pay packets, net pay was rounded off to half crowns and the positive or negative balances carried forward to next week. And so on and so on.

This contrasted with the scene several years later in the States where, generally, only part of the job was done.




**LEO I Schematic**

At the beginning of 1954, after a searching period of parallel running, 1700 Cadby Hall Bakery employees received their pay packets with their pay slips prepared by LEO. From then on the payroll job ran regularly in one form or another as long as Lyons were in business.

## The Teashops Distribution job

The Payroll application built closely on what had been done before while taking advantage of the new opportunities offered by the computer. But it came as no surprise that some applications had to be radically changed if the full advantage of the computer was to be obtained. So, I want now to discuss the first example of Systems Re-engineering in the Computer Revolution.

That concerned the office work connected with the distribution of goods nightly to each of the two hundred or so high street teashops. There were hundreds of items, and as freshness was a matter of pride to the company there was little scope for keeping stocks in store.

This is a picture of some of the Teashops and Bakery vans waiting to be loaded in the Cadby Hall yard. We were very conscious that unless the computer produced its paperwork punctually, they would not start moving at the right time.

Back to the teashops

There was a manageress in every shop. Under the existing system she filled in ten or more multi-item order forms every day. Analysis showed that if all those entries had to be key-punched the job could not be done in time for packing to take place the same night.

The solution was to have each manageress set up a standard for each item for each day of the week, and only send in alterations for those items that she wished to modify. A call centre was set up staffed by operators with headsets and card punches. They phoned each shop at a set time and the alterations were punched into cards. It was a quasi on-line job. It went as far as the technology of 1954 permitted.

A particular advantage of the system re-engineering was that the manageress had to spend much less time at her desk. She could spend her saved time looking after her customers. The manageresses were a formidable set of women and it was a matter of **great** satisfaction when they expressed their appreciation of the change.

## Out-sourcing

I want to go on to LEO's introduction of the concept of out-sourcing, though the term hadn't been invented then.


LYONS
TEASHOPS
CADBY HALL
LONDON, W.14
LYONS
SWISS ROLLS
CADBY HALL
LYONS
SWISS ROLLS
LYONS
SWISS ROLLS
FROOD
LYONS TEA
NO EXIT

IT out-sourcing occurs when an organisation hires some outside body to take over its IT functions, so enabling it to concentrate on its core expertise. Increasingly, businesses and government departments have handed over their equipment, their staff, and even their intellectual property rights to the specialists, sometimes from overseas.

It might be said that like most good things, you can have too much of it.

Using LEO, the first stage of business out-sourcing occurred with the provision of a service for the payroll of the Ford motor company in 1955. LEO analysts produced a job specification that was approved by the local management. The LEO staff then produced the programs, training Ford staff to be able to make changes when these became necessary.

After trials, the programs were put into effect. The clock card data were brought by courier across London at a due time and the LEO organisation returned the completed pay data in the same way. Traffic congestion was less daunting then.

Previously, engineering and actuarial organisations had had their work done in this way, many of them on LEO. But this was the first time that a business firm had off-loaded a routine, time-sensitive body of work. It was a very brave decision by a senior administrator, who put his reputation at stake.

## LEO III

Eventually, to provide cover for the payroll and other Lyons jobs, a second LEO was produced and copies were installed on the premises of a number of forward looking office organisations. These included the steelworks at Corby, the Imperial Tobacco company in Bristol, the Ford Motor company Spares Depot at Aveley and the Ministry of Pensions and National Insurance in Newcastle.

By this time LEO Computers were running what amounted to a high-powered consultancy and software house as well as a computer production line and a service bureau.

From all this experience came LEO III. John Pinkerton set out to give the consultancy staff what they wanted in terms of facilities and performance. At the same time he embodied the rapid technological advances that had occurred.

There were no longer thousands of fallible valves. Germanium transistors, silicon crystals, and ferrite cores were the materials with which he worked.

> The machine was very much faster.
>
> The fast store was very much bigger and there was back-up storage on magnetic tape and drums.
>
> There was much less heat to get rid of.
>
> The whole ensemble was altogether more reliable.

And there were new features. The most important was that more than one program could operate at the same time. The feature was known as multi-programming or time-sharing. Several quite unconnected programs could run concurrently under the control of the operating system.

The system as a whole was particularly attuned to on-line working and the first steps in that direction were taken. All in all, the LEO III system that started work in 1961 was reckoned to be at least three years ahead of the IBM 360, in terms of facilities provided.

In the year, 1964, that the IBM 360 was announced, the Post Office, already a large-scale LEO user, awarded the biggest computer order ever placed in Europe. It was for a network of LEO 326 systems right round the country, handling telephone billing, National Savings and Premium Bonds as well as applications for other government departments. Later they were used to introduce the Giro. In its day the telephone invoicing operation was the biggest computer billing job in the world.

Announcing the order, the Postmaster-General of the day, Tony Benn, expressed satisfaction that a British company had been capable of 'standing up to and beating on its own merits,' the competition from overseas.

## Why?

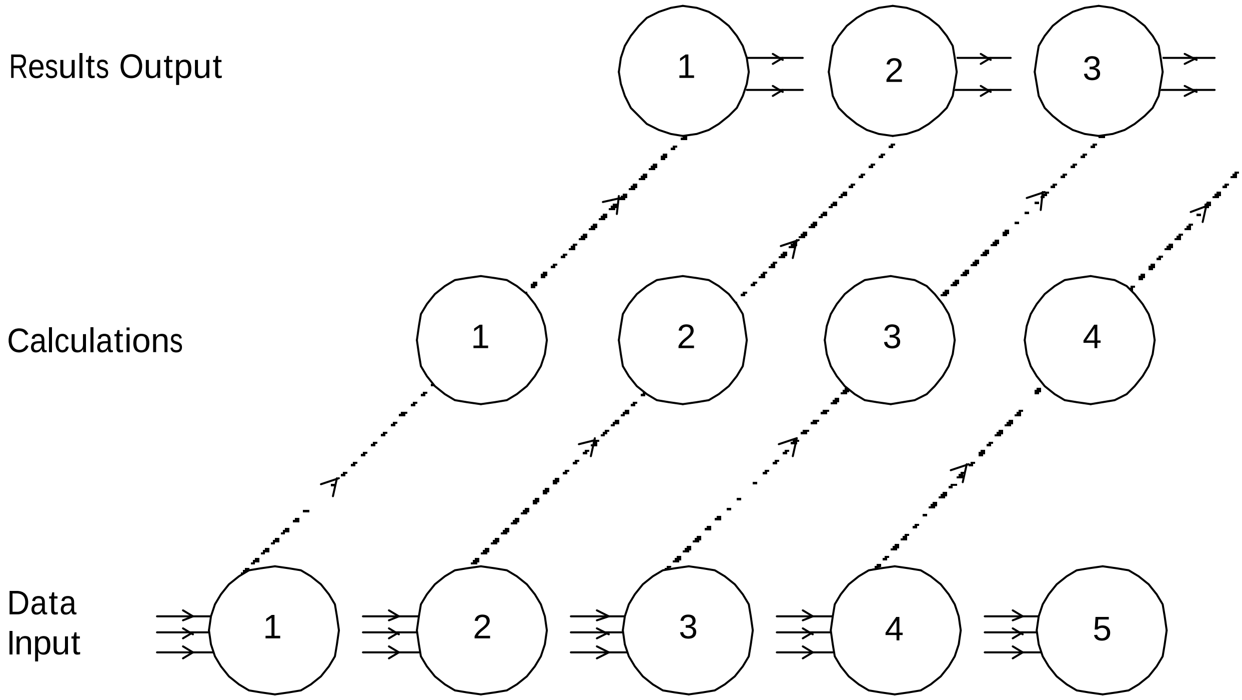
So that is an outline of how the Computer Revolution was set in motion by a teashops company.

The Computer Revolution still has a long way to go and Britain has a lot of catching up to do now.

> Our desk and home computers mostly use operating systems developed on the Pacific coast of the United States.
>
> Their processor chips also come from across the Atlantic.
>
> Systems are put out of action by viruses as virulent as the diphtheria bug that carried off children at the start of the Industrial Revolution.
>
> Eternities are spent by users getting their systems on to the air again.
>
> Computers, many, many more times as powerful as the most powerful LEO 326 lie abandoned.
>
> Millions of pounds have been spent on Government installations that have never met their specification.

So we need to learn from the past. And to ask the questions, 'Why, if LEO was so much in the forefront of the Computer Revolution when it started, did it not retain that lead?' 'Why did the United Kingdom become a second-class nation in IT, a follower rather than a leader?' 'How do we get into the front rank again?'

These are potent questions that have been asked not only about business computers.




**LEO: Concurrent Operations**

They have also been asked about other inventions that have emerged in this country and then been swallowed up in the exploitation stages. That's true of LEO's counterpart in the Industrial Revolution, the railways. We are a long way behind even there now.

In LEO's case there was a mixture of internal weaknesses and external forces that led to the decline. It is fitting that we should examine these briefly to try to prevent the same errors from afflicting us again.

I suppose one prime weakness was that LEO had a sugar daddy in J.Lyons. It is comforting to be freed of financial worries while history is being made, but it is more than likely that worries will catch up with you later. A good many Dot Com companies have found that out.

The worries caught up with LEO just when John Pinkerton had produced what was another world-beating machine. There had been no difficulty in finding the funds while the operation was still small scale and when Lyons, itself, was doing well and increasing its profits year by year. But times were different now. Lyons was needing all the funds that it could muster for its core businesses. The scale of the diversification had gone too far.

Accordingly, when the time came to launch LEO III, it was decided that it would not be attended by the fanfare of trumpets that might have been expected.

Emphasis would be placed on two bureau systems, one in London and the other in Johannesburg. Further sales of the system would be obtained by confidential whispers to existing customers, and to users of the bureau services and to such large-scale businesses that presented themselves as word got around.

I don't think I need say more. Just think of IBM following that strategy for the introduction of the 360 range, three years later.

Instead, Lyons chose to reduce its exposure to the computer business by forming a partnership with what was then a leading electrical machinery manufacturer, English Electric. It was not a suitable combination for fostering the Computer Revolution.

It is fair to say that I know of no computer merger anywhere where there has been added value from the merger of competing forces of engineers, marketers and programmers. It is like two civilisations trying to come together. The merger of LEO and English Electric wasn't as bloody as the coming together of the Incas and the conquistadors, but sometimes it seemed just as unpleasant… . to both parties.

When the time came for a new range, English Electric went across the Atlantic to its licensing partner, RCA, better known for its colour televisions. And that signalled the end of the development of the LEO marque, though installations continued very successfully for several years.

Looking back at the past, it is tempting to beat our breasts.

> Our vision was blinkered.
>
> We were too occupied with making work whatever we were occupied with.
>
> We took too much satisfaction in working on a shoe-string.
>
> We were too often arrogant about always knowing best.
>
> We had no idea, nor did anyone, of the rapid rate of technological advance.

## What of the external forces ?

The first of these was the size of the market. From first to last, Britain was LEO's home market. There were sales in the old dominions and behind the Iron Curtain but none at all, not even a service job, in Western Europe or the Americas. .

Everything was too small-scale as compared with the vast United States domestic market. Western Europe as a whole would have produced a comparable market, but there was never any likelihood of that happening.

Then there was the failure of the UK governments over the period to play a truly constructive part.

The financial assistance that they felt able to give was pathetic compared with what was happening in the States. Over the early period, IBM was given more in development contracts by the US Defense Department than the total amount spent on development by all the fragmented British companies together. Other US companies profited in the same way.

In Britain, such little help as was given went toward scientific computing.
Murray Laver, the senior civil servant who later became responsible for guiding government computerisation, commented candidly:

> 'In Britain generally we were slow to realise that the computer market for commercial work would outgrow and greatly exceed the market for science and engineering.'

Unhappily, that realisation came too late.

Finally there was a national malaise that made the going hard for LEO:

On our coast-to-coast tour of the United States in 1958 to see where best practice had reached, John Pinkerton and I were bowled over by the difference in attitude to innovation.

At home we were still fighting to convince big business that computers were the gateway to the future.

In the States we found highly expensive machines being installed in quantity.

The American psyche had taken off. With only one exception, none of the installations we saw in action was as venturesome or as integrated as what we had left behind on LEO l.

We were often mystified as to how the costs of the big IBM and Univac systems had been justified. But the Americans had sensed that this was the way forward and were anxious to take their place in the front. There was scarcely a breath of this at home.

Charles Babbage, the grandfather of automatic computing, had encountered the same syndrome a hundred years before.

Here is a picture of the grand old man of automatic computing.

I will leave it up while I recall his words. He said:

> 'Propose to an Englishman any principle or any instrument, however admirable, and you will observe that the whole effect of the English mind is directed to finding some difficulty, defect or improbability in it.
>
> If you speak to him of a machine for peeling potatoes, he will pronounce it impossible.
>
> If you peel potatoes with it before his eyes, he will declare it useless because it cannot slice pineapples.
>
> Expose the same principle or show the same machine to an American and you'll observe that the whole effort of his mind is to find some new application of the principle, some new use of the machine.'

I can only add that we have to recognise that syndrome and eradicate it. Otherwise, we will never regain the place in the forefront of the Computer Revolution that Wilkes and Pinkerton and those that worked with them, won for us. Let us start from here.