

# **MY WORKING LIFE**

**The story of a 20<sup>th</sup> century computer programmer**

An Autobiography

**by D. J. Pentecost**

**November 2018, with corrections in 2020**

To Kai and other members of my family.

To historians of the computer industry.

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## Chapter 1: THE SHORTLANDS PRESS



The Shortlands Press former premises (2015 photo), and a Thompson letterpress machine

In some of the school holidays around 1950, I worked in my father's printing shop at 650/652 High Road, Leyton, E10; the business was listed in the local Chamber of Commerce Trade Directory for 1957-58, and for some earlier years too, certainly in 1949, and up to 1974 in Kelly's directories. The business was opened in 1946 with Percy Budd, my father's business partner, whom I think he had met during their service in the Royal Marines during the second world war. My father and I travelled by bus from North Finchley to Leyton, leaving early in the morning. Mostly I worked by collating papers after they came off one of the two printing presses, for example making up sets of 3-part invoices. One of the presses was a Heidelberg, the other a Thompson, which was later moved to my father's printing shop at our North Finchley home. A third machine was a powerful paper cutting and trimming machine, which was hand-driven via a large wheel with a handle to turn it, to lower and raise the cutting blade.



I learned a little about the printing processes, including manual type-setting, picking the pieces of mirror-image type (one per character) from a special typesetter's tray of small boxes, and putting them into a hand-held device, called a composing stick, before transferring a few words into a larger block of pieces of type which would eventually form a single page. You can read more about this process at:

<https://letterpresscommons.com/setting-type-by-hand/>

## Chapter 2: NATIONAL PHYSICAL LABORATORY

CS/ABE.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH



### National Physical Laboratory

TEDDINGTON, MIDDLESEX

Please reply to the DIRECTOR and quote our reference    Telegrams : Physics, Teddington    Telephone : Molesey 1380, Ext. 9

OUR REF: AD(E) 40/9/01B

YOUR REF:

20th November, 1958.

Dear Sir,

I am directed by the Executive Committee of the National Physical Laboratory on behalf of the Council for Scientific and Industrial Research to offer you an appointment as Sandwich Course Student for a period of six months, at a wage of £6.10s.-d. per week. You will work in Mathematics Division.

The appointment will be subject to satisfactory service, and to termination on one month's notice being given in writing on either side at any time.

The maximum allowance of annual leave will be  $7\frac{1}{2}$  days in addition to the usual Public Holidays. Sick pay will be allowed in accordance with the regulations from time to time in force.

Your normal hours of attendance at the Laboratory will be 42 per week (Monday to Thursday 9.0 a.m. - 5.30 p.m., Friday 9.0 a.m. - 5.0 p.m., inclusive of one hour each day for lunch.

The following conditions apply to all appointments at the Laboratory:-

- (a) No outside professional work may be undertaken without the previous written consent of the Department.
- (b) All work done for the Department is confidential and its results must not be disclosed to any unauthorised person.
- (c) No member of the staff is allowed to apply for a patent otherwise than as provided for in the approved recommendations of the Report of the Patents Committee of the Civil Service National Whitley Council.
- (d) Every member of the staff is under the obligations imposed upon him or her by the provisions of the Official Secrets Acts, 1911 to 1939.

You will also be required to observe the general regulations of the Department as laid down from time to time.

I enclose for your information, a statement on the policy of the Government which limits the range of work on which persons who are members of Communist or Fascist organisations, or, in some cases who have associations therewith, may be employed in Government Departments.

Please confirm in writing your acceptance of employment on the above terms. We understand that you wish to take up your appointment in January, 1959, and perhaps you will indicate the date on which you will be able to commence duty at the Laboratory, please.

Your birth certificate should be forwarded for examination. It will be returned to you in due course.

We shall be pleased to help you find accommodation in this area if you require it.

Yours faithfully,

D. J. Pentecost, Esq.,  
Torrington Cottage,  
Church Path,  
Finchley,

  
for Director.

My appointment letter to the National Physical Laboratory



**Entrance to the National Physical Laboratory, Hampton Road, Teddington.**

For a short period of my life I was technically a Government employee – a member of the Scientific Civil Service. I worked for the Department of Scientific and Industrial Research, (DSIR) from January 1959 for just six months, as a student from Brunel College of Technology, near Acton Town station. It was part of a four year course, providing periods of industrial experience between six month periods of study in mathematics.

I was living with my parents in Finchley, and travelling each day to work in the Mathematics Division of the National Physical Laboratory (NPL) in Teddington. Luckily for me, working there already, was a friend of a primary school friend of mine, and he travelled daily by Lambretta scooter from Whetstone, less than a mile north of Finchley. I met him each morning at Finchley Central Station, and rode pillion from there, on to Teddington, after he had dropped off his girlfriend at the station. His name was Michael Bacon. I think that he worked in the Physics Division of the Laboratory.

My job had a few different aspects. Doing long calculations for the mathematicians was one of them. I used various calculating machines, mostly large electro-mechanical ones, for example a Friden (below left) or Marchant (right).



But I also used a mechanical calculator, and whilst I was still at Brunel, I bought one for home use, a reconditioned large capacity (20 digit) Brunsviga mechanical calculator, from Block & Anderson, made by Grimme, Natalis and Co. A.G., Braunschweig, Germany, between 1931 and 1939. At the time of writing, it is in the loft at 2 St Andrews Close, Leighton Buzzard. It is now a museum piece, and in perfect working order. It could be given to a museum, or auctioned. On 31.10.2016, I found one on eBay on sale for \$425+shipping. Mine is identical to this one:



**Brunsviga large capacity calculator**

Other tasks at NPL were working with large scale matrices, multiplying them together for example. The Mathematics Division also had some clever machines for processing punched cards in various ways. They were controlled by plug boards,

and I worked on wiring up the boards to control the machines; the process was a bit hit and miss, at least for me!

The most impressive machine was the large ACE computer, developed from Alan Turing's design. Its predecessor was the Pilot ACE, which English Electric developed into a production computer called DEUCE. When I was at NPL, it was the DEUCE computer which programmers were using, and it was in great demand, by many users. Twice a day, there was about half an hour allocated to employees to come and use it for small processing jobs, for which they had already prepared program and data input on 80 column punched cards; this half hour period was called 'popping-in' time; one formed a queue to wait to use the computer for a few minutes.



**English-Electric DEUCE at NPL**

Somehow, with a struggle, for there was no training course, and I don't even recall seeing a formal manual, I learned to program some aspects of the machine. But I suppose I must have had some individual tuition. Machine code instructions had to be worked out in a quite complicated way, for the computer had no sequence control register, so one had to tell the computer where to find the next instruction after it had obeyed the current instruction. Each instruction needed conversion into binary, and each binary instruction then had to be punched out on an 80 column card: one row per instruction, so twelve instructions per card; see photo below.



**A typical hand card punch machine**

I loved that programming – it was huge fun, and I was hooked! I wanted to become a programmer.

After my second six months back at Brunel, I felt that I was not going to succeed on the course – I could not follow the electronics teaching at all; nor some of the statistics; the lecturer on the latter subject one day wrote a huge formula across almost the whole length of the large blackboard, and announced that we had to commit it to memory; for me that was impossible. I decided at that moment to quit, but stuck out the course until the end of the six months. I had completed half of the academic part of the course, and one period working in industry. I later learned that of the thirteen students on the course, only one completed it, and he was something of a genius. I joined in the very first year of the course, and I believe that the course level had been pitched too high, because all the students except one, dropped out.

### **Chapter 3: ELLIOTT BROTHERS (LONDON) LTD** (Later, part of Elliott Automation)

I bought the Daily Telegraph, around 14th March 1960, and found an advertisement for a junior programmer at a computer manufacturer: Elliott Brothers, in Elstree Way, Borehamwood – luckily not far from home for daily travelling. (This was also not far from my father's father's father's home, which was on the site where now stands Borehamwood's Post office in Borehamwood high street).

I travelled from my Finchley home by motorbike: a Royal Enfield 'Prince' model, with a bright red fairing. Below is a photo of it taken in France, probably somewhere between Beauvais (where my French pen-friend lived), and Le Raincy in Paris (with which Finchley was twinned); the photo may have been taken in Le Raincy, when I was on a 'semi-official' visit to see the Mayor, for at the time, I was secretary and treasurer of the Finchley Council of Youth.



Why that bike? It was because whilst working at the National Physical Laboratory, an employee there travelled to work on a Royal Enfield bike, although larger than the 'Prince' model, and I was so impressed with it, I decided that I wanted one. It was my uncle John Lawrence, home on a visit from his workplace in Kuwait, who arranged to buy it for me at a huge discount though his employer, the Kuwait Oil Company.

Mine was a very impressive looking machine, and the bike was stared at by many people in France, whenever I stopped. They always asked 'How fast does it go?' But it was only 148 cc capacity, with a top speed of 60 mph. Once, I skidded over on black ice when travelling to Elliotts in winter, and I then decided to ride it no more in

bad weather. So I sometimes used two buses: one from North Finchley to High Barnet, and then another from Barnet to Elliotts at Borehamwood.



## ELLIOTT BROTHERS (LONDON) LTD.

CENTURY WORKS, LEWISHAM, LONDON, S. E. 13

TELEPHONE: TIDEWAY 1271 - Established 1800 - GRAMS: OHM LONDON TELEX

BRANCH ESTABLISHMENTS AT ROCHESTER AND BOREHAMWOOD

PER/GER/EH.

31st March, 1960.

Mr, D. J. Pentecost,  
Torrington Cottage,  
Church Path,  
Lodge Lane,  
Finchley. N. 12.

Dear Mr. Pentecost,

We have pleasure in offering you the post of Junior Programmer in our Organisation and Methods Department, at a salary of £550/- per annum, and in accordance with the enclosed Conditions of Service. You would be based at our Head Office, and operate at our Borehamwood Establishment.

We shall be glad to learn as soon as possible as to whether or not you accept our offer, and if so the earliest date upon which you would be available to take up your duties with us.

Yours faithfully,  
For ELLIOTT BROTHERS (LONDON) LIMITED.

G. E. Robson,  
Personnel Manager.

Encl.



The old 2-storey Elliott building is in the foreground on the right. The large L-shaped building in the background was the newest Elliott block. My office was on the third floor of the wing on the left side of the photo. I also spent many hours in the computer bureau/showroom which you can see fully illuminated on the ground floor on the left side of the photo. All these buildings were later demolished for redevelopment.



Here is part of the computer showroom/service bureau, showing an Elliott 4130 (foreground) and an Elliott 4120 (background). These models were respectively introduced in 1965 and 1967, after I had left Elliotts.

I applied for the post, and after interview on 29th March 1960 by a couple of high level programmers and computer designers, I was accepted, to start on 19th April 1960, in the Internal Computer Applications (ICA) department of Elliotts, working on the third floor, above the vast and impressive ground floor computer showroom/service bureau, which was said to be the biggest in the world at the time. I spent many hours in that computer room, sometimes working through the night on the Elliott 405 computer.



**An Elliott 405 computer; I think this one was at NCR's premises in London**

There appear to be no photographs taken of the Elliott computer bureau room in the early 1960s, showing the two 405s, the 402 and the film and lineprinter output machines. The above photo is the best I could find showing a good portion of a 405.

But I was keen to find a better photo of the console of the 405, including a paper tape punch and reader, and Google helped me after a long search to track one down. Below is one of the best photographs which I have come across. I found it in March 2017 as a small image on the website of the Powerhouse Museum in Sydney, Australia, which is part of the Museum of Applied Arts & Sciences.

The tiny black and white photo is at <https://collection.maas.museum/object/210779>.

I clicked on the photograph and was delighted to find a much larger high quality image, but the original print had been degraded over the decades by creases, scratches, and hundreds of the black and white patches which are commonly found on old photographs; the images of the people's faces had been damaged by white marks.

I spent several hours restoring the worst of the damage, and the result you can see below.



Copyright is thought be owned by National Cash Register Co. Ltd

In 2011, I had corresponded with Matthew Connell at the Powerhouse Museum about my involvement in the development of the British computers heritage website (see Chapter 11). I sent him a copy of the improved photo, asking for the identity of the computer installation, and for caption details which I should use to include the photo in this book. He was delighted with the restored photo, and told me that the computer was installed at the commercial computer bureau office of the National Cash Register Co. Ltd, in 1959 at Barrack Street, Sydney, the first bureau of its kind in Australia. Most 405 photos show the whole of the installation; this one for a change, concentrates on the console and the electro-mechanical input and output devices.

Shortly after my arrival and induction at Elliotts, I was sent on an excellent two or three week 405 computer programming course run by The National Cash Register Company (NCR) in Marylebone Road, London. Elliotts had an agreement with that company for them to market the 405 computers and run training courses. I was scheduled to work on writing programs for the 405, probably physically the largest commercial machine ever made by Elliotts.

Although I was at Elliotts for only a short time (April 1960 to September 1962), that period proved to be one of the most useful for my future career, and oddly, later in retirement. It enabled me to contribute 45 years later, and after a considerable amount of research conducted over several years, to writing a significant amount of an Elliott section of the history of British computers website, which is published at

[www.ourcomputerheritage.org](http://www.ourcomputerheritage.org), and which has been formally adopted for archiving by the British Library. More on this subject appears in Chapter 11.

My time at Elliotts was spent mostly on writing 405 programs for the stock control system required by Elliotts to assist in its manufacturing processes. But I was also required to write a few library programs for the 405, not only to help Elliotts themselves, but also to make them available to Elliotts' 405 customers, one or two of whom I visited.

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One library program which I wrote, was to enable the time taken by another program, or a critical part of another program, to be measured precisely; if it was found to be working too slowly and was causing a job to take much too long to run on the computer, then steps might be taken for a full or partial re-write of the program, to improve its efficiency. This was important, because some processes on computers designed in the 1950s took many hours to complete, and available time on a computer was often at a premium. In addition, computers were not as reliable as they are today, and a job which should take several hours to run, might not finish, because of a computer hardware failure. An engineer was usually on stand-by in case of such failure.

Another library program's function was to sort data. A new sorting technique, known internationally now as Quicksort, (see Wikipedia for a brief explanation) had been invented by Tony Hoare (see also Wikipedia), another Elliott employee, who is now (2016) Emeritus Professor at Oxford University.

My boss, the head of the ICA department, Patrick Shackleton, had written the old existing sort program used by most Elliott customers. He was surprised at the claimed better efficiency for Quicksort, and was determined to prove whether or not it would be faster than his own program, when run on the 405 computer. So he designed and wrote Quicksort for the 405, but was unable to get it to work at all. In frustration, he gave the coding sheets to me, with instructions to find the errors and make it work.

As far as I knew, he had written the program without having specified it in logical steps on paper, and without having drawn a detailed logic flowchart; the logic was only in his head, and he was so brilliant that he normally didn't need flowcharts. For him they were an unnecessary step, but in this case, he was wrong. So I set about reading the coding sheets, and at the same time drawing a flowchart from the code, in order to try to understand the complex logic. After many days of studying the coding sheets, I finally had a flowchart completed.

So I then set about trying to understand it, to find out what the program was supposed to do. It was I think the toughest intellectual task I have ever undertaken, for the logic of the flowchart did not make sense. Finally I found two places where a jump instruction at the end of a loop was returning back to an illogical point in the coding; I made corrections. I then began to understand what the correct sorting

process was intended to be. Having found the innermost loop in the process, which needed to work at maximum efficiency, I re-wrote it, so that it executed faster.

Then I tested the program several times on small and large sets of data held on the 405's disc. Quicksort finally worked on the 405 for the first time, and it was also the first time Quicksort had been used on a computer where the data was stored on a sectored disc. But was it faster than Shackleton's old sort program? I used my timing program to measure both sort programs, each operating on the same sets of data. Quicksort was indeed faster, and it now forms the basis of nearly all computer sort programs, worldwide. Tony Hoare published his Quicksort paper in the British Computer Society's Journal (Vol. 5, no. 1, 1962, pp. 10-15); his article mentions me as having run timing tests for Quicksort.

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From time to time, internal courses were held at Elliotts, designed to teach some aspects of computing to new employees. My section of one of the courses was to explain the timing of part of the 405 computer's instruction set, known as 0-code orders. I gave the lecture on 28th February 1962 in the Borehamwood office of Elliotts.

The contents of the talk are formally set out in part of the Computer Conservation Society's website at [ourcomputerheritage.org](http://ourcomputerheritage.org), and specifically on pages 180-183 (at the time of writing), at <http://www.ourcomputerheritage.org/ccs-e2xtra4.pdf>. I was responsible for researching and producing the whole of that 186 page section of the website, between 2003 and 2011.

\*\*\*\*\*

I sometimes spent very long hours at Elliotts' Borehamwood offices, occasionally through the night, when it was quiet with no interruptions to concentration. One day I fainted after stepping out of the lift on the third floor. I was taken to the medical room in Elliotts' small old building to recover, where it was suggested that I had not been eating enough. The diagnosis was correct. But I was not the only one who often worked through the night. My colleague and life-long friend Harry Lawrence also liked to do this. Sometimes we would go out in his car very late at night or in the early hours to a lorry drivers' café which never closed; it was called the Busy Bee, and I think it was somewhere on the A41 road.

We had to complete time-sheets in those days, which were not designed for working outside normal hours. There were sometimes weeks on end when Harry recorded apparently very few hours or no hours worked at all, because night hours were not recordable on the sheets. He delighted in scrawling over the whole week's time-sheet just two words: ODD TOIL, which puzzled the administration staff, and he was summoned to explain himself. He said that the abbreviation stood for 'Out During the Day – Time Off In Lieu', because he had been working at night. I copied him and did the same, although I was rarely absent for the whole of a day's working hours, so I always had some hours recorded, as well as some ODD TOIL entries.

\*\*\*\*\*

I spent some of my time whilst at Elliotts, after normal working hours, writing some programs for fun. One of them was to calculate and print a list of factorials – as many as the computer reasonably could, without involving an enormous programming effort.

I still have the complete results listing, but I am showing here just the first and last pages. The program stopped at factorial 146, which has 255 digits, so there was clearly a storage limitation which caused the program to stop. The results had to be stored on the computer's hard disc, because the computer's fast memory was not large enough, and was microscopically small by today's standards. The challenge of the programming, was to work out a method of calculating numbers of enormous length, and being able to print them in a readable decimal form.

<b>FACTORIALS</b>	
1	1
2	2
3	6
4	24
5	120
6	720
7	5040
8	40320
9	362880
10	3628800
11	39916800
12	479001600
13	6227020800
14	87178291200
15	1307674368000
16	20922789888000
17	355687428096000
18	6402373705728000
19	121645100408832000
20	2432902008176640000
21	51090942171709440000
22	1124000727777607680000
23	25852016738884976640000
24	620448401733239439360000
25	1551121004333098598400000

142	2695364137888162776588507508037290267094 0085168913961107920895997344647146988670 5721287973193419489734024361060974102771 6867307764822172854447798975861254848682 9479004434022298980073807909182159855712 8192667156480000000000000000000000000000 000000
143	3854370717180072770521565736493325081944 4321791546964384326881276202845420193798 9181441801666589870319654836317192966963 5120250103695707181860352535481594433616 6154976340651887541505545310130488593669 331551403376640000000000000000000000000000 00000000
144	5550293832739304789551054660550388117999 9823379827628713430709037732097405079070 4421276194399889413260302964296757872427 4573160149321818341878907651093495984407 9263165930538718059767985246587903574883 83743402086236160000000000000000000000000000 0000000000
145	8047926057471991944849029257798062771099 9743900750061634474528104711541237364652 1410850481879839649227439298230298915019 8131082216516636595724416094085569177391 4931590599281141186663578607552460183581 564279330250424320000000000000000000000000000 000000000000
146	1174997204390910823947958271638517164580 5962609509508998633281103287885020655239 2125984170354456588787206137541623641592 8927138003611428942975764749736493099899 1580012227495046613252882476702659186802 9083847822165619507200000000000000000000000000 0000000000000000

Last page of a list of factorials calculated on the Elliott 405 computer

How long would it take to program a modern computer to perform the same task? It ought to be much quicker, but I wonder. Would there be capacity problems? Certainly it would be far quicker to execute the program. Unfortunately I did not keep the 405 program coding sheets.

Another program which I wrote for fun, was to calculate and print out some magic squares. A magic square is a square grid of numbers, in which the numbers in every row and every column add up to the same total. And the numbers in the two diagonals also add up to that same total. Here is a very simple example, where all the totals are 15:

```

4 9 2
3 5 7
8 1 6

```

Below is the paper tape program listing, and on the next page the set of results. The magic squares are shown in two columns, reduced for ease of display, to smaller than their original size; on the actual printout they were printed on a single piece of continuous stationery. The last magic square completely filled the width of the paper.

```

MAGIC SQUARES 128/254@
110'27,110'29
110'30,110'30
11'141,113'0
173'0,11'140
10'2,11'140
114'4,4'0
10'4,110'29
110'29,110'30
110'30,110'30
110'30,8'143
3
2
1
1000
10'220,4'0
11'138,10'16
11'16,2'2
10'17,11'17
2'2,10'18
121'255,11'255
11'17,10'19
11'17,13'1
10'20,11'2
10'30,11'19
6'16,11'3
0'20,5'16
5'3,0'142
10'156,11'30
0
10'25,8'158
11'19,0'2
10'19,11'19
2'16,9'162
4'0,10'19
11'20,0'2
10'20,11'20
2'16,9'166
4'0,10'20
11'25,0'2
10'25,11'25
2'16,9'181
11'19,2'2
9'176,9'171,8'176
11'8,10'19
11'20,2'2
9'174,8'178
11'17,10'20
8'182,
11'19,2'139
10'19,8'172
11'20,2'2
10'20,8'180
4'0,10'25
11'19,6'16
11'3,0'20
5'16,5'3
0'142,10'187
183/254@5'16,5'3
0'142,10'187
11'30,0'2
10'30,11'30
0
10'28,11'16
6'16,11'3
2'30,3'28
9'158,4'0
192/255@10'24,4'0
10'23,4'0
10'22,11'200
0'22,10'0/3
0
11'23,0'2
10'23,11'22
0'201,8'203
11'220,114'4
0'1,
11'200,8'195
10'22,11'23
2'16,9'202
4'0,10'23
110'29,110'30
110'30,11'24
0'2,10'24
11'24,2'16
9'202,11'138
0'139,10'138
11'138,2'214
9'135,8'215
19
8'215,
175/254@8'180,
171/254@11'18,10'19
>

```

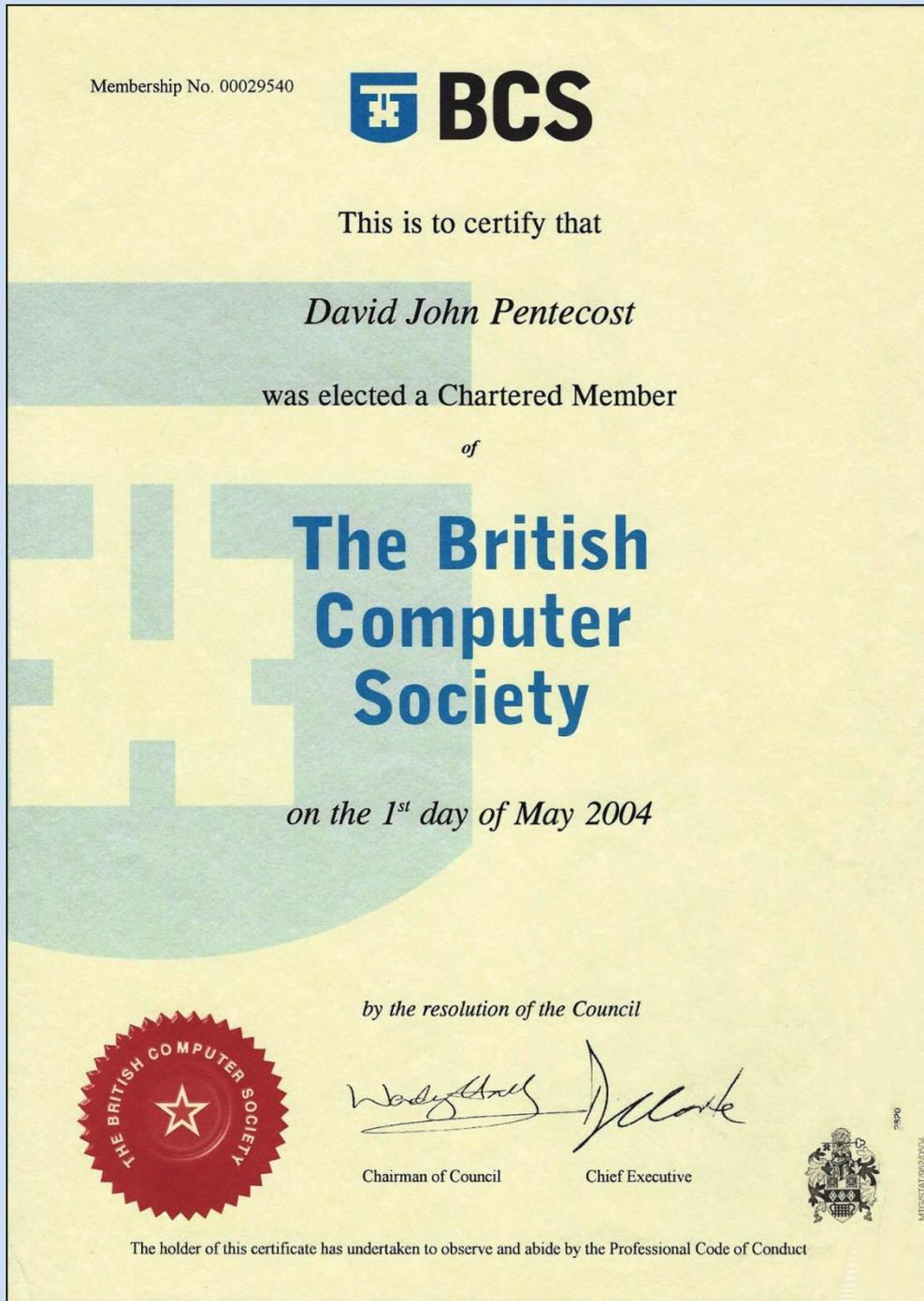
It looks to me as though there is an error in the penultimate line in the first column, which must have been corrected before the program was run, but not corrected on the paper tape. Or perhaps the paper tape which I kept was not the final working version. So here is a puzzle for a keen future student to solve, by referencing the 405 computer instruction set described in the website at [www.ourcomputerheritage.org](http://www.ourcomputerheritage.org)

MAGIC SQUARES														
1														
4	9	2												
3	5	7												
8	1	6												
11	18	25	2	9										
10	12	19	21	3										
4	6	13	20	22										
23	5	7	14	16										
17	24	1	8	15										
22	31	40	49	2	11	20								
21	23	32	41	43	3	12								
13	15	24	33	42	44	4								
5	14	16	25	34	36	45								
46	6	8	17	26	35	37								
38	47	7	9	18	27	29								
30	39	48	1	10	19	28								
37	48	59	70	81	2	13	24	35						
36	38	49	60	71	73	3	14	25						
26	28	39	50	61	72	74	4	15						
16	27	29	40	51	62	64	75	5						
6	17	19	30	41	52	63	65	76						
77	7	18	20	31	42	53	55	66						
67	78	8	10	21	32	43	54	56						
57	68	79	9	11	22	33	44	46						
47	58	69	80	1	12	23	34	45						
56	69	82	95	108	121	2	15	28	41	54				
55	57	70	83	96	109	111	3	16	29	42				
43	45	58	71	84	97	110	112	4	17	30				
31	44	46	59	72	85	98	100	113	5	18				
19	32	34	47	60	73	86	99	101	114	6				
7	20	33	35	48	61	74	87	89	102	115				
116	8	21	23	36	49	62	75	88	90	103				
104	117	9	22	24	37	50	63	76	78	91				
92	105	118	10	12	25	38	51	64	77	79				
80	93	106	119	11	13	26	39	52	65	67				
68	81	94	107	120	1	14	27	40	53	66				
79	94	109	124	139	154	169	2	17	32	47	62	77		
78	80	95	110	125	140	155	157	3	18	33	48	63		
64	66	81	96	111	126	141	156	158	4	19	34	49		
50	65	67	82	97	112	127	142	144	159	5	20	35		
36	51	53	68	83	98	113	128	143	145	160	6	21		
22	37	52	54	69	84	99	114	129	131	146	161	7		
8	23	38	40	55	70	85	100	115	130	132	147	162		
163	9	24	39	41	56	71	86	101	116	118	133	148		
149	164	10	25	27	42	57	72	87	102	117	119	134		
135	150	165	11	26	28	43	58	73	88	103	105	120		
121	136	151	166	12	14	29	44	59	74	89	104	106		
107	122	137	152	167	13	15	30	45	60	75	90	92		
93	108	123	138	153	168	1	16	31	46	61	76	91		
106	123	140	157	174	191	208	225	2	19	36	53	70	87	104
105	107	124	141	158	175	192	209	211	3	20	37	54	71	88
89	91	108	125	142	159	176	193	210	212	4	21	38	55	72
73	90	92	109	126	143	160	177	194	196	213	5	22	39	56
57	74	76	93	110	127	144	161	178	195	197	214	6	23	40
41	58	75	77	94	111	128	145	162	179	181	198	215	7	24
25	42	59	61	78	95	112	129	146	163	180	182	199	216	8
9	26	43	60	62	79	96	113	130	147	164	166	183	200	217
218	10	27	44	46	63	80	97	114	131	148	165	167	184	201
202	219	11	28	45	47	64	81	98	115	132	149	151	168	185
186	203	220	12	29	31	48	65	82	99	116	133	150	152	169
170	187	204	221	13	30	32	49	66	83	100	117	134	136	153
154	171	188	205	222	14	16	33	50	67	84	101	118	135	137
138	155	172	189	206	223	15	17	34	51	68	85	102	119	121
122	139	156	173	190	207	224	1	18	35	52	69	86	103	120
137	156	175	194	213	232	251	270	289	2	21	40	59	78	97
136	138	157	176	195	214	233	252	271	273	3	22	41	60	79
118	120	139	158	177	196	215	234	253	272	274	4	23	42	61
100	119	121	140	159	178	197	216	235	254	256	275	5	24	43
82	101	103	122	141	160	179	198	217	236	255	257	276	6	25
64	83	102	104	123	142	161	180	199	218	237	239	258	277	7
46	65	84	86	105	124	143	162	181	200	219	238	240	259	278
28	47	66	85	87	106	125	144	163	182	201	220	222	241	260
10	29	48	67	69	88	107	126	145	164	183	202	221	223	242
281	11	30	49	68	70	89	108	127	146	165	184	203	205	224
263	282	12	31	50	52	71	90	109	128	147	166	185	204	206
245	264	283	13	32	51	53	72	91	110	129	148	167	186	188
227	246	265	284	14	33	35	54	73	92	111	130	149	168	187
209	228	247	266	285	15	34	36	55	74	93	112	131	150	169
191	210	229	248	267	286	16	18	37	56	75	94	113	132	151
173	192	211	230	249	268	287	17	19	38	57	76	95	114	133
155	174	193	212	231	250	269	288	1	20	39	58	77	96	115

Results of the Magic Squares 405 computer program

\*\*\*\*\*

Whilst at Elliotts, my boss, Patrick Shackleton, advised that I should join the British Computer Society (BCS), which I did. I attended a few of the specialist BCS group meetings. In the 1980s when I was working at Coward Chance (see Chapter 9), I enquired about applying for a Fellowship of the BCS, in relation to the major project which I had then managed, but I was unable to apply because I was out of time according to the Fellowship application rules. Much later, in April 2001, I bought life membership of the BCS for £395, and in May 2004 I was elected as a Chartered Member of the BCS:

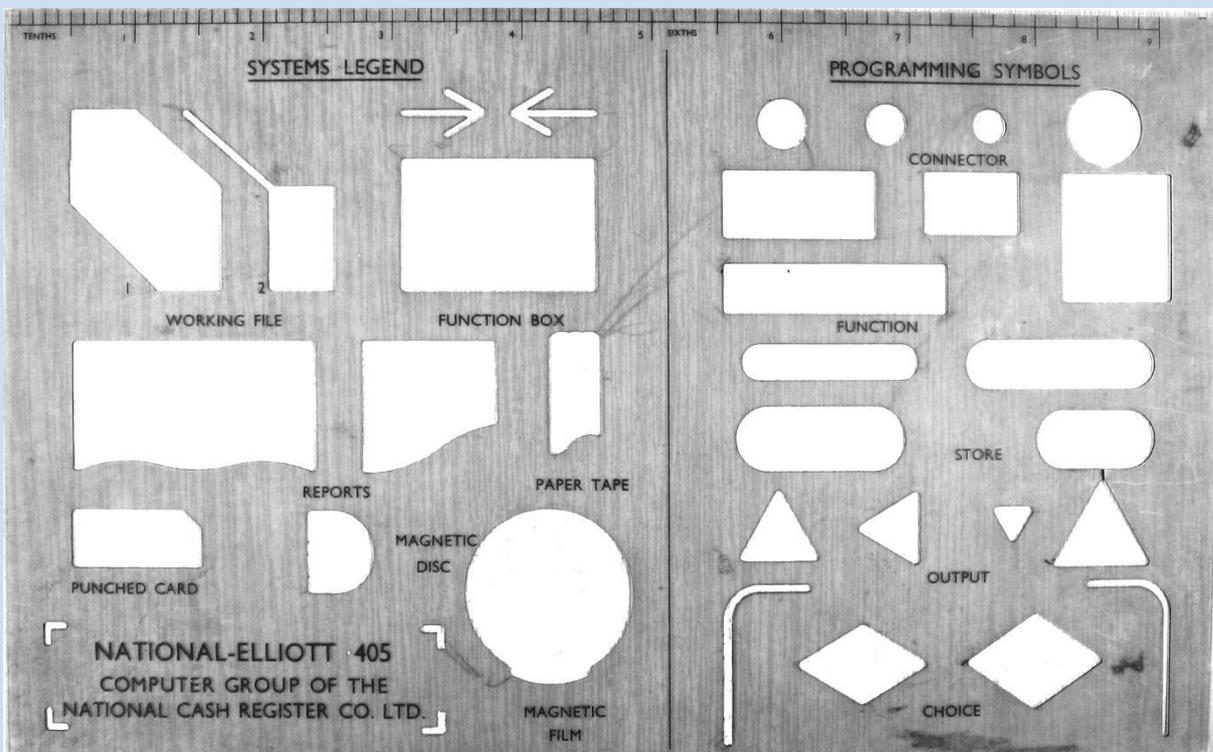


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Now I shall describe some of the practical aspects of my employment, to explain that developing computer programs had many physical aspects to it – I wasn't just sitting at a desk writing lines of code on a programming sheet.

How did we prepare a computer program at Elliotts? The first stage was to define the function of the program. This could be a very short process, as in the case of my 'fun' programs mentioned above, or for a commercial application, it could take weeks of investigation and discussion with the users of the eventual system. Such a system could require the specification of more than one program for a complete system.

But what about a single program? The first step was to draw a flowchart to enable the writing of the code to be undertaken more reliably than without such a logic chart; typically this would be a freehand drawing. The drawing might be produced very neatly at the end of a project, if required to form part of the formal project documentation.



The flowcharting template which I used

The programming symbols on the template were not entirely adequate. In particular, it was often impossible, because of lack of space, to express a clear question inside the tiny CHOICE diamond shapes, and I resorted to using the STORE symbols, sometimes much larger than on the template, for defining decisions.

The program code would be written on a set of blank program sheets, following the flowchart. Below is an example of half of one such completed program sheet.

NATIONAL-ELLIOTT 405 PROGRAM

SHEET 1 OF 2

TITLE AUTOMATIC TIMING ROUTINE  
LIBRARY ROUTINE 405 PT 02/DJP

PROGRAMMER D.J. PENTECOST.  
 DATE MAY 1961  
 COST CODE 310/833

DIRECTORY 192/400; @ cr lf bl BLOCK \_\_\_\_\_  
 LABEL \* cr lf bl SECTOR \_\_\_\_\_

PREVIOUS ADDRESSES	Address	F	A / B	F	A / B	NOTES
	192	8	0 3			Not in use
	193	11	1	8	210	ENTRY S-R(i)
	194	11	1	8	200	ENTRY S-R(ii)
	195		≡			Maximum estimated time = $T_{max} (\times 2^{-31})$
	196		≡			Actual time taken = $T (\times 2^{-31})$
	197		0			
202 →	198	11	1	3	220	
	199	9	245	8	207	Estimate too small
194 →	200	10	227	11	222	Store link of S-R(ii)
204 →	201	10	1	11	311	Measure $T_i$
	202	3	197	9	198	
	203	11	1	0	225	
	204	8	201			
	205			32		
	206		≡			$T_{max} -  T_{max} _{16} + 32 = N$ , number output
199 →	207	11	195	8	242	

(This is actually part of the program mentioned a few pages earlier for measuring the time taken for another program to execute). The full program sheets for the above program, the formal published specification of the program and other forms of the program can be seen from pages 16 to 25 on the website at

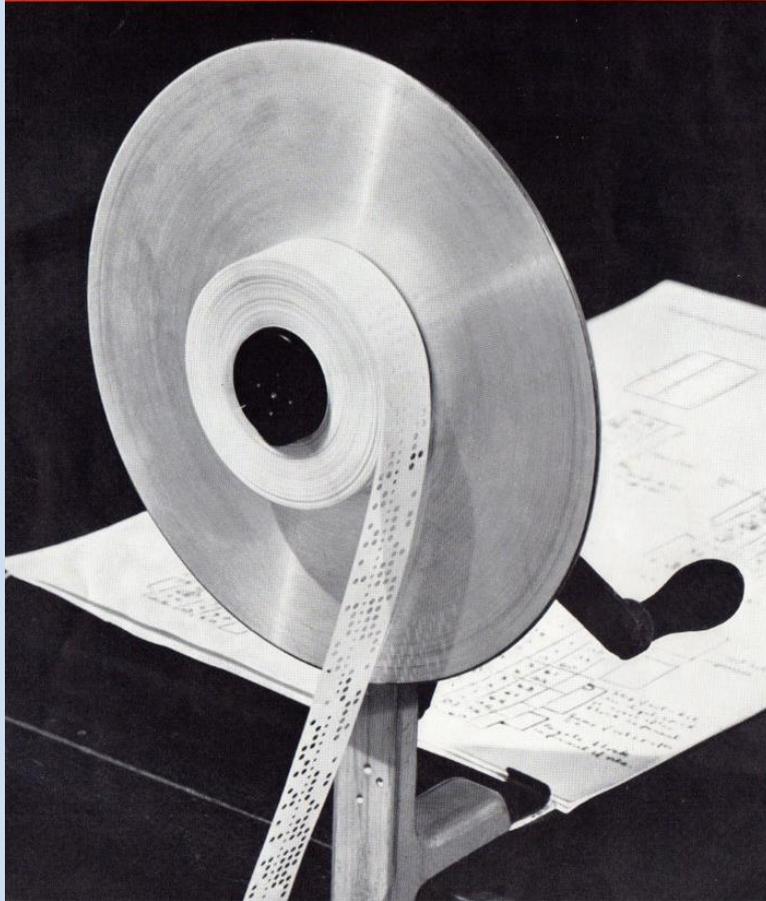
<http://www.ourcomputerheritage.org/ccs-e2extra1.pdf>

Once written, the program sheets were given to an operator in the data preparation room, which had about eight electro-mechanical machines, (manufactured by Creed as far as I recall). The operator would type from the written program sheets using a keyboard, and the machine would produce simultaneously a 5-channel paper tape. This would be the physical form of the program, which would be fed into the computer via a fast paper tape reader attached to the computer.

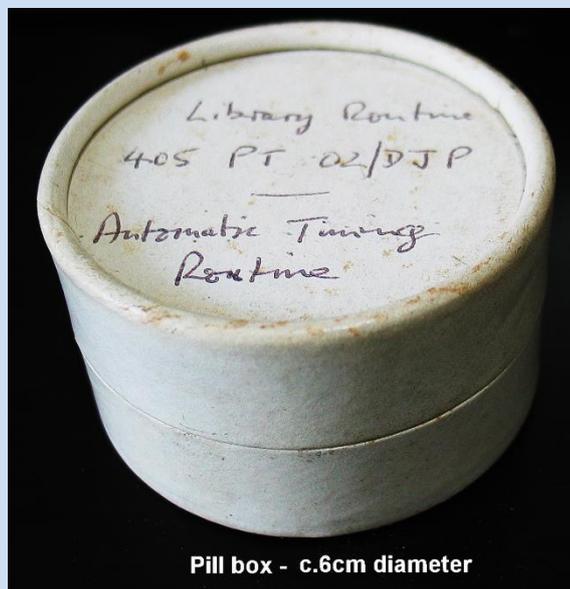
A newly prepared paper tape would emerge from the Creed punch machine, and fall into a large paper tape bin which stood on the floor next to the Creed machine. After completion of the paper tape, it would need to be wound up carefully, and for this, a hand cranked tape spooler was used. A photo follows, taken recently from an old Ferranti product manual:

### Tape Spooler—Hand-operated, Type A3

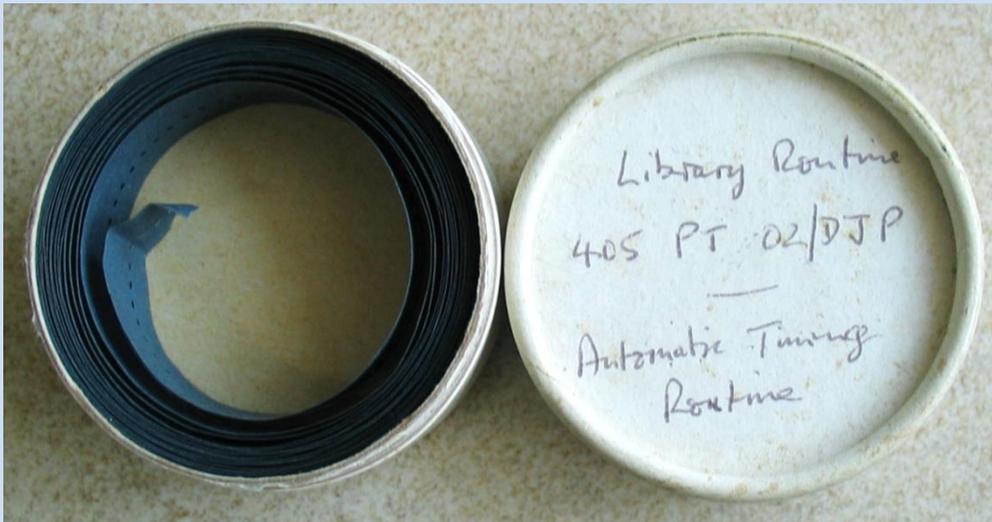
This device clamps on to the edge of a table, and is for spooling tapes direct from tape bins. It is supplied with one removable core (Type A5). The gears are so arranged that the spooling shaft and handle rotate in the same direction. It is recommended that there should be one near the computer, and at least one in the tape editing room.



The master copies of the paper tapes were stored in cardboard pill boxes, which were available in various sizes. Below are photos of the above program's pill box, closed and open, showing the dark grey paper tape curled up inside.



Pill box - c.6cm diameter



For my 'fun' programs, I would use a Creed paper tape punch machine to type the program, preparing the paper tape myself.

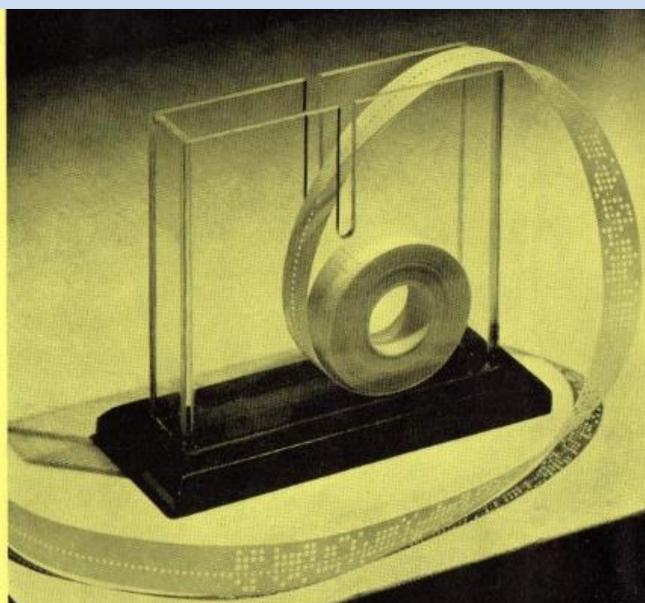
The paper tape would later be input to the computer by being fed through a paper tape reader. In 1962 I used a reader manufactured by Ferranti, which read at 100 characters per second. (Later, a much faster and more compact reader was manufactured by Elliotts, reading at 1,000 characters per second).

Paper tape read by a Ferranti or Elliott tape reader would have to be presented to the tape reader by a reliable method, so that it did not become tangled or torn. So it was suspended in a rectangular transparent perspex trough, from which it could be safely pulled and read at high speed. Below is an example from a Ferranti brochure, although the picture does not show the best method of using the trough, because the tape is shown resting on its base. At Elliotts, we suspended the tape from its centre using a short smooth metal rod which was lowered down the slit in the trough.

### **Tape Trough, plastic, Type A7**

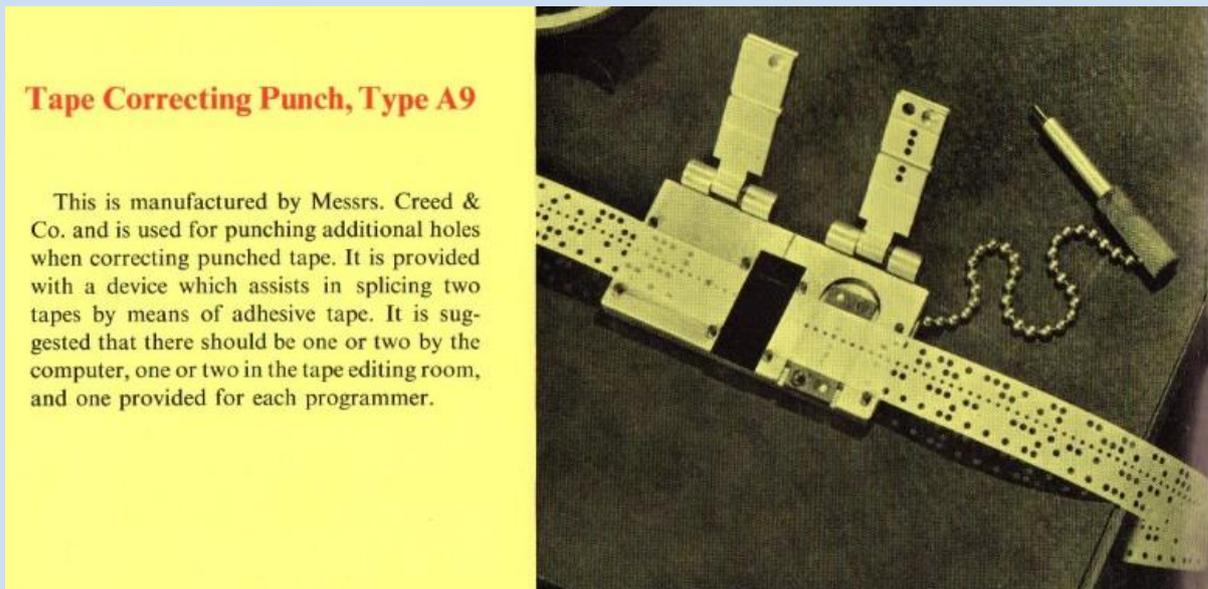
This plastic trough will hold spools of tape being fed into the tape reader of the computer or into the tape editing equipment. Spools of tape are usually dropped into this trough but, if the spools are very large, it is preferable to keep them in the tape boxes and place the boxes in the trough.

At least two tape troughs are recommended for each tape reader of a computer and three or four tape troughs for each set of tape editing equipment.



When testing a program, one would sometimes find an error on the paper tape. It could be a programming error, or an error in the original typing of the program. The standard way to deal with this, would be to feed the tape through one of the Creed machines, copying it up to the position of the error, type in the correction, and then reproduce the remainder of the tape. This was not a very quick process.

But occasionally it would be possible to correct the tape by a much quicker manual method in an emergency. There was a small device, which we called a uni-punch. One is shown below from the same Ferranti brochure, but they gave it a different name.



It is fairly obvious from the above photo, how it was used. A metal flap was closed over the centre of the device, thus covering a small part of the paper tape. This flap had 5 holes drilled through it; and so did the metal surface beneath the metal flap under the paper tape. With a piece of tape held firmly on the uni-punch, the tiny cutting cylinder (attached to the chain) was pushed through the metal flap, and down through the tape into the base of the uni-punch, thus cutting a tiny circular hole in the paper tape.

The by-product of this procedure was a tiny disc of paper tape, which fell from the bottom of the uni-punch. If necessary, this tiny disc could manually be placed into a hole in the paper tape to fill up an unwanted hole; one used the smooth top of a finger nail to smooth the tiny disc into place, first from one side of the tape, and then from the other side, with the tape firmly pressed on to a hard smooth surface. This second procedure of filling up a hole rather than making a new hole was not very reliable, and one had to check after using the corrected tape that the hole was still filled up. Such a tape could not be repeatedly used, and the standard reproduction and correction process would have to be used later, to create a permanent re-usable tape.

I had to do all the above tasks, especially when a program was being developed. After a regular job went into production, it was normally run by operations staff, and we programmers would normally only be called upon when a difficulty arose.

But the major stock control project was special. Each computer run could take many hours, and computer breakdowns were quite common. I sometimes had to take over the running of a long job, because operations staff had to go home, or for whatever reason, were unavailable. This did not involve just sitting at the console and reading a book whilst waiting for a job to finish. The computer had to be monitored in several ways.

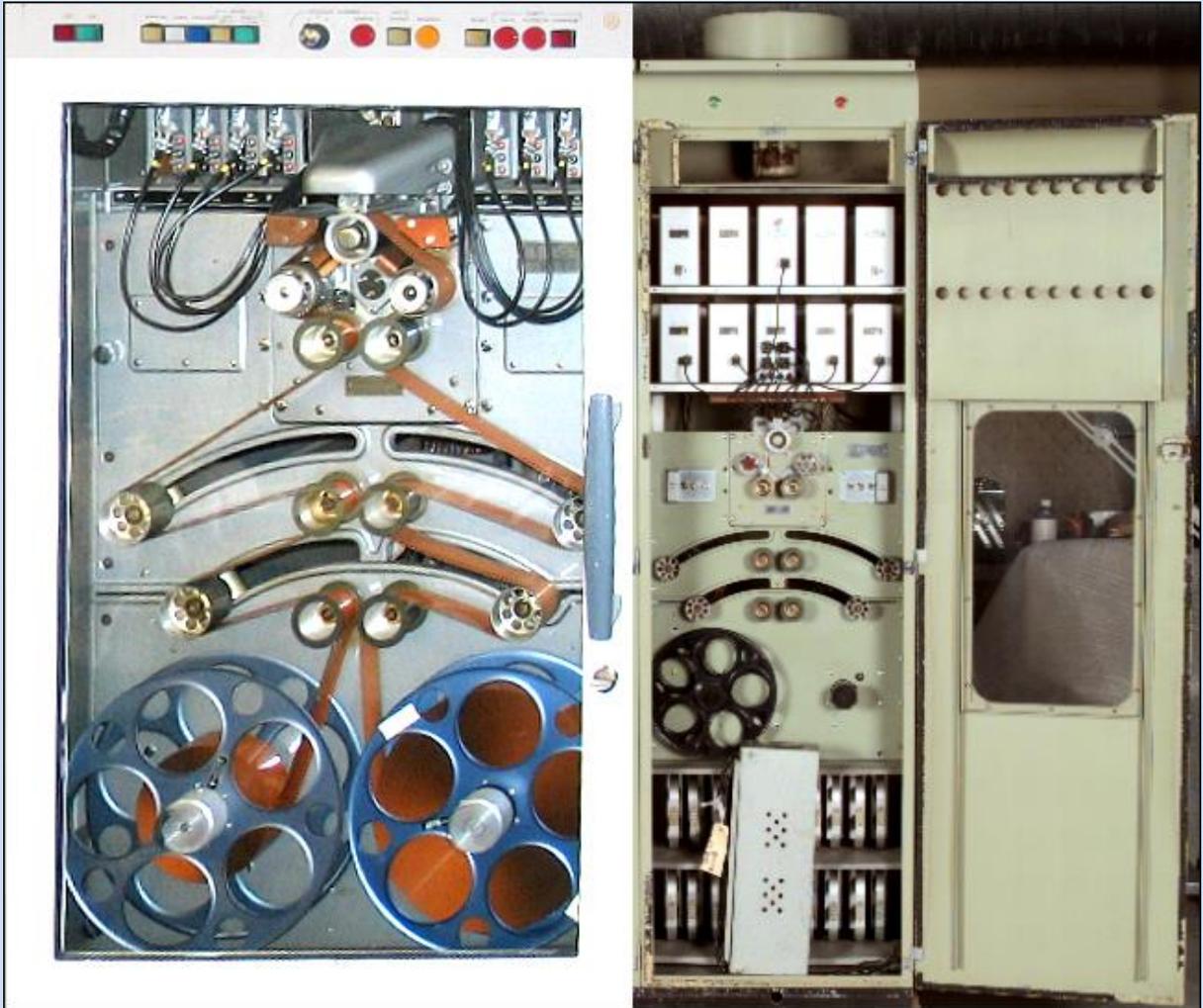
Each computer program had its own normal audible and visual characteristics, which one learned to recognise by sounds coming from the loudspeaker, and from the pattern of flashing lights on the console. A change in these signals could indicate that a problem may have arisen; a program might have ceased running, or it might be “going round in circles” abnormally.

Large scale data was stored on very long reels of 35 mm magnetically coated film, a medium which had been developed originally by Disney Studios for sound recording. Elliotts had I think decided to use this medium for storing data partly because of its strength, and because of its easy availability: the Elliott offices were very close to the Elstree and Borehamwood film studios.

(One of the film sets was next to Elliott’s car park opposite its main building, and sometimes I would walk over to see what was being filmed; I remember seeing on one occasion, small models of warships on a lake, which were being filmed as real warships).

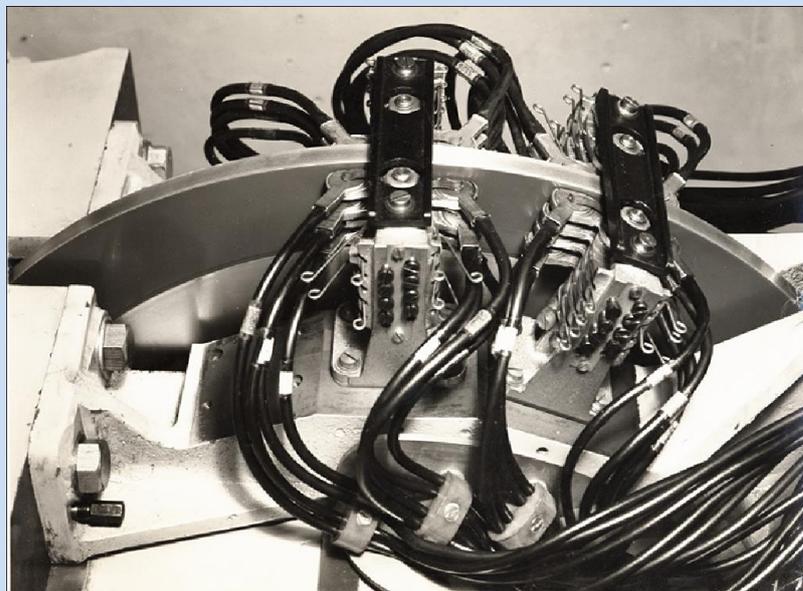
On the left side of the next page, is the only photo I have found of one version of an Elliott magnetic film deck, showing how a reel of film was wound around the servo mechanisms.

The servo mechanisms on the 405 (I do not know about on the 803) had a tendency to ‘drop out’, leaving the magnetic film slack, instead of taught around all the small metal reels. Anyone running a lengthy job on the 405 had to keep an eye on the film mechanisms, for early warning signs of the film’s becoming slack. A simple adjustment of a screw would enable the mechanism to be tightened up a little. That is one of the jobs which I did from time to time.



On the left is a film deck on an Elliott 803 computer. The mechanism is essentially the same as that on a 405 computer, which is shown on the right, but on the left you can see how the film was wound around moving servo mechanisms. The read/write head for transferring information from/to the magnetic film is above the topmost central circular mechanism. The 803 unit shown above, is held at the London Science Museum, and the 405 film unit is part of the computing equipment held at the Powerhouse Museum in Sydney, Australia.

Another important task was to monitor the state of the high speed disc. A photo of part of a disc unit is below.



You can see the top of the disc in the photo above. It revolved at very high speed, and from time to time we had to check the oil level and temperature to make sure that it was in a safe range; I have forgotten the exact temperature figures but they were something like 24-26c.

On one occasion, during early testing of the unit in the 1950s, the engineers did a safety test, deliberately speeding up the disc above its rated revolutions per second. The disc exploded, and parts of it penetrated a 23cm thick brick wall. The story of that test was passed down to 405 operators in subsequent years, and one or two were a little nervous, because the chair at which they sat in front of the control console, was directly in line with the revolving disc. I did not worry about it, but I was careful to check the disc regularly.

Computer programmers/operators who have worked in computing for many years, seem to have a favourite computer on which they worked, and often this is one of the early machines in their careers. Certainly for me, the Elliott 405 was my favourite, and the one about which I remember the most details. It had to be 'nursed along', sometimes, and one experienced a sense of triumph when a job completed successfully.

I am no electronic engineer, but I had watched engineers working on the computers, and I did learn enough to be able to deal with some problems. I remember that during one very late evening, the computer failed, and there was no engineer available. I was able to trace the fault to one section of fast memory. Memory was stored on what were called nickel delay lines, and at the back of part of the computer was a bank of such delay lines, each one with a handle, which was there to enable the unit to be pulled out. I first switched the computer off. Luckily there was a second 405 computer, switched off, next to the one I was working on, so I pulled out the same delay line from the second computer and installed it in the first computer. That solved the problem, and I completed the job.

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To conclude this section of my work at Elliotts, readers may wonder about the monster computers of the 1950s, and wish they could see one functioning. Well, there is a short film available at the Yorkshire Film Archive, which in 2018 was available to see.

The film was made in March 1959 depicting the delivery, installation and later subsequent use of the 405 installed at Reckitt's in Hull. The film was viewable by visiting [www.yorkshirefilmarchive.com](http://www.yorkshirefilmarchive.com), and then doing a search using the term: NATIONAL 405 computer. Alternatively search Google for Yorkshire Film Archive, and do the same search. The film lasts for 13 minutes 38 seconds.

Unfortunately there is no sound track, so I have written a summary of the events shown, indicating the start time in minutes and seconds of each event. It is interesting to note not only the considerable logistical task of installing a business computer in the late 1950s, but also the rigorous method of data preparation,

involving not just initial keying in of the data, but also its re-keying for verification, which was standard practice. *(In February 2011, the written commentary on the YFA website was inaccurate and incomplete).*

Here is a correct commentary on the events depicted in the film:-

- 9" General view of the computer, and then a paper tape being punched out, announcing the film, saying "N E 405 AT RECKITT'S".
- 35" Three delivery lorries from Bullens arriving at Reckitt's premises
- 1'12" Unloading the computer begins
- 1'36" The control console of the computer
- 1'44" Part of the air conditioning unit.
- 1'51" Some of the main cabinets being unloaded
- 2'41" A set of magnetic film cabinets being moved into the building.
- 2.54" Installing the memory, logic and film unit cabinets
- 3'27" The magnetic disc unit, and examination of same.
- 4'05" Installing the magnetic disc unit
- 4'48" Attending to circuitry
- 6'07" Connecting under-floor cables
- 6'15" The alternator set and control unit being lifted into the building
- 7'50" Engineers at work; the cabinet of equipment in front of the engineer in the foreground, is a standard 405 engineering test rig.
- 8' Operating the console to load a paper tape (probably containing a computer program) into the computer
- 8'15" At the console controlling the operation of a program.
- 8'35" Four men at a meeting
- 8'45" Entrance to the programmers' room
- 8'49" Chart analysing processing of daily cash
- 8'59" A programmer at work
- 9'26" Stage 1 of preparing numeric input data on a Creed paper tape punch machine.
- 9'50" Close-up of the paper tape punching mechanism

9'59" Verifying data – stage 2 of data preparation. The tape punched previously by the first operator is being read by the machine to the right of the keyboard, as the second operator keys in the same data again. If the machine detects a difference between what she types and the data already on the paper tape, the operator is warned, and she makes a correction if necessary. The corrected paper tape is punched out on the machine to the right of the picture, and is then ready for input to the computer.

10'56" Collecting the input documents and the paper tape prepared from them

11'04" Putting the data tape into the Ferranti paper tape reader

11'20" Starting the program which inputs the paper tape data. The tape falls into a large bin, from which it is subsequently retrieved and rolled up into a reel, using a manually operated tape winder.

11.26" One of the magnetic film mechanisms, either reading a file of data or writing an updated file of data

11'34" The computer is punching out information on a Creed paper tape punch

11'39" Off-line Creed equipment. The computer has been instructed to print out one of its programs on the paper tape, which is now being read by the paper tape reader on the left, and the program is being printed at the typewriter at the right of the desk.

11'54" Some of Reckitt's processed business information has been punched out by the computer on paper tape, and this is being read on the left of the picture by a paper tape reader. At the same time, the data being read, is printed out by the printer on the right. This data comprises order forms with lists of different products, quantities required, their unit prices (in old pence), and the amounts due (in £ s d).

12'22" Loading a magnetic film containing a file of data produced by the computer for subsequent printing. This is a separate piece of computing equipment, not directly connected to the main computer. Its function is to read large quantities of data from the magnetic film, and transfer the data to a line-at-a-time printer.

12'34" Operating the control console of the line-printing system to start the process of printing data from the magnetic film.

12'53" Printing business records on the line-printer on continuous stationery. The printer is thought to be a Bull line-printer, manufactured by the French 'Compagnie des Machines Bull'.

Chapter 4: MILLS ASSOCIATES LIMITED & ISIS

# MILLS ASSOCIATES LIMITED

*Registered Office:*  
WOODSIDE HOUSE, THE GREEN, WINCHMORE HILL, LONDON, N.21  
Telephone FOX Lane 0956

*Temporary City Office:*  
10, MINORIES, LONDON, E.C.3  
Telephone ROYal 4272

DMM/VGS/P

27th September 1962.

D.J. Pentecost Esq.,  
Torrington Cottage,  
Church Path,  
Lodge Lane,  
Finchley, N. 12.

Dear Mr. Pentecost,

I thank you on behalf of my brother for your application to join this Company. The salary we can offer is £1300. per annum.

With regard to the other points in your letter, there will be no objections, as we like to give our Senior Personnel as much freedom from administrative restraints as possible.

If you have any questions, I suggest you talk with Cedric or Pat. Also, could you give me an indication of your date of starting?

On behalf of the Company, I extend the hope that your career with us may be long and mutually satisfactory.

Yours faithfully,  
MILLS ASSOCIATES LIMITED



D.M. Mills  
Secretary.

DIRECTORS : - R. G. MILLS - A. J. BURTON - B. KENDALL -

Patrick Shackleton was to play a significant part in my early career development. (There is an appreciation of him at <http://www.advinfo.co.uk/patrick.html>, although a few details are not quite accurate). He was persuaded to leave Elliotts by R. G. (Gerry) Mills, who had been a programmer and later Elliotts' Sales Manager. Gerry

Mills, a decade older than me, was a hugely dynamic and brilliant man and he had set up (I think late in 1961) Mills Associates Ltd, a software development company, based temporarily at 10 The Minories on the eastern edge of the City of London. Shackleton joined Mills in the autumn of 1962 after Gerry Mills moved the company to Ship Tavern Passage, right in the heart of the City.



Ship Tavern Passage, probably in the 1950s (from Gracechurch Street)

The premises were on the first and second floors of a small building, right above the shop on the right with the arched entrance, in the above photo; in 1962 that shop was a coffee house/tea room. My office was on the first floor, in the photo shown apparently directly above the circular book shop sign. The premises were demolished and are now occupied by part of a chain of shops, I think Marks & Spencer. In the 1960s one could walk directly through Ship Tavern Passage under the first floor of the building in the background in the photo, into Lime Street, (which

is just visible in the photo). But this direct route to Lime Street no longer exists, and one has to turn left and then right to reach Lime Street.

At about the time when Shackleton left Elliotts, he asked me to join him at Mills Associates. I had been taken on at Elliotts a year or two before, as a junior programmer at a salary of £550 p.a. I was earning about double that by September 1962, as a senior programmer, and Shackleton had negotiated for me a starting salary at Mills Associates of £1,300 p.a. He told me a few months later that he regretted not having made it £1,500. I think he said that, because more members of staff had by then been recruited, mostly from ICT (International Computers and Tabulators) in Putney, and at least one employee was being paid about £1,500. Anyway, my pay was raised later. £1,500 for a young man in those days was a high salary, and I was delighted with it. It enabled me to buy, around 1964, a second hand two-tone green Riley 4/72 car for £650, which I used to drive to the City each day; in those days it was possible to make the journey from Finchley, using some backstreets, in a reasonable time. Mills had made an arrangement with a local multi-storey car park, for us to use some spaces free of charge.

Gerry Mills had persuaded another Elliott employee, Cedric Dennis, also to leave Elliotts. The exodus of staff from Elliotts to Mills, caused a row between the two companies, and I think Cedric had to leave Mills Associates. Cedric knew one of the senior secretaries who worked at a firm of accountants near Liverpool Street Station, called Prince, Simon & Co. It was through Cedric, that Mills Associates gained a contract to assist Prince, Simon & Co. in the launch of a new unit trust called The Property Share Unit Trust. Mills Associates had to develop software in a hurry, to enable the unit trust administration to be computerised. I think it may have been the first unit trust in the UK to make extensive use of a computer system. I was put in charge of a small team, reporting to Shackleton (who had defined how the computer system would work), tasked with the software development – my first experience of being in charge of other people.

The unit trust software was to run on a service bureau computer at the premises of De La Rue Bull, who had offices in Southampton Row. (For use of the bureau, we negotiated with the managing director, Ian McNaught-Davis, who was also a well-known mountaineer. He later became a TV presenter, best known for presenting the BBC television series The Computer Programme, Making the Most of the Micro and Micro Live in the 1980s). I had the use of Mills Associates' bright yellow Triumph Herald, to travel to and from Southampton Row. The computer was known as the Bull Gamma 30, but it was in fact an American machine called the RCA 301. It was marketed in France as the Gamma 30, and in the UK as the ICT 1500. That computer was to form the basis of all software development in Mills' office in London. My small software team was only one of two or three teams of programmers in that office; they too worked on writing software for other projects to operate on the ICT 1500, which was becoming a popular computer.

I have mentioned Mills' London office. The company had also set up an office in Monmouth, where Gerry Mills was mostly based, and for which programmers were

recruited locally. The major project in Monmouth was providing support for a Welsh steel company; Mills bought an Elliott 803 computer in 1962, and set up a service bureau in Monmouth, providing services for the steel company. At least one other office of Mills Associates was later set up, in Hemel Hempstead, which I think was still operating in the 1990s. The Elliott 803 became the best-selling UK computer, and over 200 were installed between 1962 and 1966. Mills Associates bought two 803s. I attended an 803 programming course whilst at Elliotts, but I did not have the opportunity to develop any software for that machine.

My unit trust project had a deadline to meet. The Property Share Unit Trust was scheduled for launch to the general public in March 1963, via advertisements in national newspapers, where application forms to buy units were printed. Prince, Simon & Co. had set up a company called Unit Trust Services Ltd, to administer the unit trusts which they planned to launch.

Over 4,000 application forms were completed and posted to the offices of Unit Trust Services (UTS), which were at 16 Coleman Street, just off London Wall in the City. (I seem to remember that the exact number was 4,124).

The units were priced for the launch of the unit trust at 5/- (five shillings - 25p today) each, with a minimum purchase amount of £50, i.e. 200 units. The offer of units to the public was known as a 'block offer', and the advertising would announce the availability for sale of a block of, say, 2 million units in the trust.

For a period of one or two weeks, post arrived at 16 Coleman Street, containing the completed small application forms cut from the newspapers, with cheques in payment. The applications came either directly from the investing public, or from banks and other professional organisations who were acting as agent for the applicant. In the latter cases, the agent's stamp had been applied to the form. UTS staff had the task of checking the validity of the forms and cheques, and banking the money. Mills Associates' office and the UTS office were not far away from each other, and I worked closely with the UTS staff and with the data preparation staff, supervising the technical aspects of the processes involved.

The processes are described in the article below, which I wrote for the magazine Data and Control, published in June 1963. (I did not choose the awful title or write the text at the top of the second page).

In the first of the three magazine pages below, the photo shows the Gamma 30 computer at De La Rue Bull's service bureau in Southampton Row, which was close to the Bonnington Hotel which is still there today. Coincidentally I recognised one of the staff there (shown in the photo), as Rupert Bayfield, who was a schoolmate of my brother Edward. In the second of the three pages, the girl in the photo is one of my team of programmers – Rosemary Sibley. She was one of several staff recruited by Mills from ICT in Putney.

# SURMOUNTING THE PEAKS

## *in data processing demands*

**I**N November 1962 the Computing Service department of Mills Associates Ltd was commissioned by Unit Trust Services Ltd to formulate a system for the administration on a computer of the Property Share Unit Trust.

They undertook the system specification, the writing of programs, operation of the computer for production runs and the handling of output documents. The system design and program writing and testing for the block offer were completed in three months by a staff of three. Punching of the input data on paper tape was carried out by Datacentre Ltd.

The machine chosen was the Gamma 30 computer in the London Service Bureau of de la Rue Bull Machines Ltd; this computer is now being used in the administration of the Trust.

### **THE BLOCK OFFER**

The block offer of Trust Units was advertised nationally, and over 4,000 applications for units were received.

Throughout the period of the offer, between the 21st and 29th March 1963, data was punched on paper tape each day and was processed by the computer during the same evening. At the end of the period further operations were carried out for the production of the main results.

The output comprised:

- |                               |                         |
|-------------------------------|-------------------------|
| 1 Proof lists                 | } each day of the offer |
| 2 Acknowledgment postcards    |                         |
| 3 Cash list analysis          |                         |
| 4 Issued Sheet No. 1          |                         |
| 5 Certificates                |                         |
| 6 Name and address labels     |                         |
| 7 Register Sheet No. 1        |                         |
| 8 Advertising analysis        |                         |
| 9 Agents' commission reports. |                         |

*The Gamma 30 at De La Rue Bull Machines Ltd London Service Bureau in Southampton Row. This American designed computer is now being manufactured in Bull's recently opened factories in the Loire valley.*



Any business which experiences irregular peaks when large volumes of information need rapid and accurate processing may have a need for a bureau computer.

Unit trusts experience such a need. They are also committed to heavy bills for duplicated printing which is enforced by statute. Unit Trust Services Ltd have overcome these and other snags in administering a nationally advertised block off of trust-units by using a Gamma 30 at the De La Rue London Service Bureau.

#### DATA INPUT—NO VERIFICATION

As the application forms arrived, they were inspected, allocated a serial number (later to be used as the certificate number), batched and totalised by the managers on cash lists for banking purposes; this totalising also served as a check on computer accuracy at later stages of the process. The forms were then edited if necessary before being passed to the punch operators.

The data punched from each application form consisted of:

- Serial number
- Number of units applied for, and amount of money (for reconciliation)
- Name and address of applicant
- Newspaper advertisement code
- Names of joint applicants, if any
- Name and address of agent, if any.

The apparently risky decision not to follow the punching of paper tape by verification was taken for the following reasons:

1. The techniques for verifying paper tape are only satisfactory if the data is clearly transcribed on to properly-designed punching documents. By contrast, the unit trust data is mainly handwritten by private individuals on pieces of newspaper and consists of variable length alphanumeric fields. Transcription of this data on to special punching documents would have been too time-consuming, and transcription itself would have introduced errors.
2. To an auditor, the mere existence of a paper tape, albeit a verified tape, is not sufficient proof of the accuracy of the data on it; still less is the existence of a magnetic tape produced from the paper tape. It is therefore necessary to prove that the data is correct, when it is actually stored on the magnetic tape file.

#### INSTEAD OF VERIFICATION . . .

1. Every possible automatic check on the data was included in the programs.
2. Input was stored on magnetic tape files, initially on an 'unconfirmed' file and subsequently on a 'confirmed' one, data being copied from the one to the other only on receipt of a positive instruction from the Trust Managers' staff after they had examined the proof list, this being a print-out from the unconfirmed file of the input data (see next section).
3. The input each day was therefore of three types:



*'The Share certificates for Unit Trust Services Ltd being printed on the Gamma 30 Analex line printer. Computer bureaux are providing economical solutions to many one-off or peak processing problems.'*

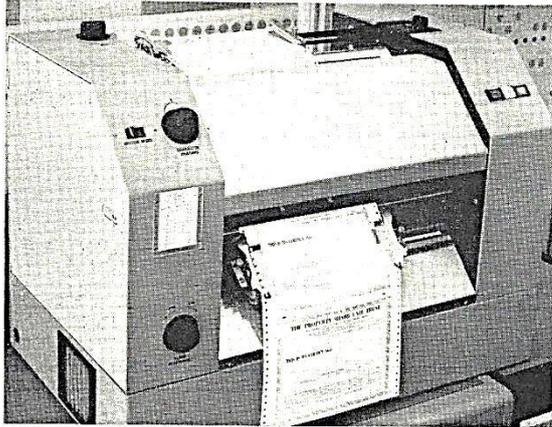
confirmations of previous input, corrections of previous input, and new applications from the public. The total amount of data repunched as corrections was 20 percent of the data punched as new applications.

#### OUTPUT—PROOF-LISTING

The two kinds of output printed each evening during the block offer period were postcards acknowledging receipt of the applications, and a proof list.

The computer printed the names and addresses of the applicants on the postcards, which were franked and posted next day, one day after receipt of the applications.

The proof-listing process replaced the conventional system of data verification before input. The proof list is simply an orderly print-out from the unconfirmed magnetic tape file of the data on the input paper tapes; it also contains indications of all errors detected by the computer during input. Each day the proof list has to be inspected and compared in detail with the application



*Proof lists and acknowledgment postcards and cash list analysis were printed out during the evening for all applicants. The final share certificates were printed at the end of the period.*

forms. The incorrect records are then re-punched and input again on the next computer run before the normal daily input of new applications; the computer uses the serial number to identify the records on its existing file which have to be corrected.

#### **SORTING**

After the block offer closed, and all the applications had been stored on a magnetic tape file, the computer sorted the file by unit-holders' names into alphabetical order. A sorting key was constructed by the computer from the name of each applicant during the input process and generally this consisted of surname followed by fore-names. Special sorting keys were formed for peculiarities such as double-barrelled surnames, names of organisations, etc.

#### **ALLOCATION OF ACCOUNT NUMBERS**

The computer then allocated an account number for each applicant; thus the present file is in both alphabetical and account number sequences; the account numbers have been distributed throughout the range of numbers one to one million so that details of new unit-holders may be inserted into the file without upsetting these sequences. The account numbers provide an easy and accurate method of referring to the details of any unit-holder's transactions, and have been chosen in such a way as to reduce the danger of reference to a wrong record on the file. The accidental alteration of any one digit of an account number, or the transposition of any two digits, is always detected by the computer, and 92 percent of other errors are detected.

#### **MAJOR OUTPUT**

The file was now ready for the major block offer output programs to be obeyed. The first of these programs printed copies of the Issued List, being a print-out from the file of names, account numbers, certificate numbers

Paper tape punching without verification, as input to a computer system is economical despite the high cost of computer time—this is one of the main practical points which Unit Trust Services Bureau application has made clear.

and the numbers of units held; this list is required by the Inland Revenue, the Trustees and the Trust Managers. Next the certificates were printed; in the cases where one person had made more than one application for units, the applications were amalgamated, and only one certificate was printed. Sheets of labels bearing names and addresses were produced for posting the certificates to the unit-holders. These printing operations occupied a total of about two hours' computer time.

#### **ANALYSIS**

An agents file was then constructed from the main unit-holders' file, consisting of the selected records of all applicants whose purchases were conducted through agents.

At the same time, a table of totals was formed of the number of applications and number of units purchased for each occurrence of a distinct advertisement code; this table was output to show the proportion of investment obtained through each newspaper and journal in which the application forms were published.

Finally the agents' file was sorted by agent's name and address; the resulting sorted file was then analysed and a list printed of all applicants for each distinct agent. Each agent receives commission, being a percentage of the total value of the units which he purchases for his clients; this commission was calculated and output.

At any stage after completion of the input (for example before or after sorting, before or after account number allocation) it is possible to perform a cash list analysis on the file. This shows the number of certificates and total number of units for each of the cash list batches which were prepared manually before input.

#### **FILE MAINTENANCE**

The unit-holders' file is being maintained on an historical basis, records being stored of all transactions, *ie* sales, purchases and amendments (such as changes of address). Computer runs to update the file may be carried out at any time, but initially are to be monthly.

Details of all transactions are input, and cause output of a new register sheet for each unit-holder concerned. The new register sheet shows not only the current transaction, but also all previous transactions.

If the transaction is an amendment, the only resulting output is the register sheet; sales by unit-holders are shown on the Cancelled Sheet, which lists all such sales since the previous computer run. Purchases by unit-holders produce two kinds of output: certificates and an Issued Sheet, which shows all units issued since the last computer run.

The programs also make provision for administering a Savings Scheme for unit-holders who wish to invest amounts regularly. The savers' account numbers and amounts invested are the computer input each month, with a Savers' Allotment Sheet as output, which lists all units allotted to savers. Every six months, a certificate is output for each saver for the total number of units allotted to him throughout the previous six months.

Each year the computer analyses all units by the date on which they were issued, in order to produce the grouping which distinguishes capital from income; this is necessary for calculation of the dividend. The computer is used to print a dividend warrant and a counterfoil for each unit-holder.

#### **DATA AND CONTROL**



Unit trusts became very popular with the public as investments over the next several years, and new unit trusts were set up, not only by UTS, but by other unit trust management companies, and by the big banks. Prince, Simon & Co's unit trusts were in due course put under the umbrella of Target Trust Group, but were still administered by Unit Trust Services Ltd. Some companies wanted to set up their own unit trusts but did not have the experience and skills or computer systems to carry out the administration themselves, so UTS began to bid to carry out the work on their behalf. I recall three of these companies immediately: one was Slater Walker, who had a huge reputation nationally and in the City as financial whizz kids; another was one of the 'big four' UK banks, (whose identity I had better not reveal, and will refer to from now on as Bank X) who were to set up more than one unit trust; and the third was the Trustee Savings Banks organisation (TSB).

Whilst at Mills Associates, I worked closely with UTS for about two years. Then Gerry Mills closed his London office, and arranged for the staff from that office to become employees of International Shipping Information Services Ltd (ISIS), as from 26th May 1964. ISIS had set up a computer service bureau, a few yards from Ship Tavern Passage, at Forum House, 15-18 Lime Street, which still exists today, although it has been extensively modernised:



**Forum House, 15-18 Lime Street, August 2018**

I visited Forum House whilst on holiday in August 2018, where the above photos were taken. When I worked there, on the left, inside the entrance hall, stood the building's liftman, who always had a cheerful smile on his face; he opened the noisy folding metal gates, and took us up to whichever floor we wanted.



In the photo above, (from Google, September 2018) you can see Forum House on the left, and a clothing shop on the ground floor, which in the 1960s was our computer bureau, which could be seen through the windows. It was possibly the first such bureau in the City of London.

In June of 1964, I, with all other Mills Associate shareholders, was obliged to sell my shares back to the company's founders, for £3 per share, which must have meant that I made a profit of £2 per share. How many shares I had bought on joining the company I do not remember, but it was probably not more than 250.

We moved into the Lime Street premises, where an air conditioned computer room had been constructed for an ICT 1500 computer, as the workhorse for the ISIS bureau. The unit trust computer systems thenceforth operated from Lime Street, rather than from Southampton Row.



Next to Forum House, you can see in the three photos above, a pub called The Grapes. In the 1960s it was known as The Bunch of Grapes. Inside it has barely changed at all. The black and white photo is said to be of some bankers in the pub, possibly in the 1960s, and next to it, is me in August 2018. Some Mills Associates and ISIS employees used to frequent the pub; I joined them occasionally, but rarely drank anything alcoholic.

ISIS were developing a system to create and maintain a register of international shipping, (based on Lloyd's Register of Shipping which had been published since the

18th century) and to make the database available to anyone in the shipping industry, to enquire about any registered ship, for a fee. I was not involved in this system, and a lot of effort was put into developing it, but as I recall, there seemed to be no real market for the services. ISIS was I think in financial difficulty as a result, and was taken over by the nearby British and Commonwealth Shipping Company (B&C).

Over approximately the next year, I undertook the task of writing a major element of B&C's payroll system, which they wanted to have computerised, to run on the ISIS computer. I was part of a team of five or six people. I spent a good deal of time at the nearby B&C offices, specifying how the hugely complex, antiquated and sometimes illogical payment rules, (which had developed over many years resulting from negotiations with ship workers' unions) could be specified for programming.

At some point, the systems and programming staff, including me, moved out of the Lime Street offices into premises, newly built, or perhaps just refurbished internally, just south of the Thames, at 67 Southwark Street, at the junction with Lavington Street. The computer bureau and the operating staff remained in Lime Street. A photo of these Southwark Street offices is below, taken by Google in July 2016; extraordinarily, by September 2017 the building had either been stripped to its steel and concrete frame, or demolished, and a new building was going up.



67 Southwark Street

Around the middle of 1966, I started looking around for another job, and on 21st October I had an interview in London for a job in Toronto, Canada, with the Canadian Imperial Bank of Commerce.

CANADIAN IMPERIAL  
BANK OF COMMERCE

HEAD OFFICE  
TORONTO, CANADA

K. H. CUTT  
ASSISTANT GENERAL MANAGER

27th October, 1966

Mr. D.J. Pentecost,  
1529, High Road,  
Whetstone,  
London,  
N.20.

Dear Mr. Pentecost,

Referring to our discussions of October 21st, I would like to offer you a position as systems analyst with Canadian Imperial Bank of Commerce at a starting salary of \$9,000 per year with a review in six months. It is also to be understood that we will reimburse you for travel expenses for you and your family - air travel, economy class.

The above arrangement is subject to satisfactory references and an acceptable medical report. We will advise you later in connection with the medical. It is also a condition of this offer that your term of employment with us will be a minimum of three years.

To accept this offer, please sign and return the copy of this letter. Also, please complete and return the two enclosed forms in the envelope provided.

Yours truly,



K.H. Cutt,  
Assistant General Manager.

As can be seen in the letter above, the bank subsequently offered me a post, for a minimum period of three years, as a systems analyst at a starting salary of C\$9,000, with a review after 6 months. I decided not to accept the job, for reasons which I cannot now remember, but perhaps because of the uncertainties involved, and perhaps because of the minimum term of three years, during which period housing would have to be arranged.

## Chapter 5: DATACO LIMITED

Early in 1967 I was continuing to seek other employment, and I arranged to be interviewed on 3rd March at ICT's offices near Putney Bridge. On 22nd March I received from them a job offer as a software planner at £2509 p.a., and I replied that I was almost certain to accept the offer, but had to await the outcome of another possible job interview. On 30th March I wrote, declining the ICT offer.

<u>CONTRACT OF EMPLOYMENT</u> <u>DATACO LIMITED</u>	
<u>DAVID J. PENTECOST</u>	
The general conditions of employment will be as follows:-	
<u>Nature of Employment</u>	CONSULTANT
<u>Salary</u>	
£2700 per annum paid monthly in arrears.	
<u>Holidays</u>	
The normal holiday entitlement will be three weeks, exclusive of public holidays.	
<u>Hours of work</u>	
The work week, Monday to Friday, will be of 37½ hours duration and between the hours 8.30 a.m. to 6.30 p.m.	
<u>Pay During Sickness</u>	
In the event of sickness or incapacity the Company will, on receipt of satisfactory medical certificates, make payment as follows:-	
1. For the first six weeks in any year - full pay less any National Insurance Benefit received.	
2. For the second six weeks - half pay less any National Insurance Benefits received.	
3. For any further absence - to be dealt with at the Company's discretion.	
<u>Confidential Information</u>	
All matters connected with the Company's business and that of its clients will be treated as strictly private and confidential and not disclosed to any third party.	
<u>Termination</u>	
This contract may be terminated by three months' written notice on either side.	
Employee's signature	<u>D. J. Pentecost</u> .....Date <u>3rd April 1967</u>
For Dataco Limited	<u>[Signature]</u> .....Date <u>31st March 1967</u>

One of my colleagues at Elliotts had been Harry Lawrence, who much later moved to live in the USA, I think in Boston. An attempt had been made by Gerry Mills to

poach him away from Elliotts, but the attempt was blocked by Elliotts. Harry left Elliotts, and I am not sure where he went, but at some later date, possibly late in 1966, I became aware that he had a consultancy company called ELF, somewhere in the north of England.

At the time when I was applying to ICT in Putney, Harry called me one day out of the blue, offering me a job with Dataco Ltd, a company set up I think by Patrick Shackleton, with Harry having been appointed Managing Director. I accepted the post of Computer Consultant at £2,700 p.a. I cannot recall exactly where their office was – but it was in the Clerkenwell district of London. The company went into liquidation in October that year, and I cannot recall having achieved anything positive during that five month period, except to define for the company the format of computer program specifications which we would all adhere to. I do recall having attended some meetings with Shackleton or Harry at potential clients' offices, to bid for a few new contracts, but we did not succeed in winning any of them as far as I can recall.

## Chapter 6: UNIT TRUST SERVICES LTD (UTS)

I had holdings in a few unit trusts run by UTS, and one day, in October 1967, before Dataco liquidated, I had a problem regarding one of my holdings, which required me to telephone the UTS office manager, whom I knew. He responded by inviting me to come to 16 Coleman Street – a small building which no longer exists. I gathered that at some point in the previous two years, they had moved their unit trust work away from the ISIS bureau, to another bureau, ITT Computer Services in Cockfosters, which had redeveloped the unit trust software, to perform on an IBM computer almost exactly the same functions as the system which I had been in charge of developing, and which had operated at ISIS and earlier at another bureau.

Michael Prince, the Managing Director of UTS, wanted to talk to me whilst I was at 16 Coleman Street, and he explained that UTS needed a better system to produce contract notes for the sale and repurchase of units. Such notes had always been produced manually, using electric typewriters on very wide multi-part sets of paper, with a large backing sheet which formed a listing of all the contract notes typed. It was a messy and difficult process, and it needed to be automated.

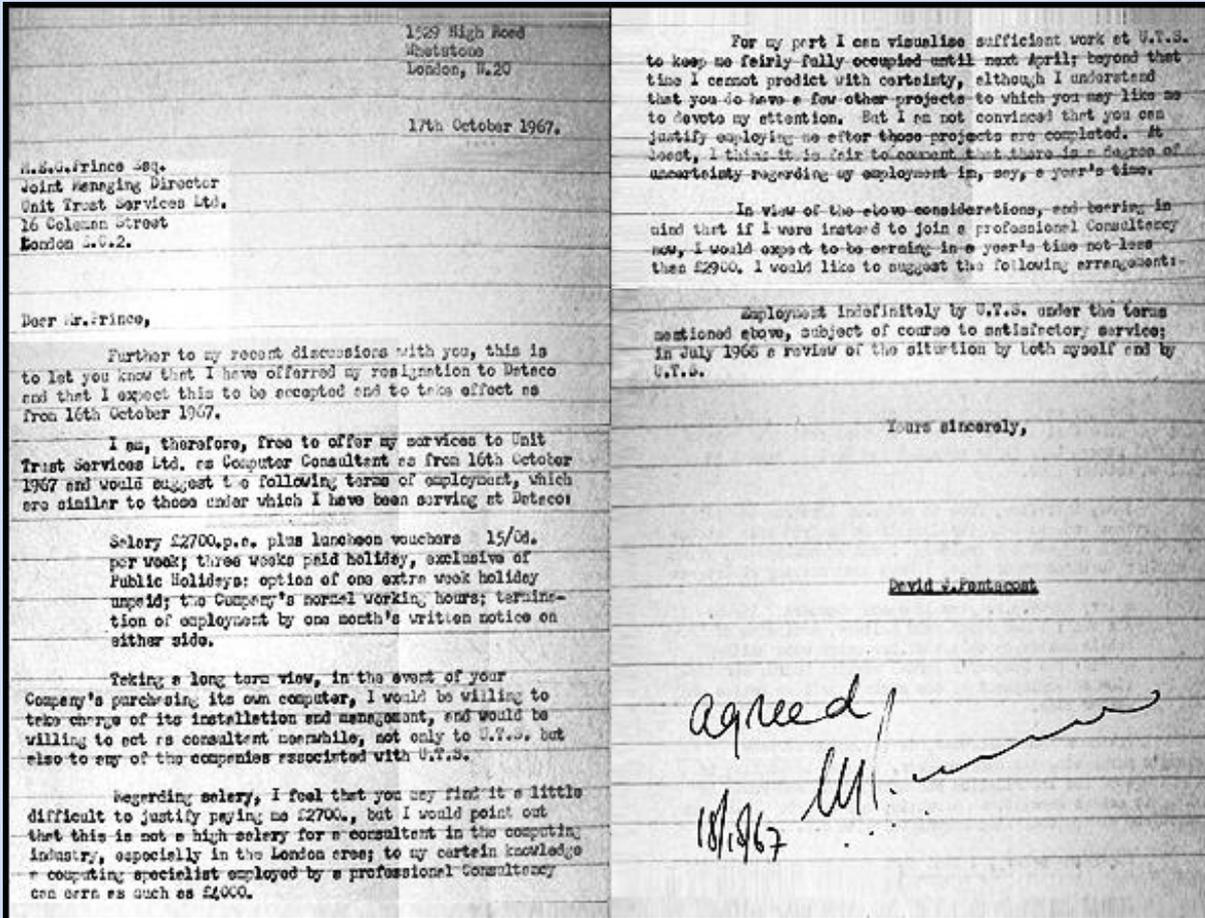
He subsequently asked if I would be interested to join UTS as an employee, to manage all computing aspects of the company. We exchanged correspondence, (see next page) and I was taken on as Computer Consultant at a salary of £2,700 p.a., the same as I was earning at Dataco. This was with the agreement of the liquidators of Dataco.

When I started at UTS, I found that investigation of automating the production of contract notes was already underway. UTS were talking to Burroughs about using an electronic calculating typewriter. I took over this embryonic project and kept running into technical difficulties while developing a system specification; the machine was simply not capable of doing all that was required. Compromises kept being made, and by some time in 1968, we had reached a point where I said that the proposed solution was not good enough, and that we should re-think the project.



Honeywell 316 computer + Olivetti Te328 terminal

So I began looking for a totally different kind of solution, based on one of the new mini-computers then coming on the market. I looked at several manufacturers' machines, and decided on the Honeywell 316 mini-computer as the central processor, with four on-line Olivetti Te328 terminals linked to it.



Letter of engagement with Unit Trust Services (from a poor carbon copy)

I was responsible for designing the system and arranging to have the programs written, and I did not want to rely on staff from another company. There was an outstandingly intelligent UTS employee, a former commercial airline pilot, whom I thought could become a good programmer, and we both went on a training course with Honeywell to learn about programming the H316 computer. This computer had been marketed hitherto for use in industry as a process control machine, but I realised that it would be ideal for our commercial purposes, and I persuaded Honeywell so. It took the two of us more than a year to develop an environment to permit on-line terminals to function independently from each other and under the control of the H316. In effect, we had to develop an operating system, as well as writing the application programs.

The H316 was available in several physical configurations, and I chose a 19" rack-mounted system, with a paper tape reader and punch attached.

A brief description of the system appeared in the Financial Times in July 1970:-

The Financial Times Wednesday July 1 1970

# The Technical Page

EDITED BY ARTHUR BENNETT AND TED SCHOETERS

## COMPUTERS

### Low-cost contract system

CONTRACTS detailing the purchase or sale of units from six of the City of London's unit trust management groups will soon be produced entirely by equipment centred in a very small computer, now being developed by Unit Trust Services, an independently operated company providing complete administrative services for unit trusts.

Based upon the diminutive Honeywell H316 computer, the £17,000 system considerably reduces the effort required to complete unit trust bargains by automatically generating the appropriate contract notes ready for posting to the client.

Each day updated prices of the trusts are first fed into the computer to join a file of standard information, including the names and addresses of the trust management companies and their principal agents. When an order for the purchase or sale of units is received, the details are entered into the system through one of four on-line terminals.

The H316 immediately allocates a contract number, calculates the cost of the purchase or value of the sale (together with the amount of commission if applicable), and prints on a standard form inserted in the terminal the complete contract including the name and address of the unit trust company and client.

At the end of each day the system automatically produces summary listings of business—in peak times up to 1,000 contracts a day. Listings are made by ascending contract number within each category of unit trust and include a financial summary of the bargains completed in each category.

A similar article also appeared in Computer Weekly:-

# COMPUTER WEEKLY

Number 198

Thursday, 2 July, 1970

Price 1s 6d

PAGE 4

## ***UNIT TRUST DEALINGS PROCESSED ON H316***

**CONTRACTS** dealing with the purchase or sale of units from six of London's unit trust management groups are to be produced entirely by a Honeywell H316-based system now being developed by Unit Trust Services, an independently operated unit trust administration service organisation.

The system automatically generates appropriate contract notes ready for posting to a client and each day updates unit trust prices on a file of standard information which includes the name and address of the trust management companies and their principal agents.

When an order for a purchase or sale is received, the relevant details are entered into the system through one of four on-line terminals. The computer then allocates a contract number, calculates the cost of the purchase or value of the sale, together with the amount of commission, and prints out the completed contract including the name and address of the unit trust company and client.

The H316, believed to be the first of its type to be used for commercial applications in the UK, was delivered last month to UTS's Coleman Street, London, EC2, offices and includes 8,000 words of memory, high speed paper tape reader and punch, and four on-line Olivetti TE 328 terminals, each with 10 chps paper tape input/output equipment.

### **Scottish support**

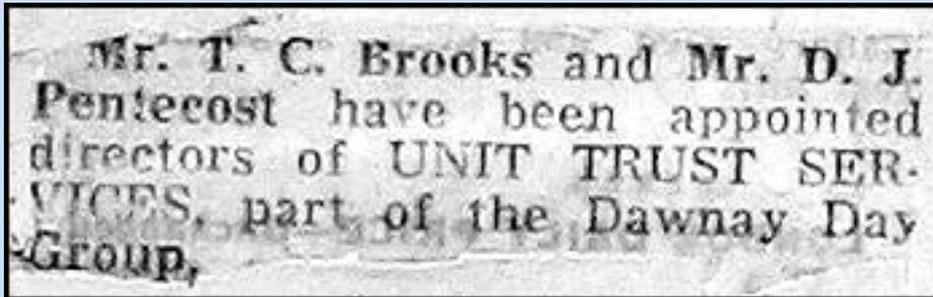
A NEW company called Systems Implementation Ltd has been formed with offices in Station Square, Inverness, to provide systems and programming support to computer users throughout the country.

The system was the first of its kind in the U.K. It was designed to be as failure proof as possible, and it functioned for an unprecedented ten years, with only four days of down time during that entire period.

The H316 system and the computer system in operation at the bureau in Cockfosters were being used for all the unit trust management company clients of UTS. The unit trusts which had been set up by Prince, Simon & Co were all brought

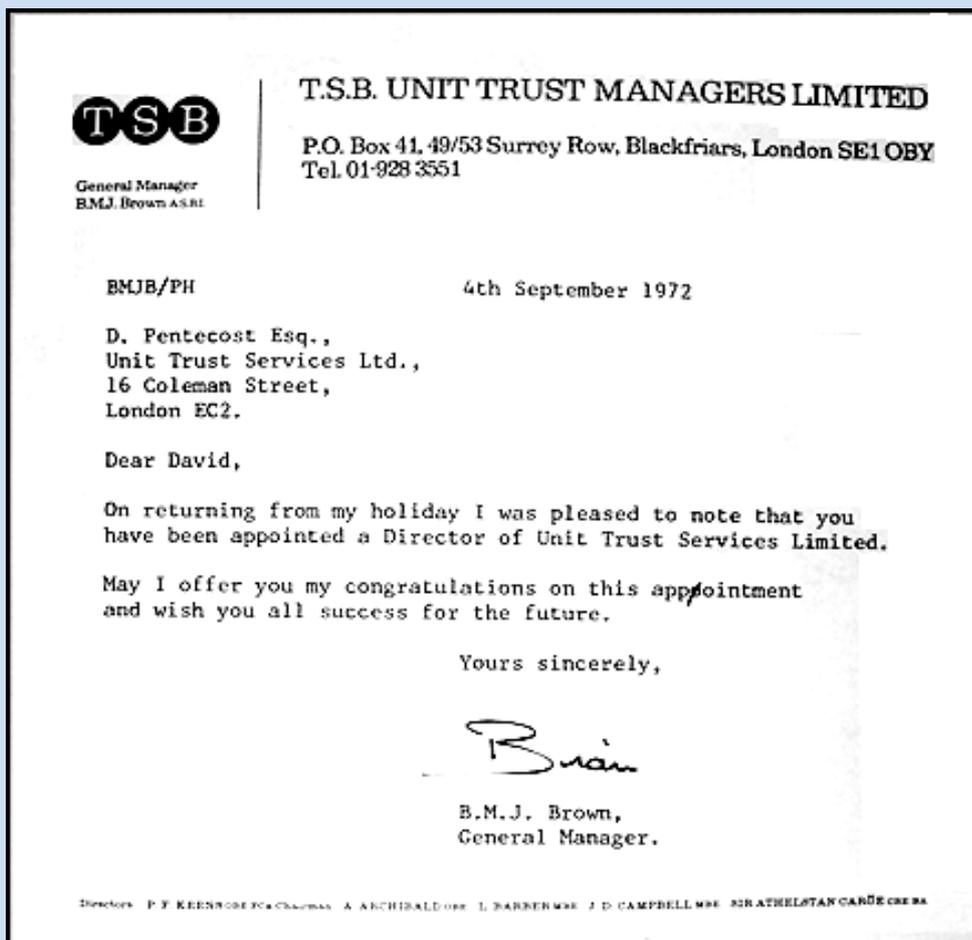
under the management of a new company which was formed, called Target Trust Managers Ltd, part of a group called Target Trust Group. Target was taken over by Dawnay Day, a financial services group in May 1972, but continued trading under the Target name.

It was in the summer of 1972 that I, and my colleague Terry Brooks (one of the accountants), were appointed as directors of UTS:



From the Financial Times

I received a letter of congratulations from Brian Brown, general manager of one of our clients, the TSB group:



There came a time when Bank X was being left behind, in that it was the only one of the big four banks which did not have its own unit trusts; it needed to set up those unit trusts in a hurry. But the bank did not have the expertise or the computer systems to do so quickly. UTS was approached (I think around 1973) in strict confidence by Bank X, to discuss whether there could be a way for UTS to administer the unit trusts which the bank wished to launch, without it becoming generally known that the bank was not doing its own unit trust administration work.

Clearly the work could not be undertaken by UTS directly. Bank X accepted that some of the UTS staff could do the work, but under the umbrella of a new company which would be set up. I think it was I who suggested that the name of the new company be Unit Trust Administration Ltd. The function of the new company would be to undertake work only for Bank X. Terry Brooks and I were appointed directors of Unit Trust Administration. A separate London telephone number was arranged with the General Post Office, (which then ran the telephone service now operated by British Telecom) for members of the public to use to make enquiries. Some of our staff acted as Bank X staff, and used Bank X stationery for correspondence.

So over the next few years, the amount of unit trust work which we did expanded considerably. The Target group had also formed a building society and a life assurance company, which were located in the City but not at 16 Coleman Street, because of lack of space.

The time came to bring Target Group's operations, including the work done by UTS and Unit Trust Administration under one roof. The Target directors decided to look for a plot of land outside London, and commission the construction of a building to house everyone, apart from a few marketing staff who needed to remain in the City. There was a long discussion about where the new building should be located, and the most important factor was not to lose critically important staff, and to make it possible for as many clerical staff as possible to move to the new location.

Enquiries centred on Aylesbury in Buckinghamshire, partly because of where three key staff (two senior accountants and myself) lived. We were in Watford, Thame and Leighton Buzzard, all of which towns were within easy reach of Aylesbury. Discussions took place with the Aylesbury local authority, regarding providing homes locally for as many clerical staff as possible who would be willing to move house.

In due course, a new building called Target House, with good parking facilities, was constructed in Gatehouse Road in Aylesbury. A photo of the building is on the next page; (it is no longer occupied by Target Group). On the ground floor on the road side of the building was a new air conditioned computer room. A large Univac computer was chosen to do the work for the unit trust company and for the life assurance company, and I helped to recruit some new computer operations staff.

The move from London to Aylesbury in due course took place, but not without difficulties with clerical staffing for a period of about six months. Terry Brooks and I were appointed joint general managers of UTS; Terry was responsible for the accounts department, and I was responsible for all the other departments.

I think it was late in 1975 when we were hit with a devastating blow. A substantial part of our income came from business with Bank X, and the bank had decided that it was then in a position to take over the administration of its own unit trusts. It may be that they had had a long term plan to do this, and if so, we were not aware of it.



**Target House, Gatehouse Road, Aylesbury**

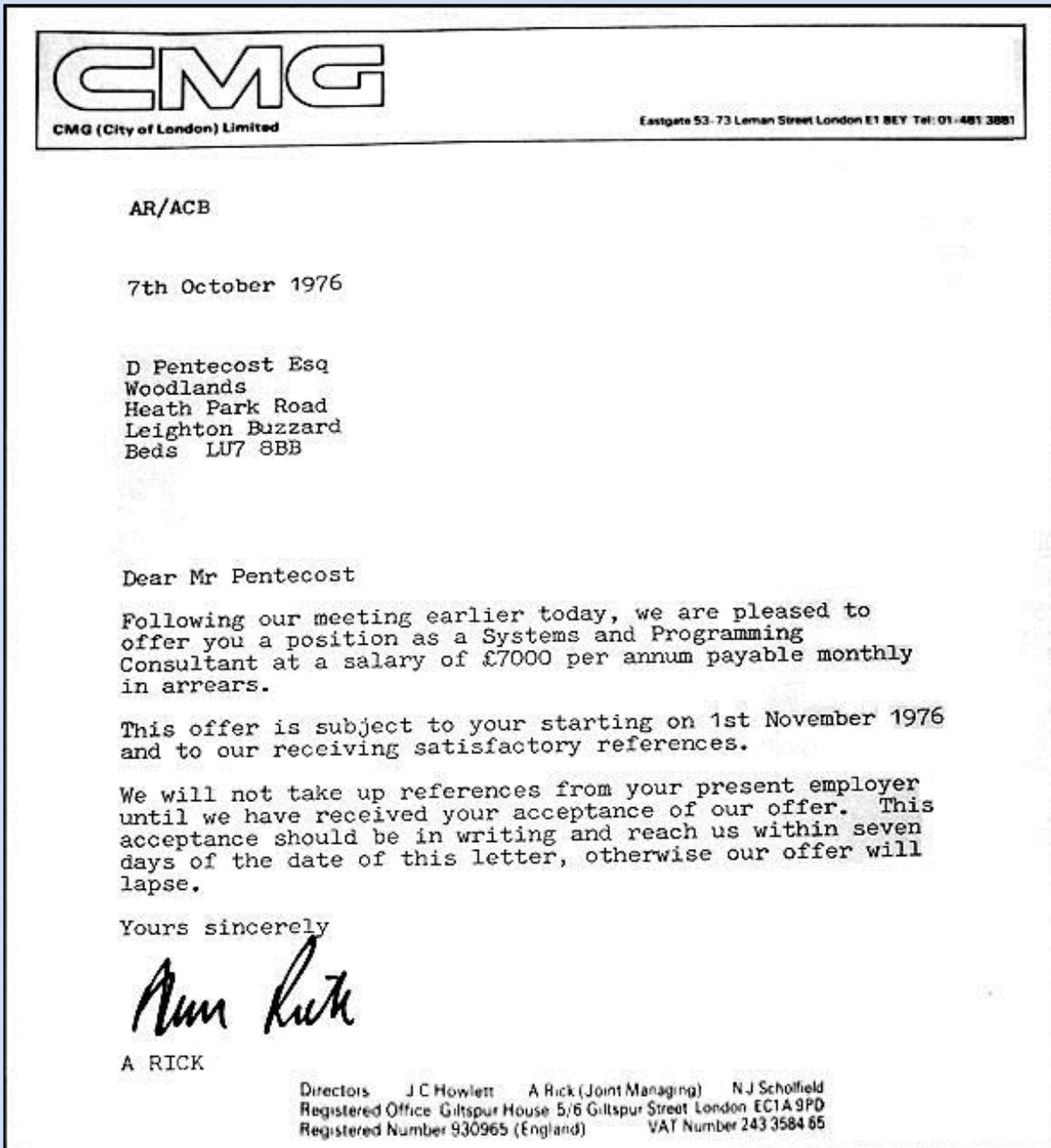
After the handover process was completed, we had to reduce staff numbers. I found it hard to tell people that they were being made redundant. In 1976, cost cutting had to continue, and Michael Prince told me in April 1976 that the group could no longer afford to employ two general managers; on 3rd May 1976 I was formally made redundant, as was a fellow UTS director. It was both a shock and a relief; a relief, because I never enjoyed managing people, apart from the technical computing aspects. I was essentially a technician – a computing specialist.

I resigned my directorships in April 1976, but remained an employee, working on my own, particularly on some specialist legal issues concerning trust deeds, as they related to the administration of the unit trusts. It was agreed that I could continue as an employee until I found a new job. I kept my salary of £8,750 until my leaving date, (which was eventually agreed as 31st October 1976), and I was allowed to keep my company car (a small fibre-glass Reliant Kitten) for an agreed fee. Because of the petrol price crisis, I had a few years earlier changed my company car from the huge gas-guzzling metallic green Ford Granada estate car, to the very economic Reliant, which did about 50 miles to the gallon, saving me a lot of money.

I decided to go back into what I knew best – computing – and I registered with some computer employment agencies. Eventually I was put in contact with CMG, founded in 1964, a well-known international software house and computer bureau, and at one time included in the FTSE 100 Index. One of its offices was near Aldgate East underground station in London. It meant a salary reduction, but I expected that.

## Chapter 7: CMG (CITY OF LONDON) LIMITED

On making contact with CMG, I found to my surprise, that one of the joint managing directors was Alan Rick; we knew each other, although not well. He had worked, as I had, at ISIS in Lime Street. That must have helped in my being offered a job as a systems and programming consultant. I was back doing programming after a gap of several years, and I was very pleased, although I had to refresh myself in programming with the COBOL language.



I soon discovered that everyone in the company was working flat out, to complete projects to tight deadlines. One had to offer a good explanation if one was more than five minutes late for work. I found it necessary to take programming work home with me, not only sometimes to continue at home, but almost always working on the train between Euston and Leighton Buzzard. The journey to work from Euston was

not easy: a walk to Euston Road station, to take an Underground train to Aldgate East, and then a good ten minute walk to the Leman Street office. I wanted to show here a photo of the building, but the whole site has been redeveloped. I remember one terrible day when the air was so filthy with smog, and visibility was so poor, that an asthma attack almost overcame me. I had to stop walking, to catch my breath for a few minutes, move a few yards, stop again, and so on until reaching the office. If there had been mobile phones in those days, I would have summoned an ambulance.

CMG decided at one point to develop a payroll and related system, called Payfact, to offer services to companies at its computer bureau. I was allocated one of the programs in the suite, and as it turned out, it became the largest program in the system; it required over 3,500 lines of COBOL code. But all went well, and Payfact was very successful. Here is a quote from the CMG entry in Wikipedia, which can be seen at [https://en.wikipedia.org/wiki/CMG\\_\(company\)](https://en.wikipedia.org/wiki/CMG_(company))

*“Though the most mission critical business process for CMG was always selling consulting services, the company also had a large internal IT department to service the company's infrastructure and manage services for large customer applications. One of the most popular applications which it developed and sold for decades, was PAYFACT, a payroll and HR reporting system that gained widespread use in the Netherlands in the 1990s.”*

There came a time, early in 1978, when business was hard to get; few of us had any work to do. So we were all ordered to become salesmen for the company. We had to use our own initiative to contact companies to elicit new business; it meant cold calling on the telephone. I really hated it, because I am no salesman. Yet the odd thing was, that I seemed to be more successful at getting appointments to visit and talk to prospective customers than anyone else.

I decided that I had to leave; this was not a working atmosphere which I could tolerate for much longer. And I missed the technical seniority which I had previously had: I was just one of a dozen or so programmers in the office, reporting to the general manager. Having experienced working near my Leighton Buzzard home, when I was employed in Aylesbury, I decided to find and register with some local recruitment agencies, to see if I could avoid the long and increasingly expensive commute into London.

That journey over the years since the late 1960s varied enormously in acceptability. In the early days, the train was almost empty when it arrived at Leighton Buzzard station on its journey to London, so there was no problem getting a seat. There were at most, six of us in the carriage at Leighton Buzzard. As Leighton Buzzard, and places further north expanded, especially Milton Keynes, commuting steadily grew over the coming years, and the journey became more and more uncomfortable, as the train became packed. One had to learn where to stand on the platform in order to get in, and sometimes almost battle to get a seat. In some harsh winters, the journey was appalling; the trains had no sliding doors, but many small conventional

swing doors, which let in a howling gale in bad weather. And often the heating system was not working. In some years, delays were extremely common.

One recruitment agency, which I found in Berkhamsted, was called Castle Recruitment. They soon found a possible opening for me, in Berkhamsted. The managers at CMG were somewhat astonished that I had found a job outside London with an increased salary, and use of a company car, thus saving me huge amounts in train fares.

## Chapter 8: ATTWOOD COMPUTER PROJECTS LIMITED

<b>ACP</b> THE ATTWOOD GROUP	<b>ATTWOOD COMPUTER PROJECTS LIMITED</b> NORTHBRIDGE ROAD · BERKHAMSTED · HERTS · HP4 1BN BERKHAMSTED 2023 · TELEX 82285
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19th May, 1978.

Mr. D.J. Pentecost,  
'Woodlands',  
Heath Park Road,  
Leighton Buzzard,  
Beds. LU7 5BB.

Dear Mr. Pentecost,

We are pleased to offer you an appointment as Projects Manager. This offer is subject to two satisfactory references and a satisfactory medical report from our Company Doctor.

Your salary will be at the rate of £8,250 per annum, paid by thirteen four-weekly instalments. You will also be provided with a Company car.

The engagement will be subject to thirteen weeks notice of termination on either side, commencing on the Friday of the week in which it is given. In addition, it will be subject to the Company's Staff Rules, a copy of which is enclosed. Also enclosed is a booklet setting out the Pension Scheme. Details concerning the transfer of your present Pension Rights to our Company scheme will be advised at the earliest opportunity.

We shall be pleased to receive your written acceptance of this offer, together with the earliest date on which you could join the Company.

When we receive your acceptance and have also obtained satisfactory references and a satisfactory medical report, we will confirm the engagement.

Yours sincerely,  
ATTWOOD COMPUTER PROJECTS LTD.,

  
K. Jarrett,  
Administration Director,  
Attwood Management Services Ltd.

Encs.

Member of  
 SNA Computing Services Association

DIRECTORS: B. G. W. ATTWOOD (Chairman) · W. G. M. FREW (Managing Director)  
D. A. W. BLACK (Financial Director) · P. A. LLOYD (Marketing Director)  
Registered in England 822850 Regd. Office: 28 CHELSEA PLACE · LONDON · SW1X 8HX

I had come across a company called Attwood Statistics Ltd back in 1962 when I worked at Elliotts in Borehamwood. In the late 1950s, there was a need by television

companies to measure the audiences for particular broadcast programmes, especially after the setting up of ITV as competition for the BBC in 1955.

Attwood Statistics arranged with a representative selection of home owners with televisions, for them to record which television programmes they watched each day, by use of a device invented by Attwood, called a Tam Meter. There must have been many hundreds of such meters – possibly a few thousand. Every so often, perhaps daily, information was collected from these meters (I do not know the mechanism for doing this) and was delivered to Elliott Brothers' computer bureau. The data were prepared on a teleprinter, producing paper tape, which was processed by an Elliott 405 computer and analysed. The resulting output was a table of popularity of TV programmes, known nationally as the TAM Ratings, and they were published in most daily newspapers.

So it was a surprise to join Attwood Computer Projects (ACP), a company run by the same man, Bedford Attwood, who had set up Attwood Statistics. By the time I joined ACP, TAM ratings had been taken over and run by a company called AGB (Audits of Great Britain).

The drive from Leighton Buzzard to Berkhamsted each day was a delightful one, through country lanes, and it was such a pleasant change from the train journey to London.

I was recruited to head up a small team running a project for a company in Chesham, called Agricultural Central Trading (ACT). ACT's business was to source farm products and sell them to farmers all over the country. I have a recollection that ACT had been created by the National Farmers' Union. Bedford Attwood was the chairman of both ACP and of ACT, and therein lay a problem for him – a conflict of interest.

He had initiated the setting up of a computer system for ACT in their Chesham office. The computer was a Modular One, made by Computer Technology Ltd (CTL) of Hemel Hempstead. (CTL had been set up by Iann Barron, having designed the 803 computer for Elliotts, and it was he who later at INMOS conceived the transputer, which was developed there). But there was a problem with the ACT computer system, and it was to solve this problem that I had been recruited, I later learned. The computer system ran much too slowly. I had to head a small team to solve the problem. I was told that work had already been done to re-write some of the program code using a different programming language, called Coral 66, but that more code needed to be re-written, to replace the comparatively inefficient COBOL-generated code, which had been used for nearly all the programs. This was undertaken with a struggle, but the improvement was negligible. We then had talks with CTL about the problem, and we concluded that the real reason for slowness was probably that the computer had insufficient fast memory for the programs to operate in, and that buying more memory could solve the problem.

Bedford Attwood was embarrassed that the system at ACT was not as efficient as it should be. He would be more embarrassed if he had to tell ACT that ACP had recommended a computer too small, and that ACT must spend more money on it.

I asked for a meeting with him, and told him that I believed that more fiddling with the computer programs would be a waste of time and money, and that the computer needed more memory. This would, of course, incur an expense, but one did not have to commit to spend the money immediately; one could ask CTL to install extra memory on trial, to see if that would solve the problem; if it did not, the additional memory could be removed, but if the problem were solved, then expenditure would be necessary: whether by ACT or ACP was Bedford Attwood's problem.

The outcome was that more memory was installed, and the system did function faster. I do not know who paid for the additional memory.

There had been another problem which occurred on most days: the system would crash, the office business would come to a halt, and the computer would need to be restarted. We noticed that the system crash often occurred at about 11 a.m., although also at some times in mid-afternoon. We spent some time wondering what happened at about that time of day on the computer to cause a crash; none of the computer programs did anything determined by the time of day. But the crash did not occur exactly at 11 o'clock – only approximately.

What was happening in the office at that time? Well, coffee was delivered around the office, from a coffee trolley, but that seemed ludicrous as a cause. One day, not really believing what we were doing, we watched the coffee trolley. Sure enough, at one position of the trolley, the computer crashed. The answer was that under the carpet was a cable, and a wheel of the heavy trolley had compressed the cable. So the problem was solved!

Early in 1980, we did not have much to do in the office, and I feared that ACP's business was going to be closed down. So I registered myself once more with a few well-known computer recruitment agencies. One of them was John Goldsmith, one of the top national agencies, and I think it was by him that I was contacted one day in April.

The agency had been retained by a very large law firm, to recruit a business systems manager. He described the position to me and asked if he might forward my CV to the firm. I don't think he revealed to me at the time which firm it was, but it was in London. He said that the initial salary was good, but that it would rocket up, in the years to come.

## Chapter 9: COWARD CHANCE (later Clifford Chance)

The firm was Coward Chance, which occupied most of one of the tower blocks along London Wall; it was in fact in Royex House in Aldermanbury Square. I was interested, because one of my ex-colleagues, John Porter (with whom I had worked at ISIS on the B&C payroll project), had done some work for a small law firm in Kingsway, London. I had met John occasionally, and I was fascinated by the work he had done there. So the opportunity to do something similar but on a much larger scale was most appealing.



**5 Aldermanbury Square, London** (Google photo)  
(This is a rebuilt version of Royex House; it looks very similar to me)

In due course I was interviewed by Michael Mathews, one of the partners, who eventually was to become President of the Law Society. He asked me if I was a relative of Wendy Pentecost, who formerly worked there as a secretary. I was not aware of it at the time, but I later discovered that she was one of my second cousins.

I was also interviewed by the partnership manager, to whom I would report. The latter, who was I think fairly new to the business, on engaging me told me “to live well here, because this is a rich firm!” (He left shortly afterwards through illness, and was replaced by a Scotsman).

I was taken on as business systems manager, as from 2nd June 1980, at a starting salary of £13,750, an increase of more than 50% over my previous salary at ACP. This was to be the first time that I would work for a big organisation, since leaving Elliotts in 1962.

I was told by the partnership manager, when I started work, that my first problem would be lack of resources, i.e. staff. I was shown the small computer room, which contained a Nixdorf mini-computer with four on-line terminals, and a few physically large removable disc platter units. Four non-technical staff were running the system, preparing and inputting data, with one of them supervising the other three, and responsible for operating the computer. It was all under the guidance of a remote software house, called Norwel, based in Manchester, which had supervised installation of the computer, developed the software, and trained the four operators.

A basic function of the system was to input the time-sheets written by each of the firm’s London-based lawyers, or dictated by a lawyer and written up by a secretary, to record each element of time (and hence its cost) against the matters worked on by the lawyers. So the cost of a lawyer’s time spent working on a matter for a client could be established at any point in time, in order to assist billing the client.

I learned from the computer supervisor/operator that there were many improvements which she thought needed to be made to the programs. But it was a practical problem to achieve these changes, because it would be necessary to call down staff from Manchester. I needed to take steps so that we would not be so dependent on Norwel.

One of the programmers who joined ACP shortly before I did was Trevor Hopkinson, who also as it happens lived in Leighton Buzzard. When I left ACP, shortly afterwards he also left, and joined Target Life Assurance, part of the Target Group in Aylesbury, working in the same building which I had left in 1976. I needed to recruit someone to assist me at Coward Chance, and I asked Trevor, a top class programmer, to join me, which he did, in July 1982.

Until 1982, I took over making improvements to the Nixdorf programs, which proved fairly easy to do, sending each proposed program change to Norwel in Manchester for approval before implementation. Thereafter, Trevor and I both worked on maintaining the system. As with nearly all computer systems, we encountered problems from time to time, especially when running the end of month accounting programs. I remember a few occasions when we both worked through the night in order to resolve an obscure program fault.

At the same time as we were keeping the Nixdorf system running, and learning more about the business practices of the firm, I began to work on an idea for a radical set

of changes, which would eventually involve replacing the Nixdorf computer. It would take a long time to specify the ideas, and seek approval from the partnership for the changes. More technical staff would be needed: system design and programming staff, and computer operators, far more knowledgeable and sophisticated than the four staff then employed.

Before I describe briefly what I had in mind, I need to explain how some aspects of the practice functioned. There were about 200 lawyers in the London office, without any computing equipment of their own. In general, each lawyer had a secretary, or in a minority of cases shared a secretary with another lawyer, and each secretary used an electric typewriter.

My vision was a large central computer to take over the time-sheet processing and accounting functions of the Nixdorf computer, and eventually to perform other tasks not yet computerised; every secretary would have an intelligent terminal replacing the typewriter, linked to the central computer. These terminals would permit input of details of clients and time-sheets to the computer, and allow enquiries on the data to be made; crucially, each terminal would also function as a stand-alone word processor, working as such, whether or not the central computer was on-line; documents would be stored on 5¼" floppy discs. Each word processor would be linked to a local laser printer, each printer normally being shared between two or three secretaries. Producing documents on time is the life-blood of every law firm, and this function could not be dependent on a central computer which might fail or might not always be switched on.

Lawyers could have a dumb terminal, if they wished, linked to the central computer for making enquiries, and for entering data if they wanted to do so, rather than devolving that task to a secretary.

I was told by a few partners that before making any major changes to the firm's systems, I should visit some of the big law firms in New York and elsewhere in the USA, with whom Coward Chance had close contacts, to see what systems they had developed, in order to gain ideas. I did so, accompanied by one of the partners, and was astonished at what I found. It had been expected that the Americans would be ahead of us, and in a sense they were, because the systems they had, had been developed many years before, and most were largely based on storing and processing millions of punched card records. They *had* been ahead of us, years before, but their technology was now very much out of date. We could learn almost nothing from them. What I had in mind was far more advanced, being based on current technology.

I searched the international computer technology market, examining equipment available from the major manufacturers, and was surprised at what I found. There was only one such manufacturer which could meet our technical requirements, and that was Burroughs. Before the advent of the PC, they had specialised word processors, called OFISwriters, which could be linked to a central computer for

entering data and making enquiries. It was surprising and disappointing that IBM did not have a comparable offering at the time.

A contract was eventually drawn up and signed with Burroughs for supply of the hardware and some of the software. The mainframe computer contracted for was a B5985, but on the advice of Burroughs themselves, when they later believed that the computer would not be powerful enough to handle the firm's workload, the computer was upgraded, I think to a model A10. We engaged Burroughs staff, and a software house to assist with the design and programming of the system. I also recruited three operations staff and two system designers and programmers as employees of Coward Chance, reporting to me.

One of the first stages of the project was to install the OFISwriters, working only as stand-alone word processors, whilst the systems for the central computer were being developed. Initially a few secretaries were chosen and redeployed to form a small word processing training team, to teach all the secretaries how to use the OFISwriters, with WordPerfect as the word processing software. Courses were arranged and implemented over a period of several months, until every secretary was using an OFISwriter.

By 1985 the computer programs had been written and tested on the Burroughs computer, and the OFISwriters had been networked to the Burroughs mainframe computer. A small team of clerical staff was provided with OFISwriters for a few weeks, to undertake the data entry tasks which had previously been carried out by the Nixdorf operators. They took over time-sheet entry for a few weeks, while the secretaries were taught to undertake this task.

As well as the major functions of the system mentioned above (time-sheet processing, billing, accounting, word processing and maintenance of a database of client and matter details), there were a few subsidiary systems developed, but also accessible from the OFISwriters and enquiry terminals.

One of these systems was a program which I wrote, to enable calculation of interest due on deposits made, particularly on behalf of clients. The system maintained a table of base rates of the major UK banks and of some major international bank base rates. The enquirer would select the base rate to be applied, enter the initial sum of money, the start and ending dates of the investment, any percentage increment to be applied above the base rate, whether a simple or compound calculation was needed, and whether just a total of interest accrued or a complete analysis of the calculation was required to be displayed or printed.

In February 1986, the management of Burroughs was so impressed with the design and functionality of the entire system, that they invited us to prepare and give a presentation to management staff at their offices in the USA. We prepared a slideshow illustrating the system with diagrams and screenshots. Burroughs flew our partnership manager Alastair Crawford, me and our word processing supervisor, Sandra Soundy to their offices in Dearborn, Michigan, and to some of their manufacturing plants on the west coast in California, driving us down the west coast

road to Los Angeles. (It was very frustrating to drive past the J. Paul Getty Museum but not have time to stop to see the exhibits). Then we visited an office in Atlanta and another in Miami. We had time to fit in a visit to Disneyland, and I took a trip parasailing off Miami beach from a speed boat; it was exciting, and my only worry was that should there be a mishap, I was (and still am) a non-swimmer.

In July 1986 I was asked to visit Coward Chance's Hong Kong office, where a proposal had been received from Wang, for a word processing system. My wife Kay came with me, and we spent about ten days there, using up some of my annual holiday allowance. I reviewed the word processing proposal, and considered an alternative system offered by Burroughs. Wang won the contract, but they had to supply the better laser printers which I had recommended. (There was time for me and Kay to join a 1-day tour party to mainland China; I remember that we were quite closely escorted, and were each allocated an identifying number, written on a sticker which we had to wear on our coats).

(In September 1986, the computer industry's major surprise news was that Burroughs had bought out the Sperry Corporation, and the new company was named Unisys, which still operates today).

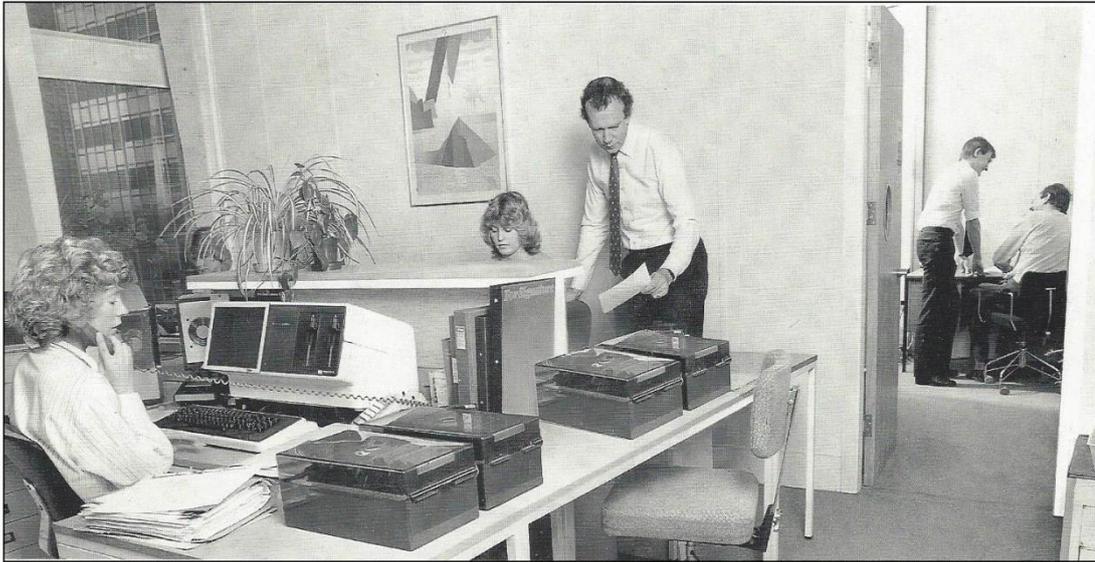
On the next few pages is the brochure which, with help from Burroughs, we produced for the staff of the firm, giving an overall view of the scope of the London system, which we called the Office Automation System.

The electronic mail system is worthy of a special note. Burroughs suggested that part of the software which they were to deliver should include the ability for staff to communicate with each other via an internal email system. There was considerable scepticism from many lawyers about how worthwhile this would be; nevertheless, it was agreed that the software would be developed. At that time there was no general Internet in existence, and it would be a decade before world-wide electronic mail became possible. Today we are all familiar with email, but in 1985 it was a new concept, and a quite brave decision to develop the internal email system.

As well as being in overall charge of the development of the Office Automation System, I specified and did the programming for the client billing part of the system, which was a major undertaking, bringing together the value of time worked by the lawyers on the one hand, and on the other, the costs of disbursements incurred on behalf of the client, in order to print a draft bill.

In 1986 the Office Automation System was in operation, and it was performing its designed functions. Our application software worked very well, but there were some problems with the underlying Burroughs operating system software. The system would sometimes crash for a while; however, Burroughs had very good recovery software which they were proud of, saying, probably correctly, that it was the best in the world; but it needed to be! The crashes were annoying, but not disastrous, and did not have serious effects on the working of the system.

# Office Automation System



**The Office Automation System (or OAS for short) is a series of computer programs that help you to create, review and distribute information around the offices of Coward Chance.**

## WHAT DOES OAS DO?

OAS runs on the Burroughs B5900 mainframe computer in the Royex House 17th floor data centre. You can communicate with it by using one of the Burroughs OFISwriter word processors or terminals.

Using OAS, you can:

- perform all the standard OFISwriter word processing tasks such as creating, storing, amending and printing documents
- transfer documents between OFISwriters. The documents may then be read, edited and transferred back
- produce documents on the remote laser printer
- send telex/teletex messages
- send and receive electronic mail
- keep details of clients and matters
- record time and copying charges
- bill clients
- maintain the firm's accounting records.

The system may be enhanced to include other facilities in due course.

You can also be sure that your work is secure, because no one can gain access to it without authorisation.

## HOW DO I USE IT?

OAS is simple to learn and use. It consists of a series of easily accessible menu screens, listing options from which you select the one that you require.

When you are entering information into the computer, "prompts" are displayed on the screen to assist you.

When one activity is finished, you can return to the menu from which the task was started, and select another option. The system also allows direct access to any activity simply by typing in the name of the one you want.

### Help

A comprehensive series of screens (known as "help" screens) can be called up at any time to assist you in using the system. In addition, the User Guide (which is available as a separate document) gives step-by-step instructions on operation of all parts of the system.

# Operation and Management



## THE MAIN MENU

When you start using OAS, the main menu is displayed. From this menu you can begin any of the OAS activities described.

The inquiry facilities will be of particular interest to those seeking up-to-the-minute information from the data base on any of the activities.

## CONTROL

OAS is managed for you by the System Administrator who has responsibility for:

- specifying which terminals and OFISwriters can use the system and where they are located
- instructing the computer about who is permitted to use each part of the system
- organising use of computer time for maximum efficiency
- monitoring usage and reliability and organising maintenance of the computer.

No one can use the system without a usercode and password, and the System Administrator assists you in setting these up; however, even he will not know what your password is.

The **Personal administration** menu allows you to change your password as necessary.

### Locking your terminal

OAS allows you to lock your terminal electronically to prevent others from altering work you have had to leave temporarily.

You could, for example, attend a meeting, leaving some work unfinished on the screen.

### Interrupting an activity

You may also temporarily interrupt your work (other than word processing) to use another OAS function.

This is useful if you receive notification on your screen telling you that an urgent message has just arrived in your electronic mail-box. You can stop what you are doing to read (and, if appropriate, print) the message.

# Telex, Document Production and Transfer...



## TELEX

You may use the **Telex** menu to send a telex or teletex message to one or more destinations on the public networks.

Telex messages can be created at and sent from an OFISwriter. A legal document prepared on an OFISwriter can also be transmitted as a telex message, although you may wish to add a preface to the document before transmission.

Short telex messages can also be created at and sent from a terminal.

You can monitor the progress of recently sent messages and cancel the transmission of any message up to the moment when it is actually sent into the public network.

You can also create and maintain a list of abbreviations for each frequently used telex number or groups of numbers. These abbreviations, instead of the full number and answerback code, can be used to send messages.

Incoming messages are monitored in the Telex Room, and at your request can be transferred to a secretary's OFISwriter disk.

## DOCUMENT PRODUCTION

### Local word processing

Each secretary has a Burroughs OFISwriter, and the preparation of all documents and correspondence is carried out at these work stations. The printing of short documents is usually done on the local printer linked directly to the word processor. A special facility for the fast printing of long documents is described below.

### Document printing

Using the Coward Chance laser printer you can quickly print high quality documents of any length. OAS:

- copies your document from an OFISwriter floppy disk
- stores it on the B5900 mainframe computer until the laser printer is ready
- prints the document complete with the page numbering which you require
- indicates how long it will take your document to print, and informs you if the laser printer stops working.

### Document delivery

For each document printed, the document header sheet contains:

- your name and location
- the name and location of the person within the office to whom it is to be delivered
- the name and location of the author.

Using this information the document will be delivered without any further intervention from you.

## DOCUMENT TRANSFER

Any document that has been produced on an OFISwriter can be transferred to other OFISwriter users for review and editing.

OAS will:

- copy your document from an OFISwriter floppy disk
- store it on the B5900 mainframe computer
- inform the person you are sending it to that there is a document waiting to be transferred
- transfer it to that OFISwriter user when they are ready to receive it on a floppy disk.

# Electronic Mail...



## ELECTRONIC MAIL

The OAS electronic mail-box directory creates an effective and quick means of dealing with internal messages.

Everyone with a usercode can send or receive messages using an OFISwriter or terminal.

**Electronic mail** means that you can:

- leave a message to await the return of someone whom you have been unable to contact by telephone
- send a message to another user without the possible disadvantages (e.g. delay, loss) of conventional methods

- rapidly send circulars to all users or to selected groups of users.

**Electronic mail** allows you to send messages:

- person to person
- to a group of users on a distribution list – you can be sure that each one will receive the message.

**Electronic mail** allows you to:

- check your own mail-box and read messages in it
- send messages of whatever length you require

- leave a message incomplete and finish it later

- check whether messages you have sent out have been seen.

You will be able to review your mail-box, create replies to correspondence as necessary and monitor the progress of messages sent out.

You can also print messages on the laser printer or transfer them to an OFISwriter for word processing and manual distribution.

## PERSONAL ADMINISTRATION

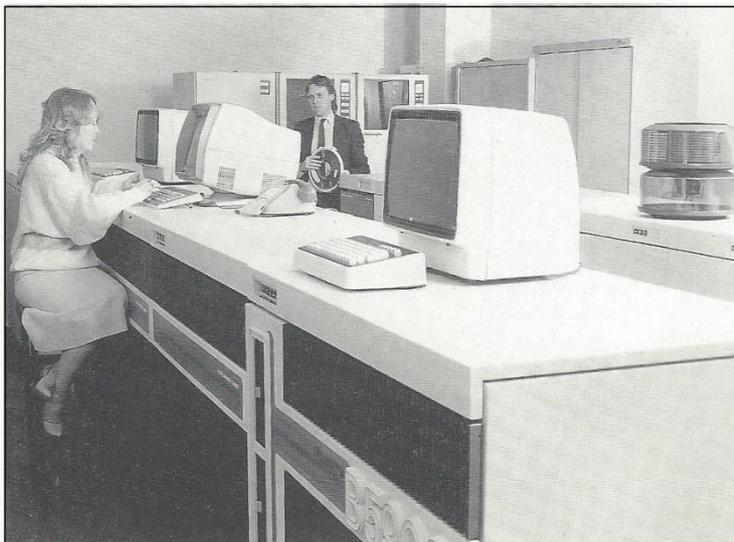
Using OAS **Personal administration** you can also:

- re-route your electronic mail to another interested party
- authorise access to your mail-box in your absence. This is useful if you wish your secretary to read your mail, or if you are ill or on holiday.

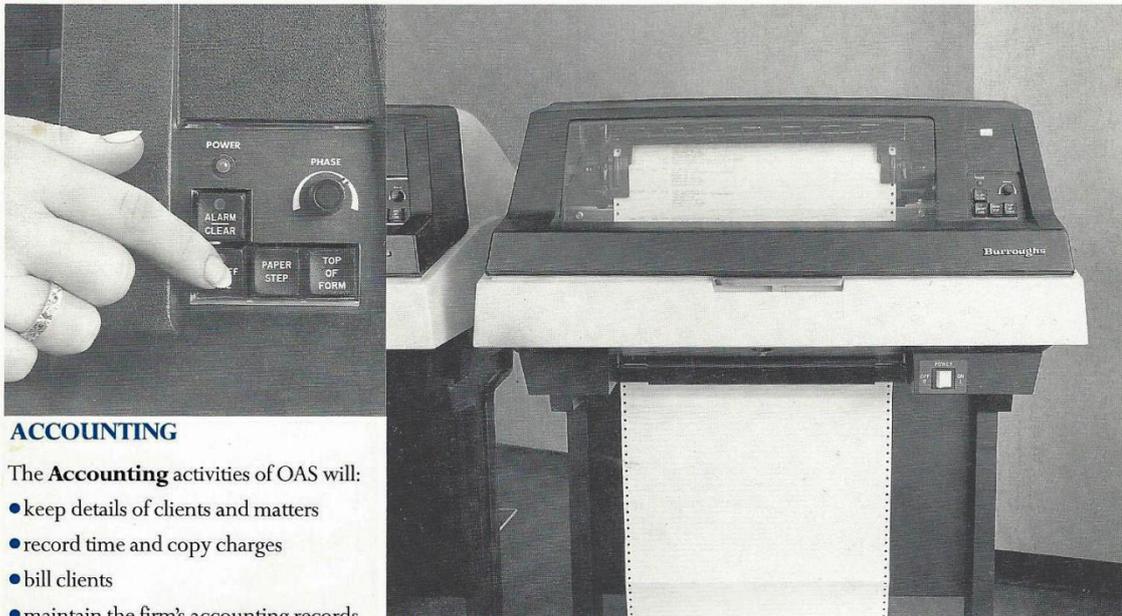
## DISTRIBUTION LISTS

Using OAS **Distribution lists** you can:

- send electronic mail to a list of users, all of whom can be accessed by a single code word
- alter your distribution lists at any time to suit your requirements.



# ...Accounting and a Day's Work



## ACCOUNTING

The **Accounting** activities of OAS will:

- keep details of clients and matters
- record time and copy charges
- bill clients
- maintain the firm's accounting records
- provide management information.

Not everyone will use all of these. For example, only people in the Accounts Department will maintain the firm's accounting records.

Using **Clients and matters** you can create, amend and inquire about information on clients and matters, and open, close, re-open or inquire about files.

You can print file labels, which the system will create and update every time a file description is changed.

**Time and copy charges** allows you to:

- record time-sheets daily
- amend time-sheets
- inquire about time records
- record photo-copying charges.

**Billing** allows the following steps to be carried out in billing a client:

- drafting and re-drafting of bills
- production of on-account bills
- settlement and delivery of bills
- creation of bill summaries.

## THE FIRM'S ACCOUNTS

Certain members of the Accounts Department can perform the following tasks:

- record disbursements
- keep details of the firm's suppliers
- keep account of client funds
- keep account of office funds
- record the delivery and payment of bills
- record petty cash transactions.

## A DAY'S WORK

At the end of a day's work on an OFISwriter you might have carried out the following tasks using the Office Automation System.

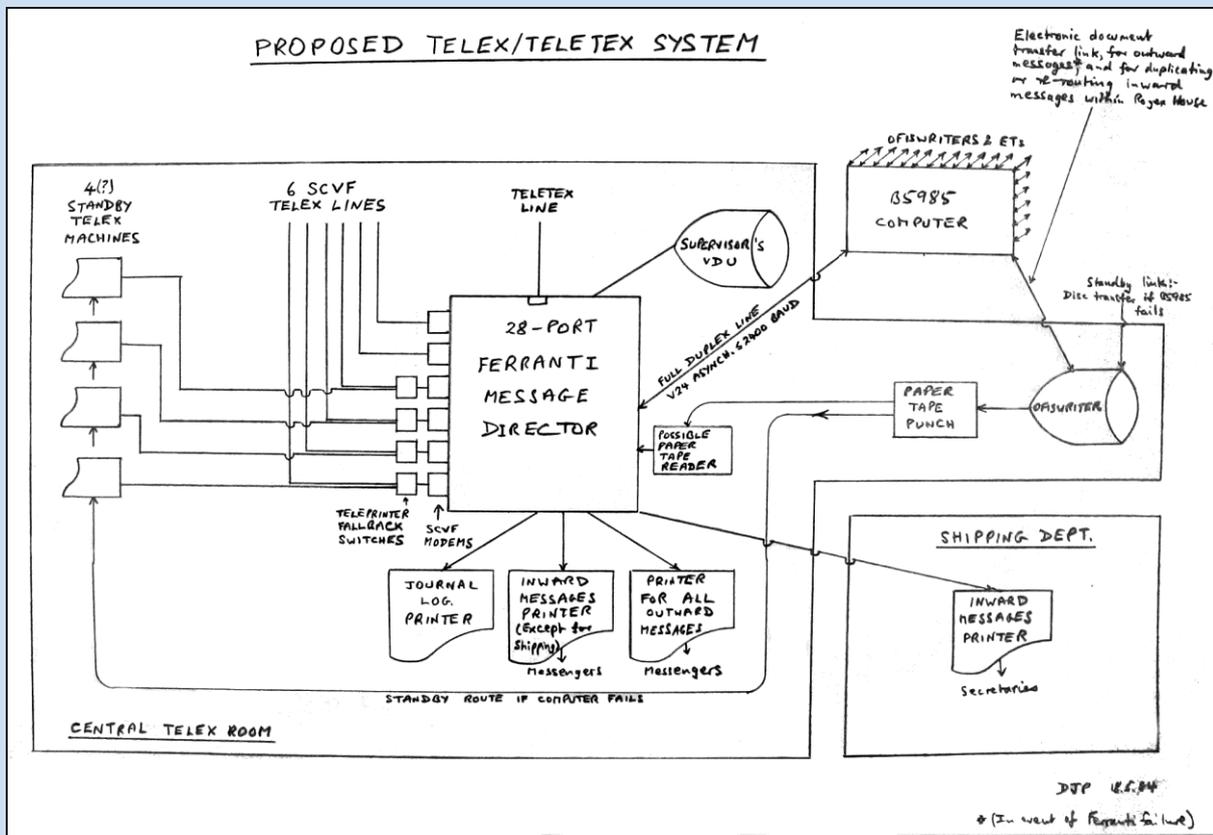
- Signed on by using your usercode and password
- Re-routed your electronic mail back from someone else to your mail-box, using **Personal administration**
- using **Electronic mail**,
  - checked your electronic mail-box and read the new messages, removing from the box those no

longer needed, and printing those for which a hard copy is required

- sent replies to these messages
- Entered or checked details concerning particular clients or matters
- Keyed in a time-sheet
- Produced a draft bill
- Created and amended documents, using your OFISwriter as a word processor, by using **Local word processing**
- Sent a long document to the laser printer for fast printing
- Locked your OFISwriter while you went to lunch
- Created a telex message as a document on your OFISwriter, by using **Local word processing**
- Sent the telex into the public network directly from your OFISwriter
- Used **Document transfer** to transfer a document to another user
- Signed off the system.

You will see from the above brochure that another feature provided within OAS, was the ability to send and receive messages to clients and others by Telex from OFISwriters and lawyers' enquiry terminals. Telex was used mostly by the Shipping Department, who needed to communicate with organisations in the far east and in other locations around the world where electronic mail or fax was not then available.

We needed a specialised computer, connected to the Telex network and which could be linked into the firm's network. Two systems were on the market which I considered: one from Ferranti, called a Message Director, the other from a much smaller company called Chernikeeff. I studied the two systems and wrote an eleven page report in November 1983 which concluded that we should install the Ferranti system. In a document dated 18th May 1984, I showed a diagram indicating the structure of the system components, with fall-back capability in the event of failure of the Burroughs computer. Here it is:



One of our programmers spent several months writing software to integrate the Ferranti system into the Burroughs network. (British Telecom ceased operating the standard Telex network in 2004, and telex is not used any more by the firm – I understand that there is no longer a shipping department operating within the firm).

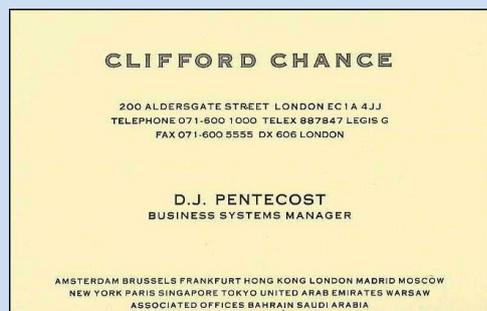
In early 1987 there came what seemed to me to be regarded by many within Coward Chance as shocking news. Secret talks had been going on between the two senior partners of Coward Chance and another large City law firm: Clifford-Turner. A merger was announced in February 1987, surprising the City as a whole, and making national and international news. The new firm would be one of the largest in the world; Clifford Chance, came into being on 1st May 1987.

It appeared to me that the immediate reactions of the staffs of the two firms could hardly have been more different; there were definite 'them' and 'us' attitudes, and there seemed to me to be a degree of despondency within Coward Chance, and, so I heard, elation within Clifford-Turner; it was reported that staff in the latter firm opened bottles of champagne in celebration, and that they regarded the merger as more of a take-over of Coward Chance.

I heard that many of the Coward Chance staff also saw the merger as a take-over by Clifford-Turner, although this was strenuously denied by the more senior partners in the firm. Within Coward Chance, there had been a tremendous feeling of loyalty to the firm by its staff, perhaps partly because of its long history, resulting from a firm founded in 1801 by Antony Brown. By contrast, Clifford-Turner had not been founded until almost a century later. I think it was significant that the new firm, would after the merger have a Coward Chance man appointed as its Managing Partner; my feeling is that this was to provide some reassurance for the former Coward Chance staff.

These differing sentiments lessened with time, but did not significantly begin to disappear until the two firms were physically merged. Plans were drawn up for the two firms to move in 1992 to amazing and massive new tower premises designed and built by Wimpey at 200 Aldersgate Street, very close to the Museum of London. After the move into one building, everyone began to develop a loyalty to Clifford Chance.

Here is my business card showing the new address:



On the next page is a photo of me taken in August 2018 in front of part of 200 Aldersgate Street. Photos of tall buildings in narrow streets are difficult to obtain, and the enormity of the building cannot be properly appreciated from this picture

After I left the firm, it even outgrew the new building, and moved to its present location at 10 Upper Bank Street in Canary Wharf. It was a bold decision to move outside the City boundaries, but the firm had become so prestigious that it no longer needed to remain within the traditional law firms' district of the City's Square Mile.

Clifford Chance now also has a very small office in the City. By an amazing coincidence, these premises are in a relatively new office block at 4 Coleman Street, on the corner of White Horse Yard and Coleman Street. It was at the end of White Horse Yard where 16 Coleman Street used to exist, and where I worked from 1967 at Unit Trust Services Ltd.



Clifford Chance's first combined London premises, at 200 Aldersgate Street

Now back to my employment at Clifford Chance. With any merger, administrative staff in particular fear redundancies, but extraordinarily and comfortingly, a memo was issued to everyone saying that there would be none. And indeed there were none resulting from the merger as such, although when recession times hit the country in later years, redundancies did occur.

A man younger than me, had been appointed in charge of Information Technology (I.T.) at Clifford-Turner, and he was given the senior I.T. job over me, but I retained my job title as Business Systems Manager. Effectively I remained in charge of I.T. in the Coward Chance offices, and the I.T. Manager for the whole firm dealt with the computer systems in the Clifford-Turner building.

I shall now digress for a couple of paragraphs to describe a surprising event which happened six years earlier. There is huge irony in what happened regarding who became the new firm's I.T. Manager. Shortly after I joined Coward Chance, I was involved in a discussion about the problems of possible conflict of interest, which all large law firms have. I wrote a short paper in June 1981 on how the problem might be dealt with by using a computer system, and I discussed it with one of the partners who was interested in the subject. To my surprise, he said that I should also discuss it with one of the partners in Clifford-Turner, whom he knew well and who was also interested in the subject, and he arranged for me to go to their office, having sent a copy of my paper to him.

I duly met him, we discussed the ideas in my paper, and before I left, he surprised me by offering me a job as systems analyst for Clifford-Turner. I think that at that time they probably had no professional computer staff. But I had no interest in such a much more junior post than the one which I had at Coward Chance, and I declined the offer. I have often wondered what would have happened had I accepted. Would

I then have found myself in charge of Clifford-Turner's computer systems at the time when the merger would take place six years later, having developed for Clifford-Turner an ambitious system similar to the one which Coward Chance had at the time of the merger? And would I have been put in charge of Clifford Chance's systems?

Now to return to 1987. The most difficult problem for the merged firm was in fact Information Technology. Clifford-Turner had an IBM-based computer system, which was totally incompatible with the Burroughs system in the Coward Chance office. Both systems had to remain operating whilst a study was undertaken to decide how to proceed with I.T. The Coward Chance system was generally more advanced and comprehensive than the Clifford-Turner system, and the IBM computer at the Clifford-Turner office was nowhere near powerful enough to cope with the merged firm's requirements. So I hoped that the Burroughs system would triumph. But as time went on, it became clear that the OFISwriter was going to be displaced by more advanced machines, with larger screens – eventually the PC. At some point the OFISwriters would all have to be replaced.

There was rivalry between proponents of each system, including amongst the legal staff, not just the computer staff; an improvement would be made to one system, and the other system would be upgraded similarly. Eventually the partners decided to take action which pleased neither side, so it appeared to me: both systems would be scrapped, and a completely new system would be developed, taking the best system ideas from each of the existing ones. An IBM AS/400 computer was chosen, and I expressed reservations about it, because I thought that the model was not powerful enough to undertake the work for the entire firm, and IBM did not then have an upgrade, should that prove necessary. If I were proved right, the firm would find itself with a most intractable problem, unless IBM were able to introduce a more powerful model.

Development of the software for the new IBM computer went ahead, and it was found that the computer was indeed not powerful enough. But fortunately by that time, IBM had produced an upgrade, and this was installed. Clifford Chance had its first computer system able to serve the whole of the London office.

In 1990 and 1991 a recession hit the country's economy, and many companies went into liquidation, or were taken over or had to re-structure. There was as a result, a good deal of company business for law firms to undertake, to help deal with the crisis. But after that work was over, the recession was then felt by the law firms in 1992-1993, and many had to contract somewhat. In 1993 Clifford Chance made dozens of staff redundant, me included.

Ever since the merger in 1987, in spite of the promise of no redundancies, I had feared that one day it would happen, and indeed it did. I had spent a lot of time specifying a big new system called the Legal Information System, together with an outside consultant and one of our own staff. But the firm decided that it would be too expensive, and the project was scrapped. So in truth, at the time, I did not have very much work to do. I left the firm in May 1993 at a salary of £46,350.

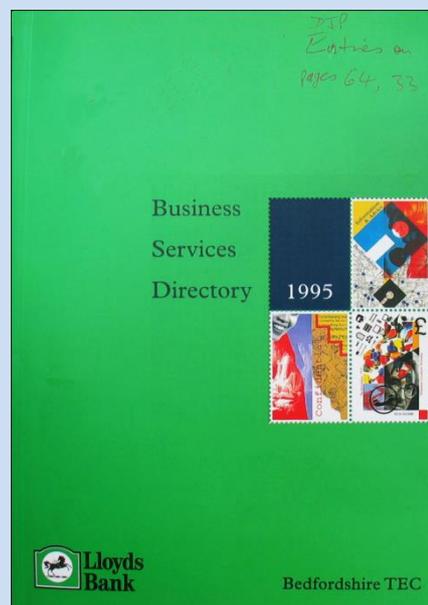
## Chapter 10: INFORMATION TECHNOLOGY CONSULTANT

Before I left Clifford Chance, I thought about what I should do next. I knew that at the age of 53, I was highly unlikely to find a senior information technology post in another firm. I had had thirteen years' experience of the benefits of using computers in law firms, and it seemed to me that I was in an ideal position to make use of my knowledge, so I set myself up as an independent information technology consultant to law firms generally, working from home.

On my first day working from home, I telephoned a senior man in a quite a large London law firm, which I thought might have some problems to solve. He agreed that I should discuss the problems with him, and we met a day or two later. I spent the best part of a day there, giving advice, and next day writing it up in a report. I submitted a bill for £700, which was settled promptly. I was over the moon – this life seemed to be highly lucrative!

However it proved to be just beginner's luck – I never afterwards had such a financially profitable day.

I joined Bedfordshire TEC (standing for Training and Enterprise Council), who were running a new business scheme course, which provided some training in setting up and running new ventures. It was helpful, especially in making me produce a business plan, which was approved and resulted in my business being listed in the Bedfordshire Business Services Directory. Here is the cover of the 1995 issue, which that year listed my entries on pages 33 and 64.



I received a small income from Bedfordshire TEC for a number of months (it may have been a year), in order to help my business get started; this was a standard feature of the Government's TEC schemes.

I was subscribing to The Lawyer magazine, and I think it may have been in one issue where I read about the Law Society's plans to produce a directory of consultants advising law firms, in all kinds of areas, one being information technology. I made enquiries, and I received the following letter from the Law Society:

Legal Practice Directorate *10/24/94*

Andrew Lockley  
Director

*4904000*



**THE LAW SOCIETY**

OUR REF: LPD/70/12/PSU

*Spoke to Mrs Buldon 24/1/94*  
*He said code of practice*  
*doesn't apply if my client*  
*is a supplier of goods/services*  
*to the solicitor & if*  
*my invoices don't*  
*go to the solicitor*

50 Chancery Lane  
London WC2A 1SX  
Tel: 071-242 1222  
Telex: 261203  
Dx: 56 LOND/CHANCERY LN  
Fax: 071-831 0057

Direct Dial Number: 071-320 5782

20 May 1993

Dear Consultant *19K Our Fin*  
*to be raised*

**DIRECTORY OF CONSULTANTS FOR SOLICITORS**

I am writing to you with reference to my letter of 2 April, or for the first time, if you were not originally on our database.

The Law Society intends to publish a Directory of Consultants for Solicitors early this summer. The Directory targets solicitors in private practice in search of a comprehensive listing of consultants who specialise in advising the legal industry and/or other professional service firms in one or more of the following areas: business planning and strategy, finance, human resources, information technology, marketing and quality. The Directory will coincide with the publication of the Law Society's Practice Management Standards in keeping with the Society's emphasis on quality and client care. This is an excellent opportunity for you to reach your market or potential market.

Attached you will find sample page layouts for the Master Index of Consultants, the Alphabetical Listing, and the Regional Listing as well as the Table of Contents to give you a "feel" for the book and how your entry would look. We believe this design will greatly simplify the user's task of finding and evaluating an entry within the Directory.

Besides the sample layouts and table of contents from the Directory, you will find enclosed the following:

1. The Law Society's Listing Procedure.
2. The Code of Practice with which all consultants must comply.
3. The data input form for your completion.
4. An application form which includes key dates for submission. Please note that we have attempted to keep the application fees as low as possible.
5. A referee's questionnaire, referee form letter and Form A for you to copy and send to your referees. The minimum acceptable number of references is three for the first specialism applied for and an additional one for each other specialism applied for. At least one of the references must be from solicitors in private practice; the others may be from other professional service firms. Former clients may provide references for more than one specialism.

The questionnaire employs a simple multiple choice format that should be quick and easy for your clients to complete. On the form, we request that your client returns the reference, once complete, directly to us and there is a slip for them to advise you that they have done so. ***We cannot qualify you for entry to the listing until we receive your references. Therefore, please note that the referee form letter requests that the questionnaire is returned to the Law Society on or before Wednesday 16 June.***

***It will not be possible to include you in a particular specialism in the listing if the satisfactory references have not been received by this date. Include a self addressed envelope addressed to me at the Law Society when you send these forms to your referees.***

Information from the references will not be published in the Directory, although, in the event that they are unsatisfactory, we may decline to list your consultancy. Should a problem be disclosed by the references, we will contact the consultancy before making a decision. Please refer to the Listing Procedure for further information. I look forward to your application.

#### **The Submission of Your Consultants Details**

The onus is on you to return your details to me by ***Wednesday 9th June*** at the latest and earlier than that if at all possible. We will not be able to follow up applications for listing which have not been received.

#### **Next Steps**

Your data will then be input onto our computer, checked and printed. You will then be sent your laser proof and any reference tables which affect you for checking and we will require confirmation from you by fax or phone that everything is correct by the schedule date.

There is a reason for the tight timetable. The Law Society has agreed its Practice Management Standards (copies of which may be ordered from the Law Society Bookshop on 071-242 1222) and wishes to ensure that solicitors have access to this directory at the earliest possible opportunity so that solicitors may seek consultancy advice in the appropriate circumstances.

I would also like to draw your attention to the following:

1. A conference for consultants organised by the Law Society has been provisionally fixed for Tuesday 14th September in Birmingham. Further details on venue, content and price will be sent to listed consultants.
2. It is intended that the lists should be reviewed annually and the facility to advertise may well be included in next year's edition.

In the meantime if you have further enquiries please contact me or my secretary Paula Crowhurst on 071-320-5782. Alternatively you may speak to my colleague Karen Monnick, Business Adviser who is also working on this project.

Yours sincerely

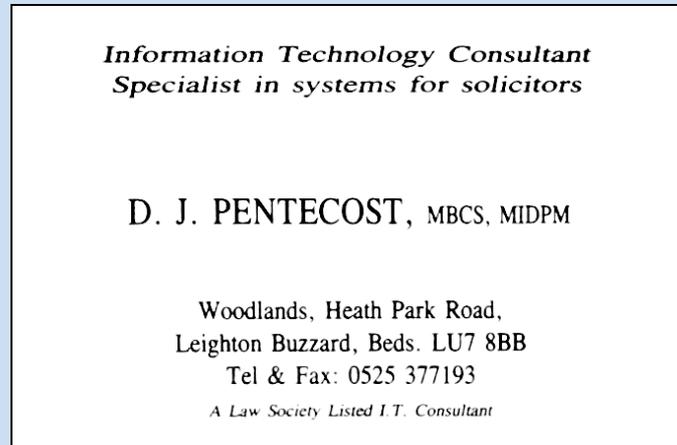


Clive Baldon  
Business Development Manager  
Practice Support Unit

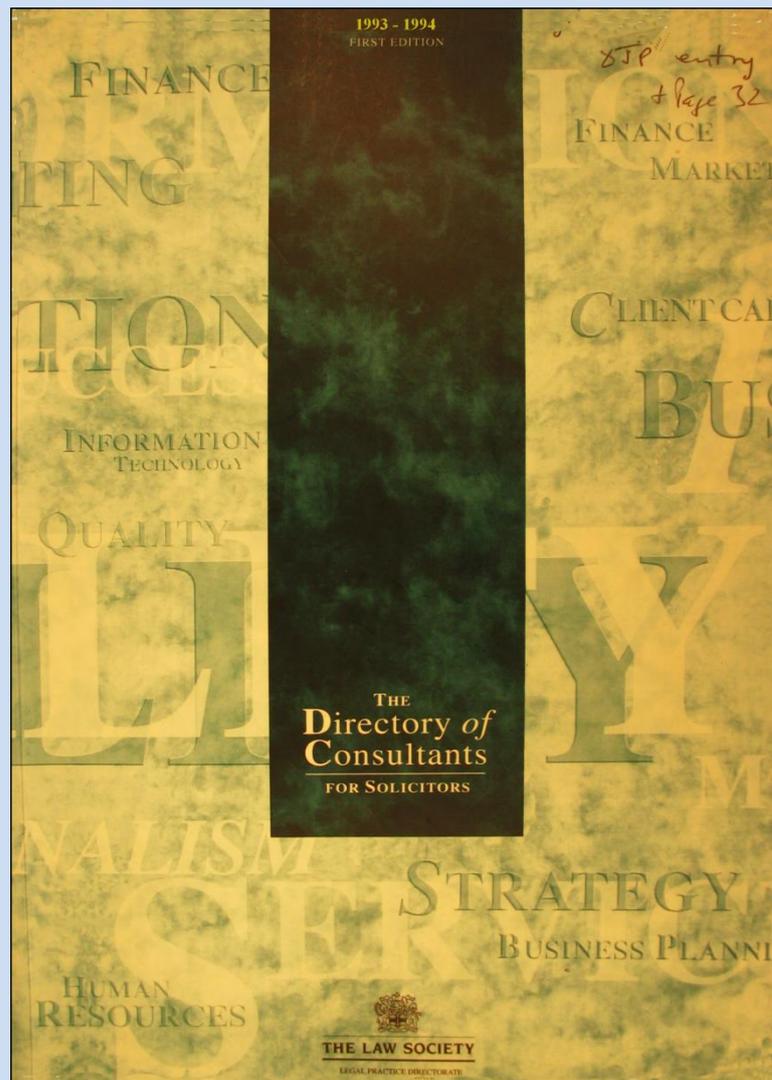


Law Society  
Listed Consultant

It was not a very simple procedure to get oneself listed by the Law Society, but I asked for and received the required references, one of which must have been from Clifford Chance (although I have not kept it), and I was duly accepted as a Law Society Listed I.T. Consultant:



My entry in due course appeared in the Law Society's Directory:



There were brief details about my services in several tables within the directory, but the main entry appeared as follows:

# THE Directory of Consultants FOR SOLICITORS

1993-1994



**THE LAW SOCIETY**

**D.J. Pentecost** Torrington Cottage, Church Path, Finchley, London N12 8GP  
Tel: (081) 445 9566, Contact: David Pentecost, Consultant

I have worked for over thirteen years for two large London-based international law firms, in charge of information technology and as business systems manager. Prior to that, I had over seventeen years in the computer industry, with software houses, computer manufacturers and commercial computer users. Having worked closely with solicitors for many years, I understand very well how they work, how law firms function and their computing needs. In the 80s, I developed integrated, client and matter, time recording, accounting, billing and electronic mail systems. More recently I specialised in legal know how systems, particularly document management, including text and image storage and retrieval. I have personal experience of voice recognition word processing. At present I offer services only to law firms, and regardless of practice size. Recent work: with firms of up to thirty partners, providing advice on I.T. Strategy, precedent management, word processing systems, and in-house computer project development. I am willing to provide consultancy without geographical constraints, but expect most of my work to be undertaken for practices in the South and Midlands. I am a member of the Society for Computers and Law, the British Computer Society and the Institute of Data Processing Management.

**Firm Details**

<i>Date Firm established</i>	March 1993	<i>Number of Partners/Directors</i>	1
<i>Initial Free Consultation</i>	Yes - up to 2 hours free within 50 miles	<i>Number of Consultants</i>	1, 1 in legal
<i>Membership of Professional Bodies</i>	BCS, IDPM, SCL	<i>Other offices</i>	-



	Area of Specialisation	Completed projects in last 18 months		DTI scheme offered
		Legal Projects	Total Projects	
Business Planning/Strategy				
Finance				
Human Resources				
Information Technology	•	2	2	
Marketing				
Quality				

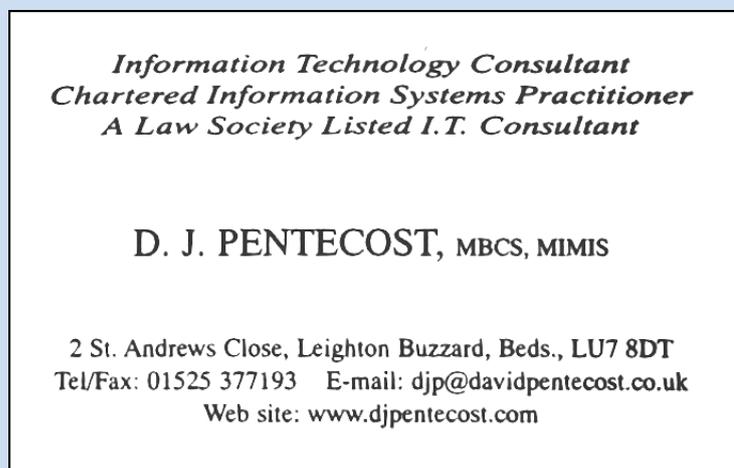
You may notice that in the above edition of the directory I used my parents' address in Finchley, in order to try to attract business from solicitors in and around London. From time to time after my mother died, I did live there with my father, and travelled to London whilst doing work for a few clients.

I wrote to law firms, announcing my services, and picked up some business, especially locally in Bedfordshire and Buckinghamshire. It was a time when many law firms were still using electric typewriters, and they needed advice and help in setting up word processing systems. Conversion to word processing systems in the legal world almost always involved installing WordPerfect; I trained secretaries for clients from time to time, and developed software to improve their use of the product. It was some years before Microsoft's Word started to become dominant in the world generally, and Microsoft provided within Word, a conversion program to read WordPerfect documents in order to capture the legal market in particular.

The move to word processing (WP) systems within the legal world was rapid, and effectively was forced on them. If a firm did not have a WP system, and another with whom they were dealing did, the former could only receive a document from the latter rapidly by hand or by fax; then the revised text could not be modified and sent back without retyping, and then further typing. Clients, especially corporate clients, in due course wanted to communicate with their own law firm by email too, which was another important influencing factor.

The most significant requirement by law firms for I.T. advice, especially for all but the very smallest firms, was for help in choosing an accounting and time recording system, and getting it operational. I had to examine the products of several software houses which had developed and were still improving systems aimed at law firms. This involved travelling to meet the suppliers at their development offices, learning their systems and plans, and even in some cases advising them on improvements which they needed to make before I could recommend their products to law firms.

After moving house in 1994, I had new business cards printed by Pentecost Printing:

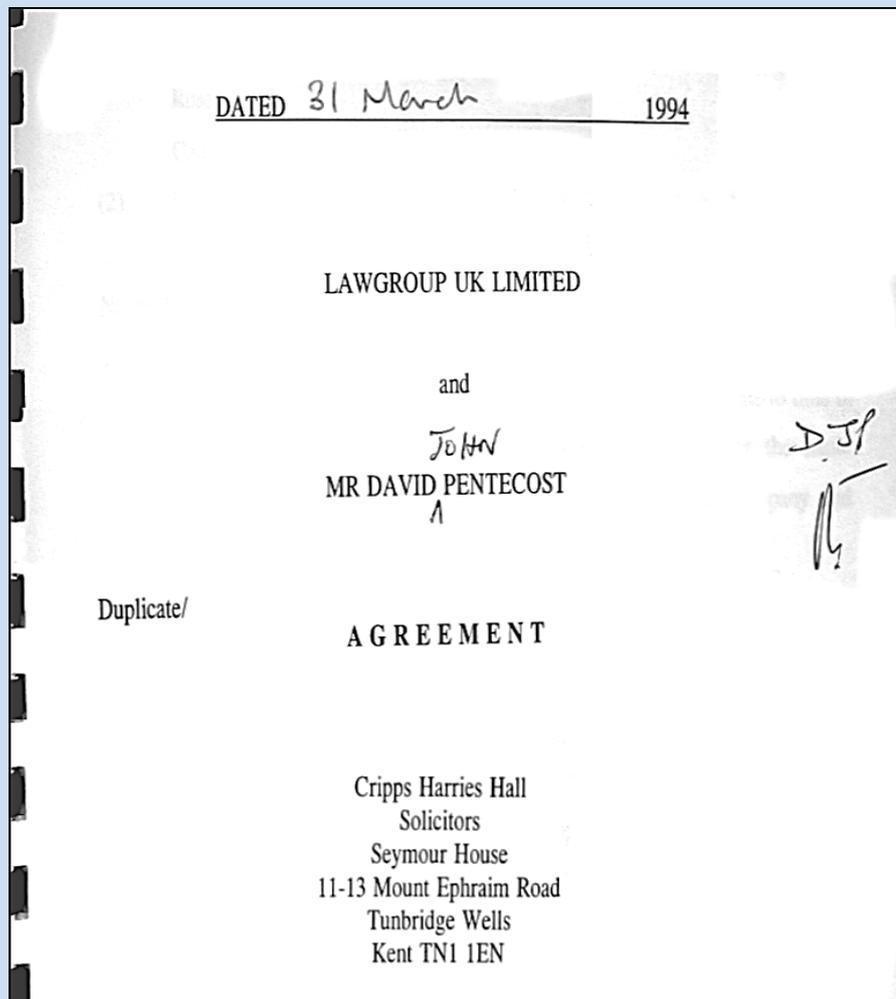


(I eventually abandoned my own domain names which you can see on the above card, at about the time when I started becoming involved in developing websites).

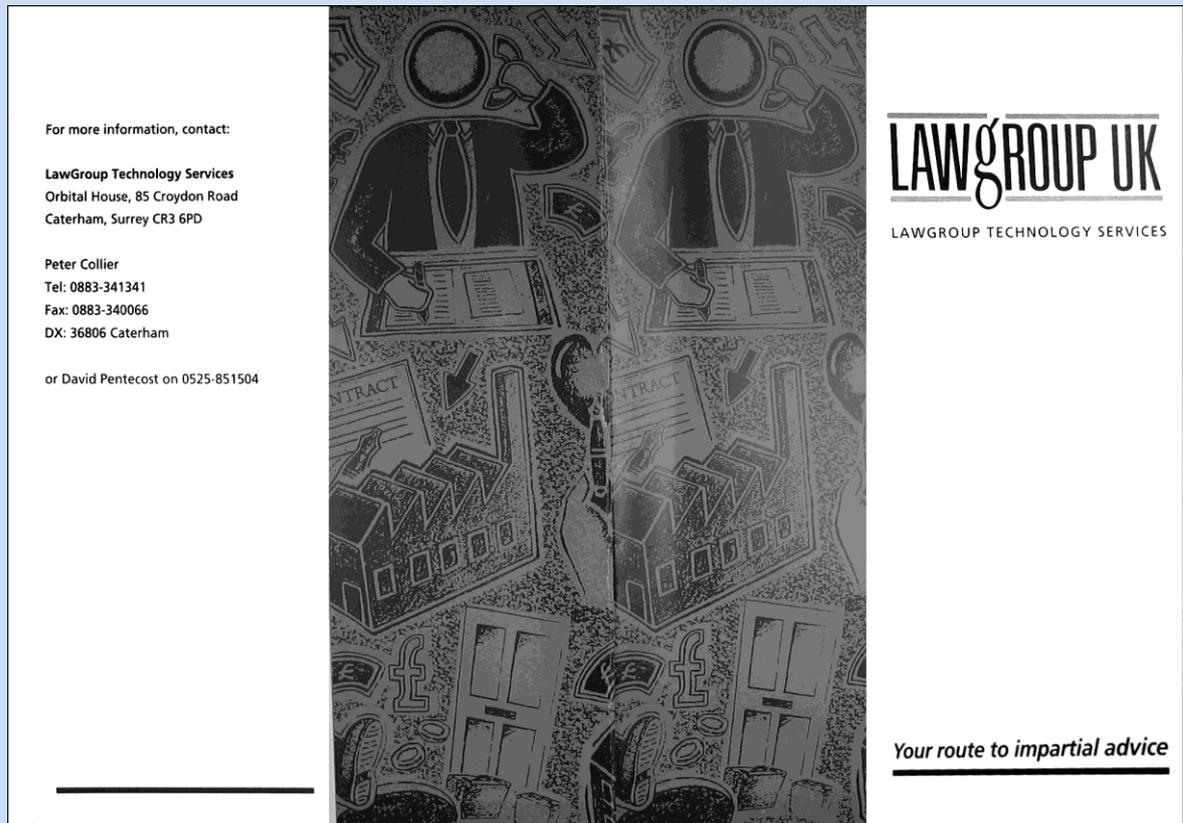
Work was not easy to get, in spite of the measures I had taken. I was sustained by a few clients, particularly one in Aylesbury, for whom I did a significant amount of work.

I had to take steps to gain more clients. I became aware of the fact that some law firms were beginning to co-operate with each other, not in the usual way in which law firms have to work together on legal matters, but in a different way, by becoming associated with a separate consultancy company which advised them on the non-legal aspects of their businesses, their methods of working, their marketing methods, training and so on.

In an edition of the Law Society's Directory of Consultants, I found a few such consultancy companies, and the most significant one was called LawGroup UK, based in Caterham, Surrey. I looked at their advertising material, noticing what services they offered, and observed that they did not offer I.T. advice at all. I contacted the managing director and made an appointment to see him, telling him that his company had a significant gap in its services, which should be filled. He agreed, and thought about how to proceed, considering whether to take me on as an employee, something which I had not wanted or requested. In the end we had a contract drawn up, which meant that all law firms in the group (more than 200) would be able to access my services for a fee, whilst I remained an independent consultant, working through LawGroup.



We created a new arm of LawGroup called LawGroup Technology Services (LTS), and produced a card, printed on both sides and folded to make four pages:



For more information, contact:

**LawGroup Technology Services**  
Orbital House, 85 Croydon Road  
Caterham, Surrey CR3 6PD

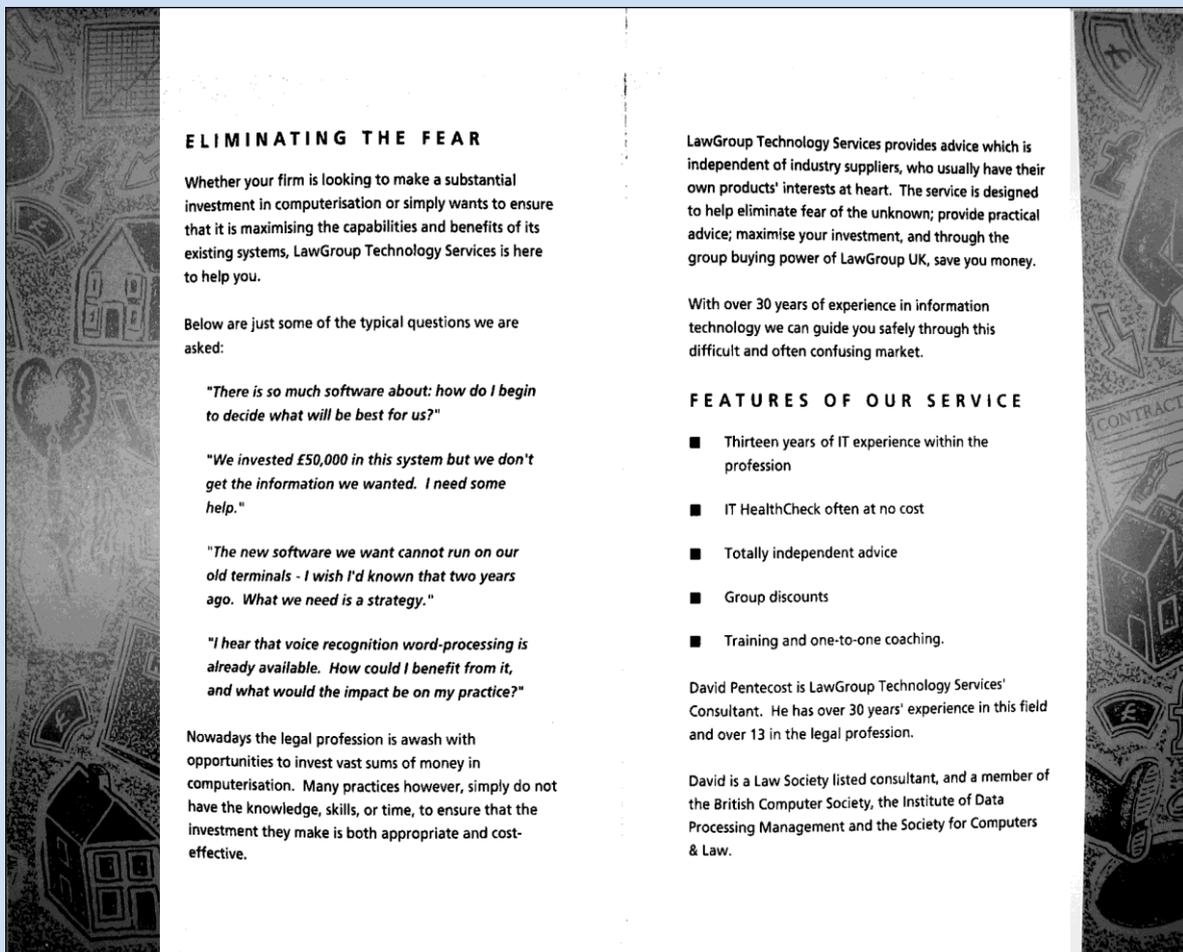
**Peter Collier**  
Tel: 0883-341341  
Fax: 0883-340066  
DX: 36806 Caterham

or David Pentecost on 0525-851504

**LAWGROUP UK**

LAWGROUP TECHNOLOGY SERVICES

*Your route to impartial advice*



## ELIMINATING THE FEAR

Whether your firm is looking to make a substantial investment in computerisation or simply wants to ensure that it is maximising the capabilities and benefits of its existing systems, LawGroup Technology Services is here to help you.

Below are just some of the typical questions we are asked:

*"There is so much software about: how do I begin to decide what will be best for us?"*

*"We invested £50,000 in this system but we don't get the information we wanted. I need some help."*

*"The new software we want cannot run on our old terminals - I wish I'd known that two years ago. What we need is a strategy."*

*"I hear that voice recognition word-processing is already available. How could I benefit from it, and what would the impact be on my practice?"*

Nowadays the legal profession is awash with opportunities to invest vast sums of money in computerisation. Many practices however, simply do not have the knowledge, skills, or time, to ensure that the investment they make is both appropriate and cost-effective.

LawGroup Technology Services provides advice which is independent of industry suppliers, who usually have their own products' interests at heart. The service is designed to help eliminate fear of the unknown; provide practical advice; maximise your investment, and through the group buying power of LawGroup UK, save you money.

With over 30 years of experience in information technology we can guide you safely through this difficult and often confusing market.

## FEATURES OF OUR SERVICE

- Thirteen years of IT experience within the profession
- IT HealthCheck often at no cost
- Totally independent advice
- Group discounts
- Training and one-to-one coaching.

David Pentecost is LawGroup Technology Services' Consultant. He has over 30 years' experience in this field and over 13 in the legal profession.

David is a Law Society listed consultant, and a member of the British Computer Society, the Institute of Data Processing Management and the Society for Computers & Law.

This was distributed to law firms within LawGroup, showing the telephone number of the second line which I had installed at my home, with a blue handset, so that I would know when I was being called by a LawGroup firm.

LawGroup also had some new business cards printed for me to use, after British Telecom lengthened many telephone numbers:



Together we produced some fold-up leaflets which were distributed to all firms in the group, setting out specific services which were not defined on the original publicity cards:

**W.P. Text Format Conversion**

Most word processor package text formats can be converted from one format to another. We undertake this either as a standard service, or arrange for conversion software to be written where necessary.

**New LINK**

LINK is a well-established specialised legal information and electronic document transfer service. We can help you to become part of the fast-growing LINK network, which also provides full Internet access for the World Wide Web and e-mail.



**Help Line**

We operate a telephone IT advice service on 01525 851504.



For further information, please contact:

David Pentecost  
MBCS, MIMIS,  
Law Society Listed IT Consultant  
Chartered Information Systems Practitioner

on

Tel 01525 851504  
Fax 01883 340066

or write to

**LawGroup Technology Services**  
Orbital House  
85 Croydon Road  
Caterham  
Surrey  
CR3 6PD

DX 36806 Caterham  
E-mail: 101714.234@Compuserve.Com



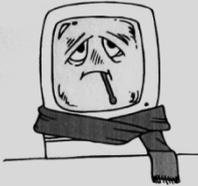
**LawGroup Technology Services**





### ***IT 'Health Checks'***

The standard health check involves a visit to your offices for about half a day. Staff are interviewed to gain an understanding of the current IT situation, and your thoughts on future developments.



We also look at data security, hardware, software, computer systems in use, and report back to you in writing, providing as much general advice as possible within the budgeted time, based on the information gained.

### ***Strategic Consultancy***

We advise on IT at a strategic level. This involves providing guidance on systems covering accounting, time recording, marketing, case management, word processing, speech recognition, and on types of network, operating systems, hardware and system software. We also help you with the choice of suppliers for all these elements of a total system.



### ***Word Processing Reviews & Training***

These services apply only to Microsoft Word 97 and the following versions of WordPerfect: DOS 5.1, 6.0, 6.1, WIN 6.1, 7.0.

Most firms do not make the best use of word processing systems. We study your use of your w.p. system, identify practices and features not used, and teach you to use them efficiently, so improving productivity.

We can also arrange for full and formal general training courses locally, conducted by experienced instructors, as well as providing one-to-one training on specialised topics.

### ***Document Assembly***

This is as yet a comparatively little-used technique for producing documents from frequently used precedent components. It represents one of the most significant productivity tools available to legal practices to-day.

The technique involves integrating a product such as HotDocs with MS Word or WordPerfect. The benefits can be enormous in terms of fee earner and secretarial time saved.



### ***Word Processing Macro Development***

Many firms use simple text-recalling macros, but do not have the expertise to benefit from the advanced time-saving features provided by use of the macro programming language. Macros can make aspects of your practice's administration simpler, more standardised and reliable.

We study your need for macros, develop them for you, and then train your staff to use them.



### ***Document Scanning***

We arrange to convert good quality copy printed text into WordPerfect, MS Word or ASCII format on 3 1/2" diskettes, for you to word process.



One of the arrangements we made was that I would on request do a free half day 'I.T. health check' for a firm within the group, and write a brief report, recommending what actions could with advantage be taken to make improvements. For work resulting, I would either quote a fixed fee, or charge by the hour, plus travel expenses. My bills would be sent to LawGroup's office, who would settle them with me each month, and LawGroup would invoice the client law firms. This arrangement proved very satisfactory for me, and provided me with a generally good income almost every month.

The Law Society's

# **INFORMATION TECHNOLOGY DIRECTORY 1997**



The 1997 edition of the the Law Society's Information Technology Directory, had the following entry for my services through LawGroup:

## **LAWGROUP TECHNOLOGY SERVICES (LTS)**

**Head Office: Orbital House, 85 Croydon Road, Caterham,  
Surrey CR3 6PD**

Tel: 01525 851504

Fax: 01883 340066

E-Mail: 101714.234@Compuserve.Com

Contact: David Pentecost MBCS, MIMIS, IT Consultant  
and Chartered Information Systems Practitioner  
Business established in 1989 (LawGroup), 1993 (LTS)  
No. of Directors 6  
No. of Staff: 31

### **SERVICES**

Target firm size: All

#### **Support Services**

Consultancy: in-house; Installation: third party; Training:  
in-house, third party; Facilities Management: third party;  
Maintenance: in-house, third party

On Site Support

Helpdesk available

Normal office hours

### **Company Profile**

LTS is the information technology services arm of LawGroup UK, specialising in providing independent advice and practical assistance for law firms throughout the UK; our expertise in this field goes back to 1980.

Originally set up to provide services for member firms within the LawGroup network, we now offer these services to all law firms. *IT Health Checks*: The standard service involves visiting your offices, and then reporting to you in writing. *Strategic Consultancy*: Guidance on systems covering accounting, time recording, marketing, case management, word processing and speech recognition; types of network, operating systems, hardware and system software. Assistance with choice of suppliers for all these elements of a total system. *Word Processing Reviews*: Many firms make inadequate use of word processing. We improve your productivity by identifying methods and features you do not use, and teach you to use them efficiently.

*Document Assembly*: This as yet comparatively little-used technique for producing documents from frequently used precedent components, represents one of the most significant productivity tools available to legal practices today. We assist with the development work. *Word Processing Macro Development*: Many firms use simple text-recalling macros, but lack expertise to benefit from time-saving features provided by advanced use of the macro programming language.

Working as LTS kept me generally very busy. Because the law firms of the group were all over the country, I had to do a good deal of travelling, not just by car, but preferably when I could, by train. The train was more relaxing and allowed me to write reports on the return journey, whilst the discussions were fresh in my mind. I had the pleasure of visiting parts of the country which I had never been to before, for example in the north-east. On one or two occasions I had to fly to Scotland, and on several occasions I visited a law firm in Wales, for whom I did quite a lot of work, specifying new systems and helping them to choose a computer system supplier.

Each year, LawGroup held a conference in a large hotel somewhere, usually in a different part of the country on each occasion. I took part in one of these conferences, and had to prepare an illustrated lecture. It was a little unnerving, standing on a stage and lecturing to a few hundred lawyers, advising them how they might make use of technology in their offices; but all went well. It was at the time when speech recognition was being considered for use in law firms and elsewhere, and my lecture included a demonstration.

I also continued doing work for a few law firms locally, which were not part of LawGroup, and I decided to print some leaflets for my own practice using some ideas which were included in the LawGroup consultancy leaflet:

<p><i>A Law Society Listed I.T. Consultant Chartered Information Systems Practitioner</i></p> <p><b>D. J. Pentecost</b></p> <p><i>Member of The British Computer Society Member of The Institute for the Management of Information Systems Member of The Society for Computers &amp; Law</i></p> <p><i>Over 18 years' experience in the legal computing world</i></p> <p>2 St. Andrews Close Leighton Buzzard Bedfordshire LU7 8DT</p> <p><b>Tel. &amp; Fax: 01525 377193</b></p> <p>E-mail: DavidPentecost@Link.Org</p> <p><i>You are invited to take up references</i></p>	<p><b>I. T. 'Health Checks'</b></p>	<p>The standard health check involves a visit to your offices for about half a day. Staff are interviewed to gain an understanding of the current I.T. situation, and your thoughts on future developments.</p> <p>Data security, hardware, software, computer systems in use are examined, and you receive a written report providing as much general advice as possible within the budgeted time, based on the information gained.</p>	<p><b>Document Assembly</b></p>	<p><b>Speech Recognition</b></p> <p>The latest continuous speech recognition products now available, allow lawyers without fast keyboard skills to produce their own documents more efficiently than with the older discrete speech products; services provided include supply, installation and instruction.</p>
	<p><b>Strategic Consultancy</b></p>	<p>Advice on I.T. is provided at a strategic level. This involves guidance on systems covering accounting, time recording, marketing, case management, word processing and speech recognition; types of network, operating systems, hardware and system software. Help is given with the choice of suppliers for all these elements of a total system.</p>	<p>This is as yet a comparatively little-used technique for producing documents from frequently used precedent components. It represents one of the most significant productivity tools available to legal practices to-day.</p>	<p><b>Document Scanning</b></p> <p>Good quality copy printed text is converted into WordPerfect, MS Word or ASCII format on 3½" diskettes, for you to word process.</p>
	<p><b>Word Processing Reviews &amp; Training</b></p>	<p>These services apply only to the following versions of WordPerfect. DOS 5.1, 6.0, 6.1, WIN 6.1, 7.0, and to Microsoft Word 97.</p> <p>Most firms do not make the best use of word processing systems. Use of your word processing system is examined, practices and features not used</p>	<p><b>Word Processing Macro Development</b></p>	<p><b>W.P. Text Format Conversion</b></p> <p>Most word processing package text formats can be converted to another format. (e.g. from WordStar to Word). This is provided either as a standard service, or where necessary, arrangements are made for conversion software to be written.</p>
			<p>Many firms use simple text-recalling macros, but do not have the expertise to benefit from the advanced time-saving features provided by use of your word processor's macro programming language. Macros can make aspects of your practice's administration simpler, more standardised and reliable. Your need for macros is studied, these are then developed for you, and your staff are trained to use them.</p>	<p><b>LINK version 3.5</b></p> <p>LINK is a well-established secure electronic DX service for lawyers. Become part of the LINK network, and you can opt also to have access to e-mail via the Internet.</p>
				<p><b>Help Line</b></p> <p>A telephone I.T. advice service is operated on 01525 377193. If the required information is to hand, you will receive instant advice; otherwise, an offer will usually be made to research the point for you, and report back as soon as possible.</p>

There came a time when I began to be uneasy about doing work for LawGroup firms, in spite of having good personal relationships with lawyers in the firms. LawGroup had always been very good at settling my bills to them, but increasingly, there were longer and longer delays. At one point I was waiting for a whole year before the bills were paid, and it was then that I was thinking of refusing to accept any more work for LawGroup.

I rarely visited the LawGroup office in Caterham, so I did not have any feel for how things were, and what the atmosphere was like. One day I learned that the managing director with whom I had set up LTS had left LawGroup. So it seemed to

me that something had been going wrong in some way with LawGroup during the previous year. In due course, a new manager whom I did not know contacted me, saying that the group no longer wished to have an outsider acting for LawGroup. I was stunned: it seemed to me that he was not aware of the work which I had been doing, or that I had a formal signed agreement with LawGroup. I decided not to argue the point, especially because I had been funding LawGroup's LTS activities for about a year, and it was a relief for that position to end. The situation must have been bad in some way in Caterham which I knew nothing about. But all my invoices were settled, which was also a relief.

My connection with LawGroup ended in around 1999, as far as I can recall. But I continued doing work for a few non-LawGroup firms actively until about 2003.

In 1996 Microsoft brought out its first website development software, called FrontPage. I bought a copy in 1998 or 1999, and taught myself to develop websites, at first simple ones by today's standards. I decided to offer website development services, not only to law firms, but to any business, however small. I bought the domain a1webdesign.co.uk, initially for a two year period, and renewed it several times until eventually giving up after retiring from the information technology world.



So I added another activity to my consultancy business, and had some additional business cards printed in July 1999:

## **A1 Web Design**

Internet Web Site Development Services

**D. J. PENTECOST, MBCS, MIMIS**

*Information Technology Consultant*

*Chartered Information Systems Practitioner*

2 St. Andrews Close, Leighton Buzzard, Beds., LU7 8DT  
Tel/Fax: 01525 377193 E-mail: [djp@a1webdesign.co.uk](mailto:djp@a1webdesign.co.uk)  
Web site: [www.a1webdesign.co.uk](http://www.a1webdesign.co.uk)

As well as developing and uploading my own website to the Internet, I did some press advertising for my website services, and received enough enquiries to keep myself fairly busy. The businesses were extremely varied in nature; they were mostly small companies, and about half of them sole traders, and I learned a great deal about types of business with which I had never had any previous contact.

One example which comes to mind was for a ladies' oriental fashion house based in Paris. The website had to be developed in both English and French; at last the French which I learned at school had actually helped me to earn some money, instead of just being useful from time to time in life generally.

Here is a list of some business types for which I developed websites:

- Airport chauffeur
- Builder
- Business registration services
- Cable accessories supplier
- Car purchase financing
- Chamber music festival
- Classical music club
- Cleaning company
- Dental ceramics laboratory
- Explosive protection exporter
- Finance companies
- Fish and chip shop
- Flight protection case maker
- Flooring installer
- Football coaching
- Handyman
- Lawyers
- Machine tools supplier
- Mailing company
- Map designer
- Oriental dress maker
- Osteopath
- Pet shop supplier

Power tools supplier  
Printing company  
Psychotherapist  
Public house  
Religious book promoter  
Sculptor  
Vintage car sales  
Violinist

Another customer was a man who rented out holiday homes in France. That was a difficult development for me, because it required that for the first time I learn how to integrate a relational database into a website. I had to acquire and learn how to use some special software from Microsoft to permit the integration of an Access database into a FrontPage website.

That development became important to me and to the estate agent employee in Cyprus who sold me my flat in Limassol in 2003. She resigned her post to set up her own estate agency. I told her about the website I had developed for my customer dealing in French properties. She became a good friend, and I said that I would like to redevelop the site free of charge for her, to help her with her new Cypriot estate agency.

The site was successful and had a few hundred properties on it for about a decade, until disaster struck. Without warning, suddenly the site ceased to work. The Internet Service Provider (ISP) in the UK without warning had updated their server with new software, which was incapable of supporting Microsoft's Front Page software and its extensions. They said that they had no staff who understood the old server software and there was nothing they could do. I searched to find another ISP who would be willing to host the site, and eventually I found one in the USA. The site was successfully transferred and ran for a while, until the new ISP again without warning stopped operating and he vanished. It was time to abandon the site with the out of date software, and develop a new one. I was by then retired and unfamiliar with the latest technologies; I could learn, but I said that it would be unwise from the future site maintenance point of view, and that a new developer would need to be found, which is what happened in due course.

Gradually I ended my relationships with nearly all my customers as I approached age 65, by which time I was living full time in Cyprus, and they migrated to other developers. I continued to assist a few of them from Cyprus for a few years.

My paid working life had come to an end, and I could spend my time at leisure, playing tennis, bridge, piano and composing. Or so I thought, but much more hard work was to come, although unpaid.

## Chapter 11: OUR COMPUTER HERITAGE

Leon Bagrit was a great innovator, who in 1947 had acquired control of Elliott Brothers, where I had worked from 1960 to 1962. In 1958, Elliotts and Associated Automation Ltd were merged to form Elliott Automation. Bagrit's company pioneered the use of computers in industry and made automation a household word. In 1964 he gave six Reith Lecture broadcasts for the BBC, entitled 'The Age of Automation'.

He died in 1979, and I think that it was after his death when the Bagrit Trust was set up. The Bioengineering Department of Imperial College London was named the Sir Leon Bagrit Centre in his honour in 1991, when the Bagrit Trust provided funding for it to be built.

On 21st July 2003, I received an email from Jeeva Wijeyesekera, a friend who worked at Imperial College in London. She had received an email on 9th July from Professor Simon Lavington of Essex University, who was enquiring about Leon Bagrit. Lavington was asking if any Bagrit papers were held at Imperial College, which might help him to write his book about Elliott computers built at Borehamwood. What good fortune it was, that not only had Lavington chosen to address his enquiry to her, but that she also recalled that I had worked at Elliotts decades previously!

**Subject:** [Fwd: Sir Leon Bagrit.]

**Date:** Mon, 21 Jul 2003 13:05:08 +0100

**From:** Jeeva Wijeyesekera <j.wijeyesekera@imperial.ac.uk>

David,

Were you at Elliot's during this time?

J

Jeeva Wijeyesekera  
Course Administration  
Department of Bioengineering  
Imperial College

I asked her to find out more, and she was able to tell me how to get in touch with Professor Simon Lavington who was also seeking former employees of Elliotts who had worked there in the 1950s and 1960s. Simon Lavington was leading a project to document on the Internet, the story of early British computers, as well as writing his book about Elliotts.

I made contact with him, and he sent me an email explaining his project, which was to create a definitive website about the history of British computers, for the benefit of future historians and students of computers, whilst some of the pioneers were still alive to tell the tale. He was at the time dealing just with computers made by Elliott Brothers (London) Ltd, Ferranti Ltd, Leo Computers Ltd, EMI, English Electric Ltd and BTM/ICT/ICL. Other manufacturers' computers would be researched some years later.

He was seeking people who would be willing to act as co-ordinators of other people who needed to be found, and who could be persuaded to provide historical

information about computers which they knew about or had worked on. The series of Elliott computers which I could help with was the 400 series, which comprised the 401, 402, 403, 404 and 405; I had worked only on the 405, and knew one person who had worked on the 402, but I knew no one who had worked on the 401 and 403. I knew the man, R. G. Mills, who had specified the 404, and I discovered the specification he had written, but the machine was never built, so there was no work to do in respect of that particular machine.

I was very happy to do the work for the 405, and luckily, being something of a hoarder, I had kept some historic material about the machine. Even so, some research would be necessary. The 402 required more research, but at least I had a starting point – the person whom I knew who had worked on the machine, and who knew a few others.

But the 403 computer presented a huge problem. Only one computer had been built, and I could find no one in the UK who knew anything about it. The computer was commissioned for use in Australia by the British Government, to help develop guided weapons at the secret Long Range Weapons Establishment, at Woomera, in South Australia.

This project was going to represent a huge amount of work, not only for me but for others too, whom I would have to locate and persuade to help me collect the information together; they and I would be paid nothing for our labours. But the project came at quite a good time for me, because my consultancy business had almost wound down, and my work was then mostly doing maintenance on some websites.

The new project should be satisfying, would provide me with a lot of detective work which I would enjoy, and I would as a result be able to leave my mark on the history of British computing in a section of the website which would be developed at [www.ourcomputerheritage.org](http://www.ourcomputerheritage.org).

That website now exists, and it has been accepted for archiving by the British Library, who store a copy. That copy is available to the public, as well as the master copy, which is at present hosted on a computer at Birkbeck, University of London. At any one time, the copy at Birkbeck is likely to be more up to date than the one at the British Library, because it is still being worked on at the time of writing (2016).

For each computer, the work was required to be set out in five sections:

- A list of purchasers of the computer from Elliotts

- Systems architecture

- Instructions sets and timings

- Software and sample programs

- A list of references

I had to find manufacturers' documents, photographs and manuals from many sources: individuals who had happened to keep a copy, technical libraries and museums, and book extracts. Some of these required me to get special permission from official sources to publish copies. In particular I needed to reproduce Elliott literature, and I discovered that BAE Systems were the owners of Elliott Brothers (no longer a trading company), and therefore they owned the copyright. I decided that I needed a letter of authority to ask for documents from various organisations, but in particular from BAE Systems. The letter is below. I found it necessary to use it several times during the course of the project.



I wrote to the secretary at BAE Systems, and he gave me permission to make copies of Elliott documents. In some circumstances, I had to persuade people directly involved, to write text for me. One Elliott computer manual was recorded as being at Bletchley Park, but staff there failed to find it after a lengthy search in a hut

full of documents, which had not yet been catalogued; many weeks later, someone came across the document and luckily remembered about my enquiry, so eventually I received a copy. Others I found in boxes in the Science Museum annexe at Blythe House, some I collected from an ex-Elliott employee who had kept them; photos came from many sources, some from the Internet, some about the 405 computer from the Powerhouse Museum in Australia, where large parts of a 405 were on display.

Some documents needed to be included on the website, but were copies of copies and so poor that they could never be read without a struggle. I was obliged to re-type them in their original format using the same typeface, font size and with the same layout and page numbering. Then I had to double-check them for accuracy. Some of this work was very difficult, especially when it involved special symbols and small diagrams. I spent several weeks working seven hours a day just copy-typing and checking; scanning and using optical character recognition was possible in only a few cases. This part of the project was extremely tedious.

A large and exciting part of the detective work came when tracing people in Australia who had worked on the 403 computer. I was fortunate to find them; one led to another, and then to another and so on, and most were able to contribute in some respect; one of them had moved to Canada, and I managed to find him as well.

In November 2004, an email arrived addressed to someone at the British Computer Society office, and also to Simon Lavington; it came from John Deane, secretary of the Australian Computer Museum Society, who somehow knew of the Computer Conservation Society here in the UK, and he said "I've been chasing ELLIOTT 403 (*WREDAC [Weapons Research Establishment Digital Automatic Computer]*) material for some months & I'm about to order copies of circuit diagrams & some documentation from Aust Defence archives". He had found a document concerning magnetic tape storage equipment and wanted to know if it would be of any interest to us. Simon Lavington forwarded the message to me, which started a long series of exchanges of emails between me and several other people in Australia.

The timing was fortunate, because the Australian Government had recently declassified all the 403 material. But it was not until March 2005 when John Deane was able to send me a list of almost fifty declassified 403 documents, and also his exchange of emails from mid 2004 with several people.

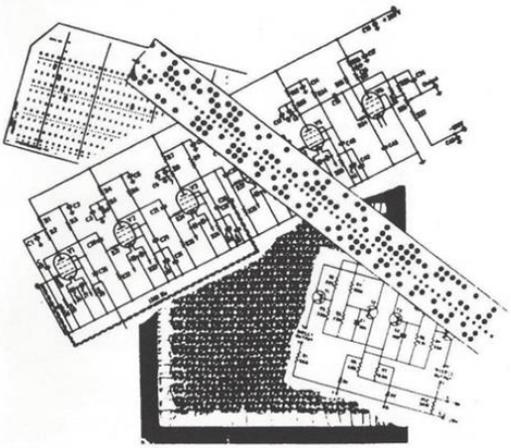
One of these was Barbara Biggins, who said that she had worked on WREDAC as an operator, and as a programmer from its installation until its eventual replacement by the IBM 7090, and she had some photos of the 403 and people working on it. The photos then came to me from John Deane.

Another set of emails was with Don Fenna, who had also worked on the 403, primarily for tracking guided missiles, and later with some software and hardware adaptations, also for tracking the Russian Sputnik satellite.

A third set of emails came from Jack Smith, in which I found addresses also for Alex Reid and Peter Main. And finally John Deane gave me the address of Peter Goddard, who had a photo of the Elliott nameplate of the 403; Peter was one of the chief programmers, and he knew of three more 403 people: John Weadon, John Penny and Frank Day. At last I had contacts with people who had direct knowledge and experience of the 403.

But there was nowhere near enough information about two key very senior figures, then both deceased: John Ovenstone and Don Overheu.

At the end of April 2005 I made myself known by a long explanatory email to Barbara Biggins, asking for her help to produce four of the sections of our website relating to the 403. She replied immediately, saying that she would do her best to help, and I responded by telling her how to set about the tasks, probably by first asking John Deane to send her copies of some of the documents which he had, which he subsequently did. She then said that she was handing over the project to Peter Goddard, who was better qualified than she was to undertake the required tasks. Peter was most helpful in producing the majority of the text, or pointing me in the right direction to obtain it from various books. Without his help, it would have been much more difficult, perhaps impossible, to complete the work on the 403 computer.

<p>Issue Number 38 <i>See page 4 for reference to me</i> Summer 2006</p> <p>Computer</p> <h1>RESURRECTION</h1> <p>The Bulletin of the Computer Conservation Society</p>  <p>science museum    BCS THE BRITISH COMPUTER SOCIETY    THE MUSEUM OF SCIENCE &amp; INDUSTRY IN MANCHESTER</p>	<h3>Our Computer Heritage Working Party</h3> <p>Simon Lavington</p> <p>CCS volunteers are making slow but steady progress in compiling technical information on a selection of early British computers – see <a href="http://www.ourcomputerheritage.org/wp">www.ourcomputerheritage.org/wp</a>. An example of recent detective work is the entry for the Elliott 403 computer which was delivered to the Weapons Research Establishment, Woomera, Australia, in August 1955, where it was used for the analysis of guided missile trials. Many thanks to David Pentecost and colleagues for the substantial collection of uploaded pages containing interesting information on the Elliott 400 series machines.</p> <p>Browsing such information has recently been made easier with the addition of tabs and drop-down menus to the Pilot Study Web site, for which we thank Phil Gregg at Birkbeck College. Finally, here's a cry for help. We badly need someone to take responsibility for the English Electric section of the Web site and especially for the Deuce and KDF9 subsections. If you can help, or if you know the name of a likely contact, please please contact me.</p> <p>Contact Simon Lavington at <a href="mailto:lavis@essex.ac.uk">lavis@essex.ac.uk</a>.</p>
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From all the sources mentioned above, and a few others, I completed my work on the 403 computer, and in due course submitted it to Simon Lavington, who was in charge of the entire project. What I did not know, because none of my Australian contacts mentioned it, was that there was a second, ancillary, Elliott machine, which was in Australia named WREDOC. Simon Lavington found out about this from

documentation which he discovered, and he amended and added to the texts which I had written. WREDOC was the 403's ancillary equipment used for bulk input/output of data. WREDOC's main mode of use was to accept from the 403, the analysis results, via magnetic tape, for off-line printing via a Bull lineprinter, and for graphical display.

\*\*\*\*\*

I owe a debt of gratitude to Peter Holland, for his help in producing material for the 401 computer. He had been working for some time on a project to get the 401, which is stored at the London Science Museum, to work once more.

And as far as the Elliott 402 computer is concerned, I had a good deal of information sent to me by Tony Limberg, who had worked on that computer many years previously. His help was invaluable.

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Anyone who wishes to read the results of my work on the massive project to create the sections of the website at [www.ourcomputerheritage.org](http://www.ourcomputerheritage.org) which relate to the Elliott 400 series of computers, must visit the website. I list below, addresses of links to some of my parts of the website. My texts for the site were submitted to the editor in 2011, and at the time of writing, many of the texts are dated 2016 after editing. (As I understand it, the website is still being developed for later British computers, so it is not impossible that the links below may change from time to time).

The main website is at [www.ourcomputerheritage.org](http://www.ourcomputerheritage.org)

At [http://www.ourcomputerheritage.org/ellio\\_15.htm](http://www.ourcomputerheritage.org/ellio_15.htm), you will find five boxes in the second column, about the Elliott 400 series of computers. The links to these five boxes, and the links contained within those linked texts are shown below. I was responsible for developing these sections of the website.

<http://www.ourcomputerheritage.org/ccs-e2x1.pdf> (A list of the Elliott 400 series computers delivered, and what applications were run on those computers).

<http://www.ourcomputerheritage.org/ccs-e2x2.pdf> (Systems architecture notes about the 400 series computers).

<http://www.ourcomputerheritage.org/ccs-e2xtra1.pdf> (It is in this section of the website, on pages 16-25, where you will find full details about the 405 computer's automatic timing program which I wrote, also referred to in chapter 3 of this book).

<http://www.ourcomputerheritage.org/ccs-e2xtra2.pdf> (Extra information about the 403 computer is shown here).

<http://www.ourcomputerheritage.org/ccs-e2xtra3.pdf> (Information about the second-hand 405 computer given to the Forest Grammar School, and within the notes, a link to a BBC film, which is available on the BBC website, but which can

apparently be viewed only from a computer with a UK IP address. This fascinating old film can be accessed at: <http://www.bbc.co.uk/archive/tomorrowsworld/8008.shtml>

<http://www.ourcomputerheritage.org/ccs-e2xtra4.pdf> (This section of the website contains programming manuals and some related papers for the Elliott 401, 402, 403 and 405 computers. There are 186 pages, most of which I very carefully typed and double-checked over a period of several weeks, from copies of original documents, because the copies were not in an acceptable condition to show as scanned documents. Some pages were barely legible).

<http://www.ourcomputerheritage.org/ccs-e2x3.pdf> (This section of the website defines the binary structure of the instructions used by the Elliott 400 series computers, and some details of the times taken for those instructions to be executed).

<http://www.ourcomputerheritage.org/ccs-e2x4.pdf> (This section shows examples of software for the 400 series computers; it is a much edited and reduced version of my original text, with the examples of software which I found shown separately, and now being referred to by links within the text).

<http://www.ourcomputerheritage.org/ccs-e2x5.pdf> (This section shows a list of sources for information shown on the website about the Elliott 400 computers).

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That brings me to the end of the description of some of my contribution to the development of the website defining a history of the 400 series of Elliott computers. The work took place on and off during the period 2003 to 2011. It was stimulating research, and involved a good deal of detective activity which I found extremely enjoyable. Some of the work was very boring and taxing, especially the typing, some of which was tricky, with use of special characters, subscripts, superscripts, underlining, and even overlining. I am very satisfied with the results, and so glad that I had the opportunity to undertake the work. Simon Lavington, in charge of the entire project, was wise to initiate the project when he did, whilst some computer industry personnel who had worked in the 1950s and 1960s were still alive, and could be traced and persuaded to take part. I am proud of the legacy which I shall leave behind.

I have also now reached the end of the story of my paid working life, which was spent almost entirely, directly and indirectly, in the computer industry. My working life continued, as unpaid self-employment, in the world of music. The first edition of 'My Life in Music' was published in February 2017, printed as a limited edition, under ISBN reference 978-0-9518719-2-8; a copy was deposited as required by law, in the British Library. A second edition, updated to 2020 is being written as an e-book, under reference ISBN 978-0-9518719-4-2, also to be deposited at The British Library.

**My Working Life** © 2018 & 2020 D. J. Pentecost. ISBN 978-0-9518719-3-5  
D. J. Pentecost, 2. St. Andrews Close, Leighton Buzzard, Bedfordshire, LU7 1DB