T362 Block 2 Units 6–8

DESIGN AND INNOVATION

The Open University
Technology
A Third Level Course

BLOCK 2
MARKETING

SINCLAIR'S QL MICROCOMPUTER

BRITISH TELECOM'S PRESTEL

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Prepared on behalf of the Course Team
by Godfrey Boyle

Design and Innovation

This text consists of two case studies on the marketing of high-technology innovations. It forms part of an Open University course entitled T362: *Design and Innovation*, which examines the processes of design and innovation under a variety of industrial, commercial, social and political circumstances.

A full list of aims and objectives for these case studies, together with self-assessment questions (SAQs) and references to relevant articles in the Course Reader (Roy, R. and Wield, D. (eds.) (1985) *Product design and technological innovation*, The Open University Press) can be found in the Study Guide for Block 2 of the course.

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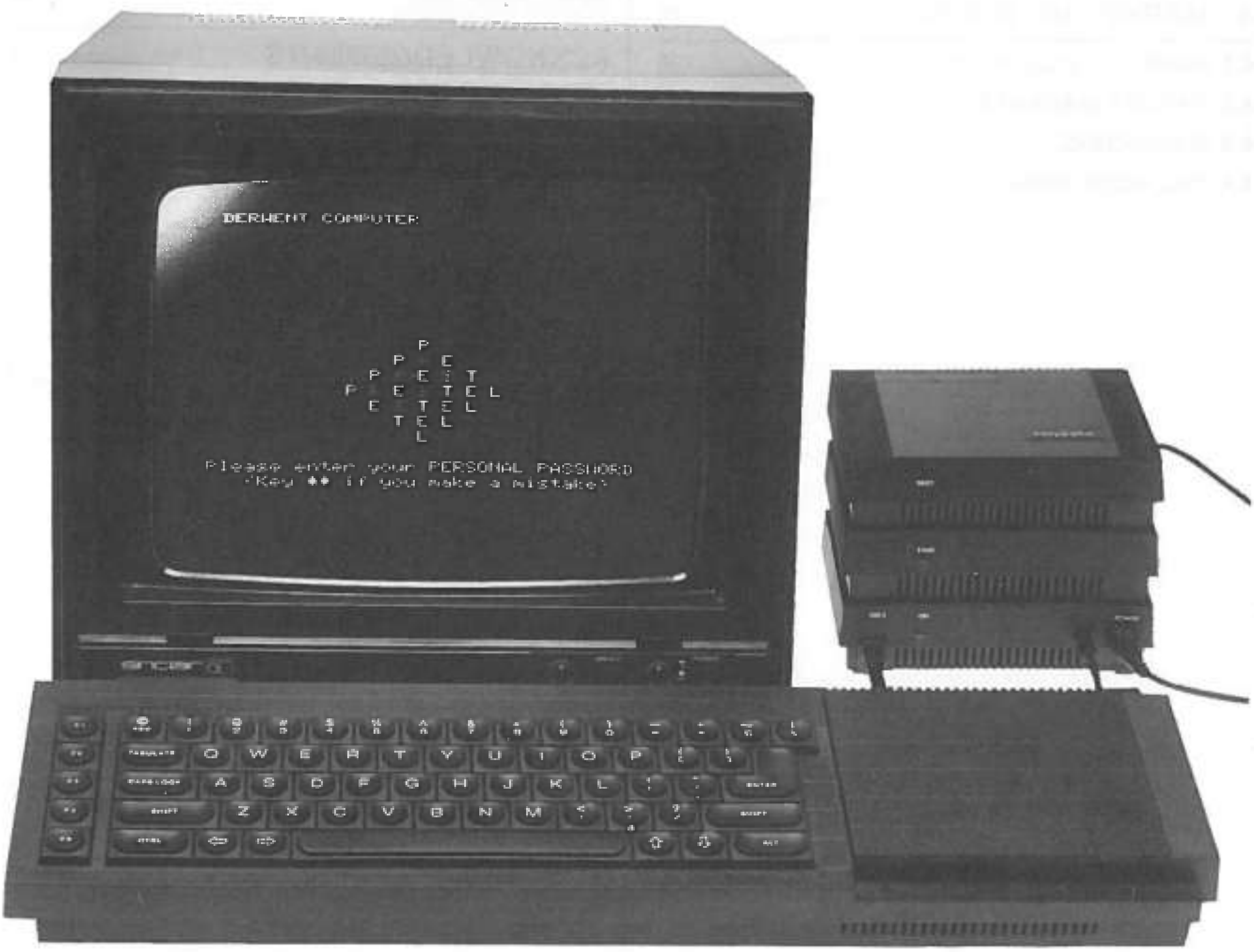

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PREFACE

In this block, the main emphasis is on *marketing*, and in particular on how companies try to assess the likely market demand for their product or services.

The two case studies we have chosen lie in the *information technology* field. They examine how two British companies, namely Sinclair Research and British Telecom, designed, developed and marketed, respectively, the QL microcomputer and the Prestel information service.

Both case studies start with general technical introductions, outlining the basic technical background you will need. This is followed by an account of how the product or service was conceived, designed and developed, how the likely market for it was researched, and how it actually fared in the market place.

Finally, in both cases, we provide some assessment of the success of the marketing strategies that were adopted; some comments on likely developments in the future; and some general conclusions. These are explored further in the Block 2 Study Guide, which is intended to be read in conjunction with these case studies.

BEGINNERS START HERE

If you know little or nothing about microcomputers, you should start here. And even if you do know something about micros, it might still be a good idea to read quickly through this preliminary section, because it should help to refresh your memory of some of the basic terms and concepts. Of course, if you really are a microcomputing expert, you can skip this section entirely. I should stress, however, that it is not necessary to understand fully all the aspects of microcomputing that are touched on here. T362 is a course on innovation, not computing, and the aim here is simply to give non-technical readers a better 'feel' for the subject matter of the QL case study proper.

The rest of this section consists of an edited reprint of a 'newcomers' guide' originally published in *Personal Computer World* in May 1985.

Micro Jargon

For those completely new to computing, let's start with the question: what is a microcomputer? We think of a micro as: a general-purpose device in contrast to a typewriter, which can only be used for typing; a calculator, for performing calculations; a filing cabinet, for filing information. A micro can do all of these and more.

If it's to be of any use a general-purpose device needs some way of knowing what to do. We can tell a micro what to do by giving it a set of logical instructions, called a *program.* The general term for computer programs is *software.* Every other part of a microcomputer system is known as *hardware.*

Programming

Programs must be written in a form the micro can understand and act on – this is achieved by writing the programs in a *code* known as a *computer language.* There are literally hundreds of different languages around, the most popular of these being *Basic.* Basic is an acronym of *B*eginners' *A*ll-purpose *S*ymbolic *I*nstruction *C*ode. Although orginally intended as a simple introductory language, Basic is now a powerful and widely used language in its own right.

Other common languages are *Forth, Pascal, Logo, C* and *Comal*, to name but a few. These are known as high-level languages because they approach the sophistication of a human language. You may also see references to low-level languages, *assembly language* and *machine code.* We'll look at these in a moment.

The heart of a micro, the workhorse, is the *processor* or *C*entral *P*rocessing *U*nit (*CPU*). The processor usually consists of a single silicon chip. As with computer languages, there are a number of different types of processor available, the *Z80, 6502, 68000* and *8088* being just a handful (literally!) of the types in common use. The processor is nothing magical – it's just a bunch of electronic circuits. It's definitely not a brain.

The processor's circuitry can be in one of two states: on or off. We represent these two states by *binary* (base two) notation, the two binary digits (known as *bits*) being 0 and 1. It's possible to program computers in binary notation, otherwise known as machine code (or machine language) programming.

Machine code is called a 'low level' language because it operates at a level close to that 'understood' by the processor. Languages like Basic are known as 'high level' languages because they are symbolic, operating at a level easily understood by people but not directly understood by the processor.

Between high level languages and machine code is a low level language known as assembly language or, colloquially, *assembler*. This is a mnemonic code using symbols which the processor can quickly convert to machine code.

Since everything has to be converted into binary form before the processor can make sense of it, we need some sort of code to represent each character to be processed by the computer. In order to simplify communication between computers, a number of standard codes have been agreed on. The most widely used of these codes is the *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange, *ASCII*. This system assigns each character a decimal number which the processor can then convert to its binary equivalent.

A program written in a high level language must be converted into binary before the processor can carry out its instructions. We could of course do this manually, but since this is exactly the sort of tedious job computers were designed to do for us, it makes much more sense to write a program to do it.

There are two types of program to do this translation for us.

The first of these is a *compiler* which translates our whole program permanently into machine code. When we *compile* a program, the original high level version is called the *source code*, while the compiled copy is called the *object code*. Compiled programs are fast to run, but hard to edit. If we want to change a compiled program, we either have to edit it in machine code (extremely difficult) or we have to go back to a copy of the source code. For this reason there is a second translation program: an *interpreter*. An interpreter waits until we actually *run* (use) the program, then translates one line at a time into machine code – leaving the program in the original high level language. This makes it slower to run than a compiled program, but easier to edit.

There are two unusual Basic words you're likely to come across: POKE and PEEK. When you program in a high level language, you are normally unable to choose in which part of the machine's memory the processor will store things. This makes programming easier because you don't need to worry about memory locations, but slows down the program since the processor has to 'look up' addresses for you. Using the POKE command, however, you can 'poke' a value directly into a desired memory address. 'POKE 10000,56' for example, puts the value 56 into memory location 10000. PEEK allows you to examine the content of a particular memory address. It you were to follow the above poke with 'PEEK (10000)', the computer would respond by displaying the value 56. POKEing and PEEKing are normally done to increase the program speed, but may also allow us to do things that could not be done through Basic.

Memory

So far, we have a processor and a program. Since a computer needs somewhere to store programs and data, it needs some kind of *memory*. There are two types of memory: *Read Only Memory (ROM)* and the badly named *Random Access Memory (RAM)*. ROM is so called because the processor can 'read' (get things out of) its contents, but cannot 'write to' (put things in) it.

ROM is used to store *firmware*, the name given to software permanently available on the machine. An interpreter is a typical example of firmware (stick with it: it gets easier!).

RAM differs from ROM in two important ways. Firstly, you can write to it as well as read from it. This means that the processor can use it to store both the program it is running and *data* (information). The second important difference is that RAM needs a constant power supply to retain its contents: as soon as you switch the computer off, you lose your program and data.

There is a type of RAM, known as *CMOS RAM*, which requires only a tiny amount of power to retain its contents. This is found in portable computers. It is normally powered by nickel–cadmium batteries so that the program and data are retained even when the main power is switched off. At present, CMOS RAM is extremely expensive and is not likely to be used in desk-top machines for a little while yet. (CMOS stands for *C*omplementary *M*etal *O*xide *S*emiconductor.)

Memory is described in terms of the number of characters we can store in it. Each character is represented by an 8 bit binary number. 8 bits make one *byte* and 1024 bytes make one *kilobyte* or *1k*. 32k, for example, means that the computer can store about 32000 characters in its memory. If 1024 sounds like an unlikely number, remember that everything is based on the binary system, thus 1,2,4,8,16 ... 1024 being the nearest binary multiple to 1000.

While we're on the subject of bits, you'll often see computers and their processors described in terms of their *bit power: 8-bit, 16-bit, 32:16-bit* and so on. This is a means of describing how large a binary number the processor can handle in one chunk. A binary number, incidentally, is known – confusingly – as a *word*. An 8-bit processor, for example can handle 8-bit words, that is, up to 11111111 (255 in decimal). Anything larger than this has to be broken down into manageable chunks before it can be processed.

A 16-bit machine can handle bigger chunks of data at a time. This means that it can handle (*address*) larger amounts of memory at one time. This is why most 8-bit machines have a maximum of 64k RAM while 16-bit micros usually have 128k upwards.

As 16-bit processors can handle larger words than an 8-bit machine, they ought to be twice as fast. In practice, however, there is a little more to it than that. While it may take a 16-bit machine half as long to work out that 2+2=4, the actual processing is only part of the story.

The result of the calculation has to be placed into the appropriate memory location, passed to the screen or whatever is required. The transfers to and from the processor are often made in 8-bit form; this is why you will hear people arguing that certain processors are not 'true' 16-bit. If the problem has to be handed to the processor in 8-bit form, turned into 16-bit, calculated and then the result turned back into 8-bit for transfer elsewhere, there may be little or no saving in time over an 8-bit system.

The other factor affecting speed is that the actual processing may form only a small part of the overall operation. A word processor, for example, spends most of its time passing files to and from disk and waiting for the user to type the next character. The processing itself consumes very little time.

Returning to the subject of RAM for a moment, a word of warning: Don't rush out with your new-found understanding to buy the machine offering you the most RAM for your money. Quite aside from the fact that the amount of RAM is by no means the only consideration when buying a micro (no matter how much manufacturers may stress it), different machines use differing amounts of RAM for things like graphics. Always check how much RAM is actually available to the user for program storage. Machines that proudly proclaim '64k' may well leave you with less than half of this in which to store Basic programs and data

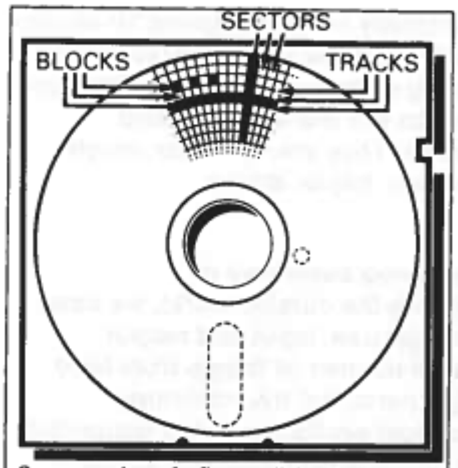
Back up storage

There are numerous forms of *permanent* or *back up* storage, but by far the most common are *floppy disk, floppy tape* and *cassette.*

Floppy disks or diskettes are circular pieces of thin plastic coated with a magnetic recording surface similar to that of tapes. The disk, which is enclosed in a protective card cover, is placed in a *disk drive.* Disk drives comprise a high speed motor to rotate the disk and a *read/write head* to record and 'play back' programs and data.

The disk is divided into concentric rings called *tracks* (similar to the tracks on an LP) which are in turn divided into small *blocks* by spoke-like divisions called *sectors.*

There are two methods of dividing the disk into sectors. One is called *hard sectoring,* where holes punched in the disk mark the sectors, and the other is *soft sectoring,* where the sectors are marked magnetically. The reason that disks from one machine cannot be read by a different make is that each manufacturer has his own way of dividing up the disk. Recently, however, manufacturers have begun to acknowledge that this situation can't go on forever, and they are working to make their disks compatible.



Cross-section of a floppy disk

Since the computer needs some way of organising the disk, we have a program called a *Disk Operating System (DOS),* usually known simply as the *Operating System (OS).* The operating system does all the 'housekeeping' of the disks, working out where to put things, letting the user know what is on the disk, copying from one disk to another, and so on. As you might expect by now, there are lots of different operating systems available, each with its own advantages and disadvantages. The three most popular OSs are *CP/M* (Control Program for Micros), *MS-DOS* (Micro Soft Disk Operating System) and *PC-DOS* (Personal Computer Disk Operating System). MS-DOS and PC-DOS, incidentally, are all-but-identical.

Disks can support what are known as *random access files.* That is, you can randomly choose a point in a file and the drive head will move directly to that point. You can then edit the file, and only the blocks affected will be rewritten. The rest of the file remains unchanged.

Floppy disks provide a reasonably fast and efficient form of secondary storage, and are cost-effective for business machines. For home computers, however, the usual form of program and data storage is on ordinary cassette tape using a standard cassette recorder. This method of storage is slow and unreliable, but is very cheap and is adequate for games, for example.

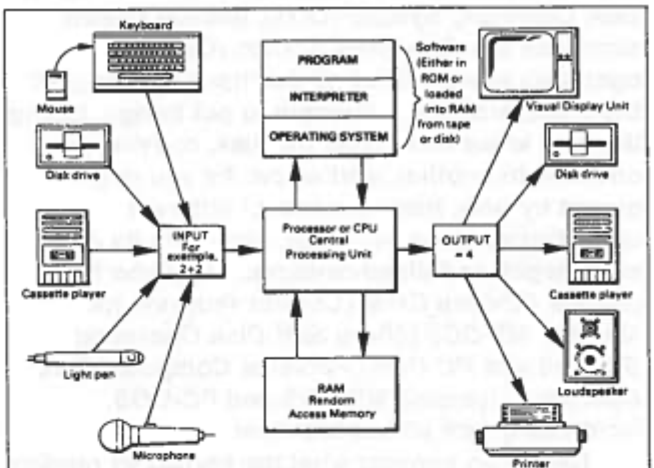
Cassettes can support only *serial access files.* That is, whenever a file is to be edited, the whole file must be written back to the tape. This makes certain applications – word processing being a prime example – extremely tedious.

Floppy tape drives are a compromise between speed and cost. They use a small continuous loop tape which, like a disk, is divided into blocks. Floppy tape drives rely on serial access files, but by rotating the tape at high speed and using the block markers, they can simulate random access files. The Sinclair Microdrive is a floppy tape drive.

Another type of disk you will see referred to is the *hard disk.* This is an extremely efficient method of storing large amounts of data. Hard disk capacity generally starts at around 10 *Mbytes* (10 million bytes) and rises to ... well, you name it. Besides offering a much greater capacity than floppies, hard disks are more reliable and considerably faster. They are, however, much more expensive than floppy drives.

Input/output

Since computers need some way of communicating with the outside world, we need *input* and *output* devices. Input and output devices include all manner of things from hard disk units to light pens, but the minimum requirement for most applications is a typewriter-style *keyboard* for input and a TV-like *Visual Display Unit* for output. The Visual Display Unit is variously referred to as a *VDU, Cathode Ray Tube (CRT)* and *monitor*.



A schematic view of a microcomputer system

The various component parts of a computer system (processor, keyboard, VDU, disk drives, and so on) may all be built into a single unit or they may be separate, connected by cables.

Take this paragraph slowly and it will make sense! When a computer communicates with an outside device, be it a printer or another computer, it does so in one of two forms – *parallel* or *serial*. Parallel *input/output (I/O)* requires a number of parallel wires. Each wire carries one bit, so with eight wires we can transmit/receive information one byte at a time (8 bits = one byte, remember). Serial I/O, in contrast, uses a single wire to transmit a series of bits one at a time (that's why it's called serial), with extra bits to mark the beginning and end of each byte.

To enable different devices to communicate with each other in this way, standards have been agreed for different *interfaces*. An interface is simply a piece of circuitry used to connect two or more devices. The most common standard serial interface is the *RS232* while the Centronics standard is popular for parallel interfaces.

Networks

When two computers want to communicate with each other over a distance, there are again two ways of doing it (nothing is ever clear-cut in the world of micros – you'll get used to it). Both methods use the public phone network. The first is known as an *acoustic coupler*. This simply plugs into your computer, and has a receptacle into which you place your telephone receiver. The acoustic coupler is convenient in that you can unplug it from one computer and plug it into another one in a matter of seconds. They are generally slow, however, and are prone to interference.

The alternative method is to use a *modem*. Unlike an acoustic coupler, a modem is wired into the telephone system and you should get permission for this from British Telecom.

A term you will hear in connection with acoustic couplers and modems is *baud rate*. The baud rate is a measure of the speed with which a device can transmit and receive data. You can safely think of the baud rate being bits-per-second, though the accurate definition is a little more complex. Therefore, a 300-baud modem can transmit/receive data at the rate of 300 bits (about 50 characters) a second.

A 1200/75 modem means that it receives at 1200 baud, but transmits at 75. Most modems are 1200/75 and acoustic couplers 300/300. By way of comparison, saving programs to cassette is normally done at between 300 and 1500 baud.

Finally, communication between computers is either *full* or *half duplex*. Full duplex is when the machine receiving the data echoes it back to the machine transmitting it and says 'This is what I think you said – is it right?'. If it's wrong, the section will be transmitted again. Half duplex is where no checking is made. If you're ever unsure of which to use, start with full duplex. If everything you type appears on your display twice, then you should switch to half duplex.

Database

A database allows you to store, process and report on structured information. Most of the cheaper packages are based on a traditional card index where each card about an individual, order or item of stock is stored in a single record, and a group of like records is stored in a file (corresponding to the index card box). Sophisticated packages can relate several files together, so that you can process groups of dissimilar but related records.

Spreadsheet

Spreadsheet software is useful to anyone who regularly uses a calculator. The VDU acts like a 'window' on a large sheet of numbers – neatly laid out in rows and columns, occasionally split by text headings. The user is able to shift the window to the point of interest and so enter text. The rest of the calculation is displayed immediately with automatic recalculations throughout.

STUDY NOTES

When you have read the previous section (or skipped it if you are an expert) you should read the Introduction (section 1) and then go on to read fairly quickly through the rest of the case study to gain an overall picture of its main contents.

You should then read through the entire text again much more carefully, pausing at the end of each section to refer to the Study Guide to Block 2, and attempting the self-assessment questions that relate to that section.

The Study Guide also contains cross-references to readings in the Course Reader, together with a check list of objectives which you should be able to achieve when you have finished this case study.

As in Block 1, at various points throughout this text technical background information will be provided in passages set in bold type. These technical inserts are *not* intended to form part of the narrative of the case study. The material presented in them will *not* be assessed, and you are free to skip them if you wish.

1 INTRODUCTION

Quantum Mechanics, now one of the cornerstones of modern physics, was founded by Max Planck in 1900 when he suggested that atoms, when stimulated to emit radiant energy, do so not continuously but in discrete 'jumps' of energy which he called 'quanta'. Today, the phrase 'quantum jump', or 'quantum leap', has come to denote any dramatic improvement in performance or efficiency. But Planck could hardly have foreseen, and would hardly have approved of, his quantum concept being used as an advertising slogan.

Early in 1984, however, that is exactly what happened. On January 12th of that year, Sir Clive Sinclair called a press conference to announce the latest in his company's range of personal microcomputers. The name Sinclair had already become a household word in Britain following the success of his earlier low-cost microcomputers, the ZX80, ZX81 and Spectrum, which had brought personal computing within the reach of millions. Sinclair's new machine was, he claimed, so much more powerful and cost-effective than other 'micros' on the market that it was being named the 'QL' – short for 'Quantum Leap'.

The initial press reaction to the new QL was highly favourable. Reviewers from both general and specialist publications were impressed by the '32-bit' microprocessor at the heart of the machine, potentially a much more powerful device than the '8-bit' microprocessors used in most home computers. They enthused about the machine's 'multi-tasking' capability – its seeming ability to carry out several programming tasks at once, displaying the results simultaneously on the screen. They were dazzled by the multi-coloured graphic displays produced by the QL's four software packages, and marvelled at how Sir Clive's company, Sinclair Research, could afford to give away software of such quality free with each machine.

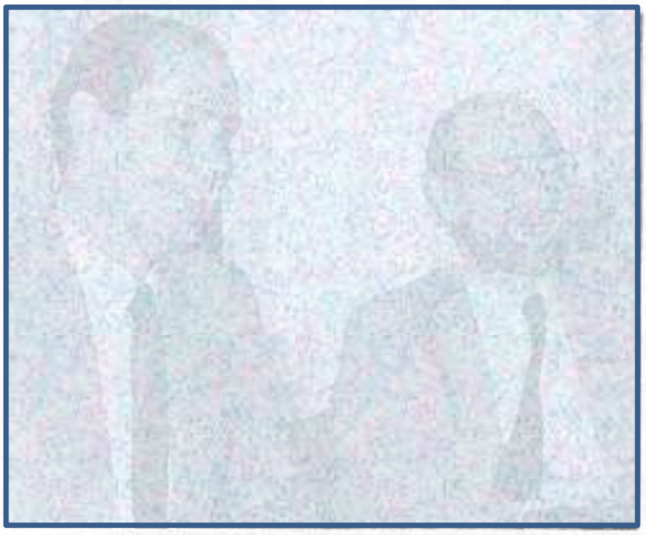


Figure 1 Sir Clive Sinclair (right) and Nigel Searle announce the birth of the QL to the Press

Some reviewers, it is true, were a little dubious about Sinclair Research's decision to use its own 'Microdrives' (which employ an endless loop of thin magnetic tape) instead of the more conventional 'floppy disks'. Others demurred at the company's similarly unconventional choice of 'operating system' for the machine. A computer's operating system allocates tasks to the various microchips and other pieces of electronic hardware in the machine, and generally does the 'housekeeping'. Sinclair Research had decided to use its own operating system, called 'QDOS' instead of one of the operating systems that were by then becoming de facto 'industry standards'.

But these and other criticisms were relatively muted, and the overall reaction in both the specialist and the general press was highly favourable. Sinclair Research promised delivery of the first batch of QL's in less than two months, by the end of February; so public and press alike reached for their cheque books, placed orders in their thousands, and sat back to await delivery.

But the end of February came and went, and no QL's had yet become available. The technical press was becoming impatient that the machines it had been promised for detailed evaluation had still not arrived. The general public, too, was becoming suspicious that the company, which had already gained a reputation for late delivery with its earlier Spectrum microcomputer, was once again making promises it couldn't keep.

At the end of April, two months behind the original schedule, a few QL's (reportedly fewer than 100) were delivered to the first eager customers. But, as most of these unfortunate purchasers soon discovered, the initial machines seemed plagued by numerous hardware and software faults, together with serious shortcomings in the reliability of their Microdrives. Moreover, the sleek appearance of the QL was somewhat marred by the addition of an extra memory chip dangling out at the back of the machine. This addition (nicknamed a 'dongle') had become necessary because Sinclair programmers still had not quite managed to get the QL's operating system and its Basic programming language to fit within the dedicated chips inside the case.

When they finally got their hands on these early production machines, the verdict of the technical press was a harsh one, reflecting the disillusionment of many of Sinclair's initial customers. As one technical magazine declared:

> . . . early QL buyers were made to pay the price for the premature launch and some contentious advertising claims. They received machines riddled with bugs of both the software and hardware variety . . . (*Electronics & Computing Monthly*, August 1984)

And to add apparent insult to injury, Sir Clive Sinclair himself was quoted as admitting not only the existence of the 'bugs' but that his company was using its customers as guinea pigs:

> . . . we are getting our customers to find those bugs for us.

was how he put it. (*Personal Computer News*, 16 June 1984.) Sinclair Research did promise, however, that all early QL users would receive upgraded operating systems as soon as the final version was ready. This 'final version' began to make its appearance at the end of May 1984, when Sinclair Research finally began to deliver QL's in reasonable quantities, with most of the faults of the initial batch apparently rectified. As deliveries built up during the summer of 1984, and the queue of dissatisfied customers diminished, the press softened in its judgement. Though there were continued misgivings about the reliability of the Microdrives, and users continued to find fault with the machine's keyboard, its operating system, its Basic language, its software and especially its Microdrives, the overall verdict appeared to be that, in the words of *QL User* (October 1984):

> . . . any shortcomings can easily be forgiven [because] the QL offers so much more than any similarly priced machine, and has the potential for very much more.

Towards the end of 1984, it appeared that Sinclair might just have pulled it off. Although pushing their customers' tolerance to its limits with the contrast between the somewhat exaggerated claims for the machine and its poor initial performance, they had eventually managed to deliver a product which more-or-less lived up to the company's promises. Production had begun to build up (though sales figures were a closely guarded secret) and the QL was beginning to make its appearance in High Street chain stores. It looked like Sir Clive Sinclair and Sinclair Research would once again be successful in creating a large new market for a highly innovative microcomputer product.

But by early 1985, it had become clear that things had gone badly wrong. Christmas 1984, instead of being another boom period for home computer sales, as the previous Christmas had been, turned out to be the point at which sales began to level off. Luckily for Sinclair Research, its cheap Spectrum machine continued to sell relatively well, but sales of the new QL were far below what the company had expected.

So in March 1985, following a management re-shuffle, some further hardware and software improvements and a careful re-appraisal of the QL and its sales prospects, the machine was in effect re-launched with the backing of a £¾ million advertising campaign. Sinclair Research, whose image and financial standing had been hit hard by the QL debacle in particular and by the down-turn in the microcomputer market in general, began the slow and difficult task of trying to restore its credibility and profitability.

But by May 1985 it had become clear that the company had insufficient resources to carry out the necessary re-structuring, and with its bankers and trade creditors pressing hard for radical changes, it opened urgent negotiations with a number of larger companies to investigate the possibility of injecting substantial additional capital into the ailing concern. These negotiations culminated a few weeks later in an offer by the businessman and financier Robert Maxwell to take the company over.

However, by early August 1985, the proposed deal had fallen through. Maxwell claimed that the prospects of Sinclair Research did not, on investigation, seem good enough to justify the £12 million investment he had originally offered. Sinclair Research contended, on the other hand, that sales of the company's products had improved, and that it therefore no longer needed to be 'refinanced' in order to continue selling its existing microcomputer range – though it did admit to needing extra finance to develop new products. Soon afterwards, the company announced substantial price cuts, including a halving of the price of the QL to £199, in preparation for what it hoped would be a very substantial further increase in sales during the autumn of 1985.

1.1 AIMS

The main aim of this case study is to look in detail at the QL, at how it was conceived, at how its hardware and software were designed and developed, at what went wrong – and what went right. The questions we'll be asking include:

What difficulties did the QL's designers encounter during its development, and how were those difficulties overcome?

What design specifications were set, what compromises had to be made between different design objectives?

What alternative design solutions were considered and why were these rejected?

Who were the main people involved in the QL project? And what roles did each play?

In particular, we'll be looking at the marketing aspects of the QL project, examining how Sinclair Research initially attempted to assess who the potential buyers of the QL might be, and what features they might want at what price. Then how, having developed the QL, the company went about the task of promoting it in various market-places to its potential customers. And how, when the initial sales of the machine proved so disappointing, it tried to analyse what had gone wrong and then attempted to 're-position' the QL in the market-place.

Finally, we'll be looking at Sinclair Research's future product strategy and at some of the hardware and software the company is developing.

2 SINCLAIR RESEARCH: A BRIEF HISTORY

2.1 SINCLAIR RADIONICS

The roots of Sinclair Research Limited lie in another, earlier company, Sinclair Radionics, which was founded by Clive Sinclair in Islington, North London, in 1962.

Soon after starting the company, Sinclair made the acquaintance of Tim Eiloart, who had in the previous year founded Cambridge Consultants, a firm offering scientific and technological consultancy skills to industry. Eiloart recalls their first meeting in London:

> ... he took me to his room in St George's square and, with the pleasure of any young entrepreneur revealing his new factory, took a black attache case from under his bed. It was almost empty except for a wireless the size of a matchbox. He wanted several thousand pounds to launch it, and my firm didn't have that much. But we offered him £50 to design a new product (the microamplifier: see below) which we would send out in his company's name. The venture succeeded. Over two years his microamplifier brought in a profit of around £800, which we shared.

Clive Sinclair had left school in 1958, at the age of 17, having had a rather unorthodox education.

> I went to thirteen different schools – towards the end of my time at school I would be on my own, with no one else doing the same sort of work. At Reading there was a very good maths teacher, who just told me what to read and left me in the library. I went from the bottom set to the top of the first set in one term. I took A-level at 16, and then turned to S-level. I spent most of my time on things like an electrical submarine run on batteries. Luckily I had left before I had time to test that one. Some of the schools had terrific workshops.
>
> I thought of University, but I didn't want to be a mathematician by then, though I had scraped through S-level in that. I couldn't seem to see any University being any help with electronics – advice was non-existent. I had no interest in electrical engineering. (Clive Sinclair quoted by Eiloart.)

So instead of going to University, Sinclair took a job as a technical journalist with the magazine *Practical Wireless*. Not long afterwards, he was offered a new job, at three times his existing salary, to write short technical booklets on electronic circuits by a publisher called Bernard Babani. He accepted:

> I came in the first morning to find a note on my desk: 'Write a book about transistors, see you in two weeks'. I would write books by the dozen with titles like 'Twenty tested transistor circuits'. (...) If a circuit didn't work people would write in, and I usually found I had calculated something wrongly. But that was quite rare.

After three years with Babani's company, Bernard's Publishers, Sinclair left in 1961 because he had been offered £3000 to launch his kit radio set. But soon after leaving, his backers got cold feet. Though he continued to try to raise the necessary cash, he worked as a freelance writer for nine months before taking another job in technical journalism, this time as assistant editor on *Instrument Practice*.

Then he discovered that the large electronics firm Plessey were in the habit of classifying as rejects those of their transistors whose gain exceeded their specification, as well as those whose gain fell below the specified level. Sinclair bought £50 worth of these 'rejects', tested them, threw out those whose gain was unacceptably low, and incorporated the rest into the simple 'microamplifier' that, as we have seen, he had designed with the backing of Cambridge Consultants.

The microamplifier was successful, and Sinclair resolved to risk all his profits on launching his miniature kit radio, which he christened the 'Slimline'. 'It had to sell', he later admitted, 'or I couldn't have afforded to pay for the parts I'd got coming in.' (Quoted by Eiloart.)

The Slimline was promoted using large advertisements with the word 'breakthrough' splashed across the page. It too was successful, and Sinclair soon designed another even smaller radio, taking over the village hall at Comberton, near Cambridge, to produce it.

Right from the start, Sinclair Radionics' products were based on the latest technical innovations in components and circuit design. The advertising which promoted them stressed both their innovative nature and the superior performance which their advanced technology was claimed to bring. Miniaturisation and elegant appearance also soon became important features of the early Sinclair product image.

But the reliability of Sinclair Radionics' early products was often poor, and they did not always match up to the high technical specifications claimed for them. This reputation for unreliability and exaggeration has dogged the company down the years and, as we shall see, such charges are not without justification even today.

On the other hand, a saving virtue of Sinclair's business practices has always been the policy of guaranteeing to customers that products, if they prove unsatisfactory, can be returned and repaired free of charge – or that purchasers, if they so wish, can have their money refunded. (Nowadays, of course, these policies amount to no more than giving customers their legal entitlement.)

Another saving grace of Sinclair products has been that they have almost always been significantly cheaper than their rivals, so customers have usually been reluctantly willing to put up with the inconvenience of sending products back to have faults rectified.

In 1964, Clive Sinclair produced his first technical failure, a hi-fi amplifier called the X10, which used the then novel 'pulse-width modulation' technique. The X10 was unsuccessful because its transistors proved inadequate to handle the 10 watts of power output expected of them – though Sinclair later launched a more successful 20 watt model, the X20.

In 1968, he persuaded Plessey to give him exclusive use of its new 5 watt integrated-circuit amplifier, the IC10. (The man with whom he clinched the deal was Rob Wilmot, who was to go on to become Chairman of Britain's largest indigenous computer firm, International Computers Limited (ICL), and who was later to play a further role in the Sinclair saga.) Sinclair then invested a lot of money in a big advertising campaign, only to discover that Plessey were about to go into competition with him. 'At that stage', as Eiloart puts it, 'most businessmen would have felt despair, and gone to court. Typically, Sinclair told Plessey he wished them luck: he was sure they would find the market for hi-fi kits quite impossible. They did.'

By 1971, Sinclair Radionics had become a fast-expanding producer of a range of radio and hi-fi products with a turnover of around a million pounds a year, a turnover which had consistently doubled every year and which was financed almost entirely out of internally generated profits. The company's continuing growth had resulted in another move, this time to St Ives, outside Cambridge, where it shared premises with an electronic instrument company called AIM Associates, which had been started 10 years earlier as a 'spinoff' from Cambridge Consultants.

AIM was encountering severe cash-flow difficulties, so Sinclair contributed £25 000, which gave him a controlling interest, to try to ensure its survival. He also gave the company a new design of digital multimeter (an electronic test instrument which measures current, voltage and resistance, displaying the results in a digital form) which he had developed, but AIM continued to have financial problems and went into receivership before the new multimeter could be produced. Sinclair, however, bought back the multimeter technology from the AIM receiver.

Shelving the digital multimeter design for the time being, Sinclair then launched what was claimed to be the world's first truly 'pocket'-sized calculator, the Sinclair 'Executive', which initially sold at the then-revolutionary price of £79. The Executive was successful, winning design awards and earning the company more than £2.5 million in export revenue. Its successor, the 'Cambridge' range, was launched in 1973 and took the company to number one position in the UK calculator market.

However, from 1973, Sinclair was investing heavily in research and development for other products, notably electronic instruments, a pocket television set, and a new digital wrist-watch. The company had been forced to abandon its hi-fi business in 1975, mainly because budget tax increases in that year had halved sales of audio equipment, although increasing competition from foreign imports must also have been a significant problem.

Figure 2 Cambridge Consultants' headquarters at Milton, near Cambridge

Cambridge Consultants has played a peripheral, but important, role in the evolution not only of Sinclair Radionics and Sinclair Research, but of many of the other 'high-tech' enterprises which sprang up in and around Cambridge in the 1960s and '70s.

Initially, the main function of Cambridge Consultants Limited (CCL) seems to have been that of catalyst, throwing off ideas that formed the basis of spin-off enterprises like AIM, and providing seed money for fledgeling entrepreneurs like the young Sinclair. Later the company became a significant provider of the highly skilled people that were needed to fuel Cambridge's extraordinary mushrooming of sophisticated business based on new technological possibilities. A number of key Sinclair personnel are former Cambridge Consultants employees – and indeed the link is a two-way one, for Clive Sinclair at one stage rescued the company from bankruptcy, though not for very long. Following the appointment of a Receiver, CCL was bought by the US-based management consultancy Arthur D. Little Inc. and is now a viable concern. Further details of the growth of the network of mutually supportive, technologically advanced firms around Cambridge can be found in *The Cambridge Phenomenon* (Segal, Quince and Partners, 1984) and in Rodney Dale's *From Ram Yard to Milton Hilton: a History of Cambridge Consultants* (1982).

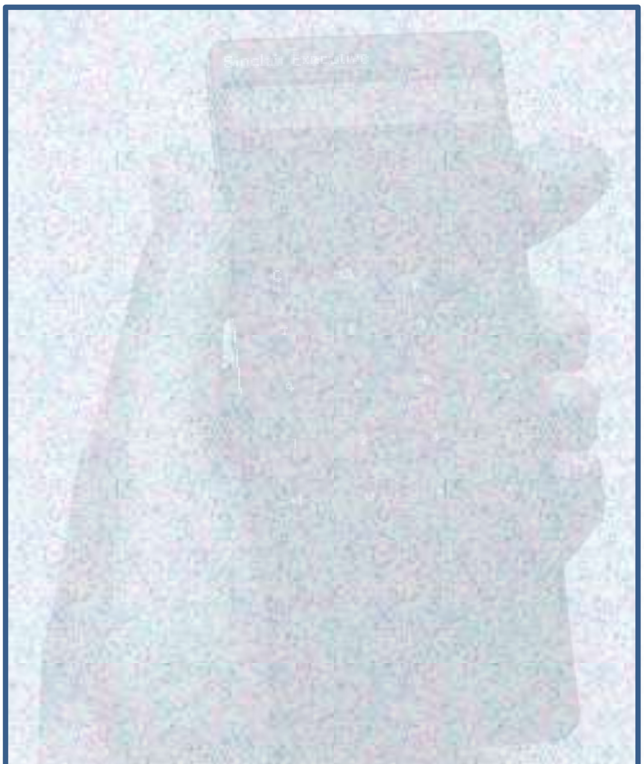


Figure 3 The Sinclair 'Executive', claimed to be the world's first truly pocket-sized calculator

The digital wrist-watch, the 'Black Watch', utilising a novel form of low-power integrated circuit technology called 'I²L', was announced in late 1975, at the same time as a new, low-cost digital multimeter, the DM2. But in 1976 the company sustained losses of more than £300 000 due to difficulties with chip supplies for the Black Watch. As a result it was unable to provide sufficient internal funds for the final stages of development of the pocket TV project.

The assistance of the Government-backed National Enterprise Board (NEB) was sought and in December 1976 the Board decided to back Sinclair Radionics, which it had earlier commended as 'the only genuinely British effort in the consumer microelectronics field', to the tune of £650 000. The NEB later loaned another £2 million in return for a 73 per cent stake in the company, though Sinclair had a clause in the deal enabling him to buy back control if 'his' company made enough profit over the next 10 years. Sinclair ceased to have overall managerial responsibility but remained in charge of research.

In January 1977 the company's two-inch screen 'pocket' TV, christened the 'Microvision' and claimed to be a 'world first', was launched, but did not sell very well.

With NEB backing, the company persisted in its attempts to sustain its early success in the calculator market. The period 1977–78 saw the introduction of the Sinclair 'Sovereign', an 'executive' calculator range, which included a solid-gold model priced at £2750; the low-cost 'Cambridge Programmable' calculator; and finally the 'Enterprise Programmable' which sold, complete with a library of programs, for around £25.

But Sinclair Radionics eventually found it impossible to maintain the brief dominance of the calculator market which it had enjoyed in the early '70s, and was soon eclipsed by foreign competition, from both American manufacturers like CBM, Hewlett-Packard and Texas Instruments, and Japanese companies like Casio and Sharp. In the instruments field, however, the company enjoyed moderate success, introducing three new digital multimeters which sold well enough to enable it to claim to be one of the world's two largest producers, at least in volume terms.

Meanwhile, a simpler version of the Microvision, costing just under £100 (less than half the initial price) was introduced in late 1978. But although sales of the new TV were beginning to pick up, the National Enterprise Board had lost confidence in the project and decided in 1979 to withdraw its support, suggesting that the company's future should lie in instruments like the digital multimeter. To Clive Sinclair's horror the sales force was fired and production stopped, with the loss of 300 jobs.

Clive Sinclair continued to believe that the company should remain in consumer electronics. In view of this seemingly irreconcilable difference of opinion, it was decided to divide the company's interests. In July 1979 Sinclair resigned all executive responsibilities with Sinclair Radionics, and took over the reins of another, much smaller company, Science of Cambridge Limited, which he had set up in 1978 as a vehicle for selling his continuing electronic kit ideas – products in which the NEB had no interest. Sinclair took with him the project that excited him most, an even-smaller pocket TV set using a novel 'flat screen' tube.

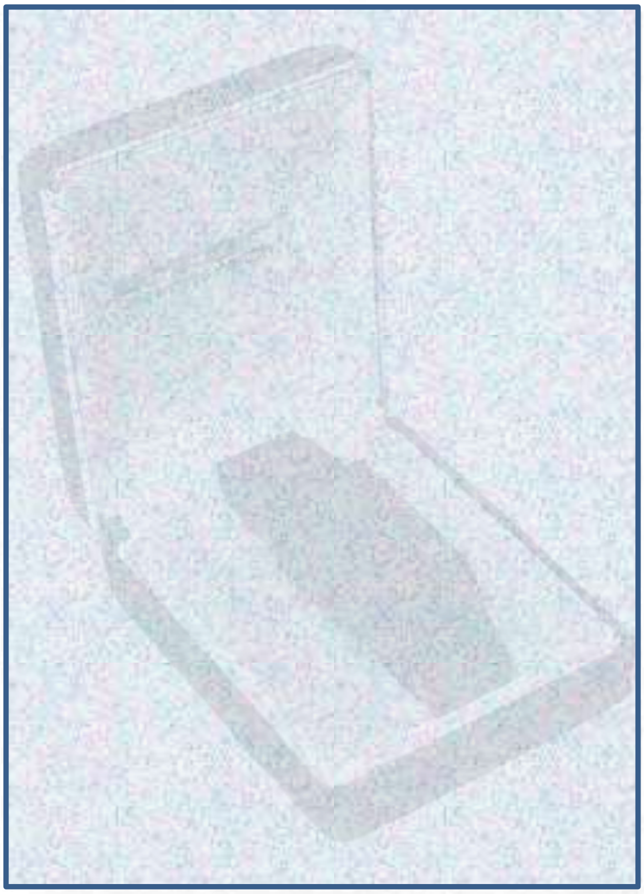


Figure 4 Sinclair's 'Black Watch'

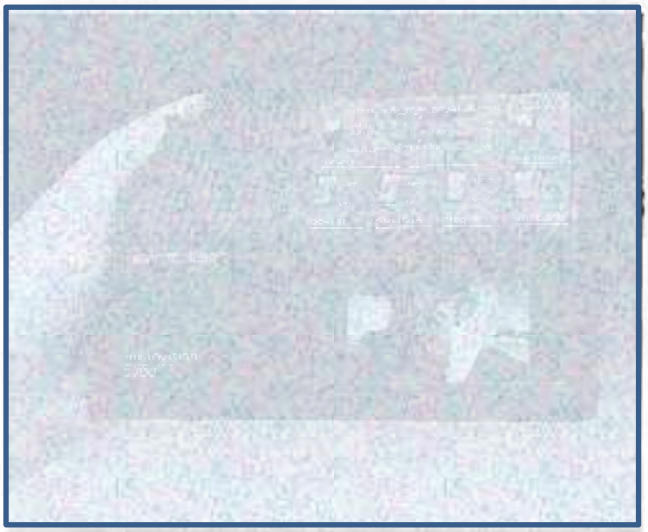


Figure 5 The Sinclair 'Microvision'

The National Enterprise Board retained control of Sinclair Radionics, which thenceforth became exclusively an electronic instruments company. The NEB subsequently changed the company's name to Thandar Electronics and under the new brand name its range of digital instruments has continued to enjoy considerable success.

2.2 SINCLAIR RESEARCH

Among the most popular products of Science of Cambridge, later re-named Sinclair Research, was a simple microprocessor-based computer, programmable only in assembly language, with a crude, 8-digit display and very little memory – but costing only £50. Within months, Sinclair had developed the design into a small, user-friendly microcomputer which produced pictures on a normal TV set, was programmable in Basic and used an ordinary cassette recorder for long-term program and data storage. Though Sinclair was not the first to put together such a package, he was the first to do so at the then un-heard-of price of £99. He launched it in February 1980 and christened it the 'ZX80'. True to previous form, he had gambled most of his resources on his hunch that a cheap 'home computer' would sell well, and had ordered enough parts to make 100 000 of them. (Ordering components in such large quantities was essential to obtain big discounts and hence to lower substantially the price of the final product.) Luckily, Sinclair's hunch proved correct.

Encouraged by this success, in March 1981 Sinclair Research went on to produce the ZX81, which despite being more advanced than the ZX80 was cheaper, at £70. The ZX81 was even more successful, winning a Design Council award in 1982 and selling over a million units in 50 countries by the end of 1983. Not content to rest on its laurels, however, Sinclair Research proceeded in 1982 to launch the 'ZX Spectrum', which sold alongside the ZX81. By the end of 1983, the Spectrum too had sold a million units worldwide and had established itself as the UK market leader.

Not surprisingly, the fortunes of Sinclair Research soared. In the financial year to March 1983, the company's turnover reached £54.53 million, double that of the previous year, with pre-tax profits of over £14 million. Despite this very substantial turnover, however, the company still employed relatively few people directly (around 50 in 1982–83) due to its policy of subcontracting-out its manufacturing work and many other activities which other companies carry out 'in-house'.

In 1983 also, the company launched a number of 'peripherals' for the Spectrum, most notably its 'Microdrive', a device for program or data storage which uses an endless loop of magnetic tape and is designed to overcome the drawbacks of using tape cassettes for storage, without incurring the expense of using floppy disk drives.

In addition, September 1983 saw the launching of yet another Sinclair pocket TV set, a development of the design he had brought with him from Sinclair Radionics following his break-up with the NEB. The TV incorporated a novel miniature cathode ray tube, with the electron gun at the side of the screen instead of behind it. But due to production quality control

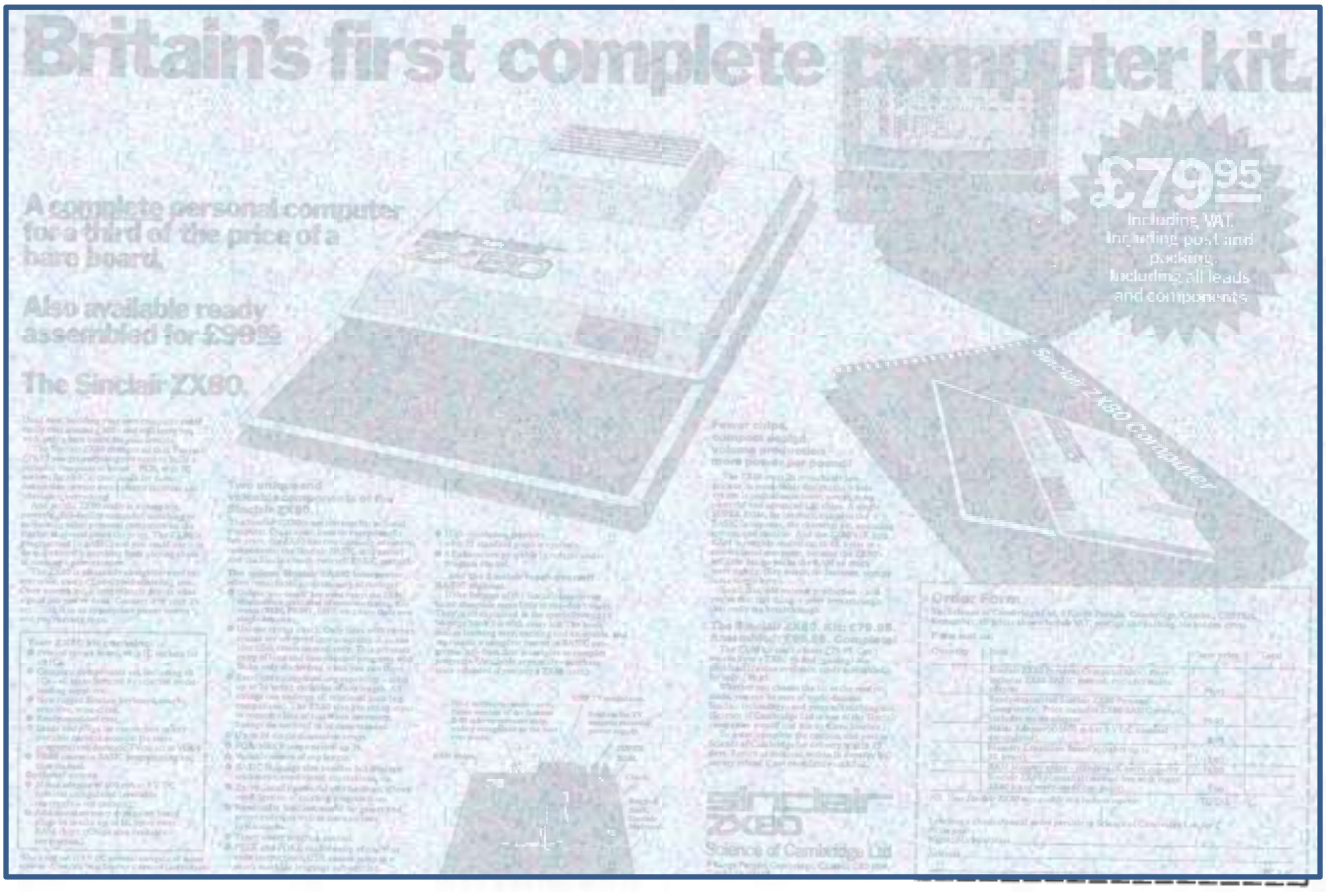


Figure 6 An early advertisement for the ZX80, which was available in kit form for £79.95 and ready made for £99.95

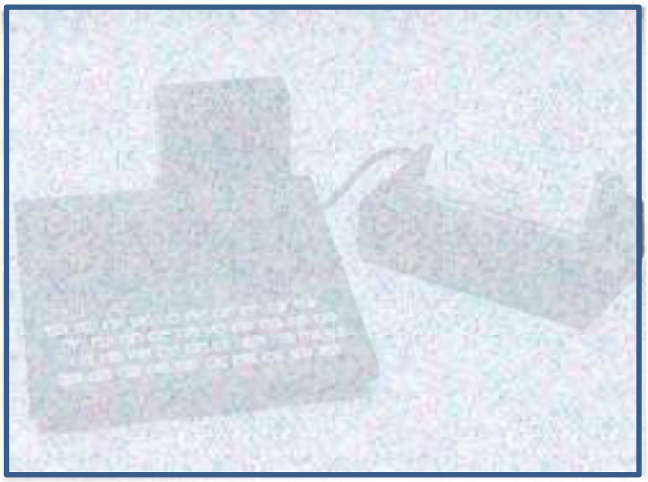


Figure 7 The Sinclair ZX81, a cheaper, but more powerful, version of the ZX80

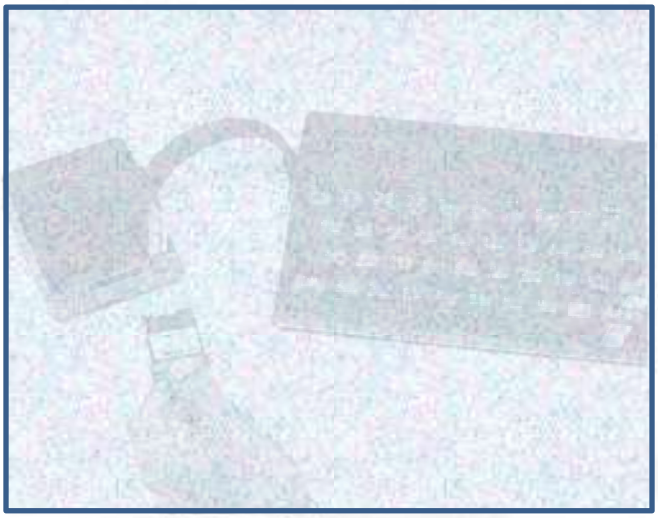


Figure 8 Sinclair's ZX Spectrum, with optional Microdrive unit and Microdrive cartridge

Figure 9 The Sinclair flat screen pocket television

problems with the new tube at the Timex plant in Dundee, to which Sinclair Research had sub-contracted the assembly work, insufficient quantities were initially available and the TV could not be distributed to shops until the end of the following year. Nevertheless, in spite of the lack of success of earlier versions, the company had an optimistic target to sell 200 000 of the diminutive sets in 1985, and was promoting it in shop windows and in advertisements with the slogan 'Now you can take a little TV anywhere.'

However, back on the home computing front, Sinclair Research had spent 1983 working on yet another novel product, a microcomputer which eventually became known as the Sinclair 'QL' and which was launched early in 1984. The QL is, of course, the main subject of this case study, and details of its design, development and marketing will be given in the sections that follow.

1983 was a good year for Clive Sinclair, both personally and financially. Early in that year he was named both as '*Guardian* Young Businessman of the Year' and as '*Computing*'s Person of the Decade', and was awarded a knighthood in the Queen's birthday honours list. Financially, the success of his company enabled him to sell a small proportion of his holding in it, 10 per cent, to some 40 institutional investors for the sum of £13.6 million. Though retaining control of the company, as its Chairman and chief executive, he passed the task of day-to-day management on to Nigel Searle, who had been with the company since 1972 and whom he appointed its new Managing Director. Sir Clive Sinclair then went on to apply his considerable energies to the creation of two new innovative activities.

The first involved using some of his newly acquired personal fortune to set up a new company, Sinclair Vehicles Limited, to bring to fruition another long-cherished Sinclair dream: the development of a range of low-cost electric vehicles. The company established offices for its staff of 25 at Warwick University's science park, and sub-contracted production work for the new vehicle to Hoover's factory at Merthyr Tydfil, in South Wales. It launched its first product, the 'C5', an electric motor-assisted, pedal-powered electric tricycle costing around £400, in January 1985. The C5, although a very interesting and controversial innovation in itself, is rather beyond the intended scope of this block. Suffice it to say that the C5 was not as successful as Sir Clive had hoped.

The second was the establishment, in a converted country house at Milton, near Cambridge, of a new research centre called 'MetaLab'. Here, he planned to hire some of the brightest brains in Britain and abroad to help him conceive, research and develop the new technologies that would, he hoped, form the basis of the Sinclair Research products of the future.

You will find some self-assessment questions relating to the history of Sinclair Research in the Block 2 Study Guide.

Figure 10 An advertisement for the C5 electric vehicle, made by Sinclair Vehicles Ltd. and launched early in 1985

3 DESIGNING THE QL

Design work on the QL began in the summer of 1982 when a group of Sinclair people began to meet about once a week to discuss what kind of computer should be the successor to the Spectrum.

The team working on the 'ZX83', or 'Super-Spectrum' as some called it, consisted of Sir Clive Sinclair; his managing director Nigel Searle; David Karlin, a young electronics engineer who had been recruited a few months before from Fairchild in the United States; Tony Tebby, one of Sinclair's senior systems programmers; Jim Westwood, Clive Sinclair's first employee in the early 'Radionics' days and now a technical director; David Southward, another technical director; and Martin Brennan, the engineer mainly responsible for Microdrive development.

There was general agreement that the new machine should be greatly superior in performance to the Spectrum. It should have a bigger memory, a better keyboard, and built-in Microdrives.

Initially, the ZX83 was to be a portable, and more powerful, version of the Spectrum, with a built-in flat screen display employing Sinclair's newly developed flat screen technology – though with a form of magnification or projection to make the tiny 2-inch wide image large enough for use as a computer display. The ZX83 was also intended to incorporate a built-in modem, giving access by telephone to on-line data services like Prestel, to have microdrives for mass memory storage, and 64k bytes of RAM, in contrast to the Spectrum's 32k.

The ZX83 portable was initially to be built around the tried and tested Zilog Z80 microprocessor chip, as used in the ZX80, ZX81 and Spectrum before it. But the trouble with tryin ɟ to use the Z80 in a portable machine is that it normally uses too much power (and a low-power version, using more advanced 'CMOS' technology, was not then available), with the result that the microcomputer batteries need re-charging too frequently. However, the Sinclair team had developed an ingenious way of circumventing this limitation. They developed a system in which the Z80 would be switched off, to conserve power, when it was not actually performing its microprocessing activities. And since the central microprocessor units of micros are idle, in most applications, for a very large percentage of the time they are switched on (waiting for their operators, or a program, to give them instructions, or waiting for data to be input or output) the Sinclair technique enabled the time between battery re-charges to be lengthened very substantially.

Then Zilog, the manufacturers of the Z80 chip, announced a new version – the Z800, a more powerful, 16-bit device (see 'Beginners start here' on p. 5), but still software-compatible with the Z80. This meant that a machine using it could not only address more memory and run faster and more powerful 16-bit software, but could also run the earlier 8-bit software

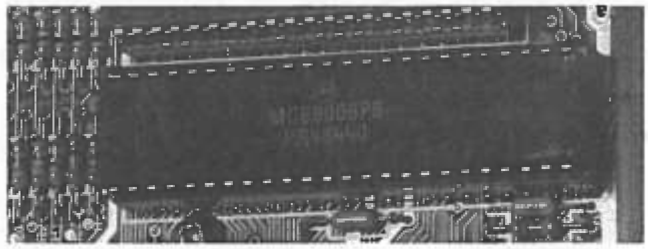


Figure 11 The Motorola MC68008 microprocessor in position inside a QL

developed for the Z80, so giving it an 'instant' base of ready-made software to attract customers. Furthermore, it used CMOS technology, enabling it to operate at low power drain without the need for Sinclair's 'power-down' technique.

At about the same time (mid-1983) Motorola announced a new 68008 chip, a simpler, 'stripped-down' version of its 68000 microprocessor, as used in the Apple MacIntosh. In both the 68000 and 68008, data are processed internally in 16-bit chunks, but the 68000 uses fast, 16-bit circuitry for data input and output, while the 68008 has slower 8-bit input/output circuitry to enable cheaper 8-bit peripheral chips to be used for this purpose.

However, both the 68000 and 68008 have what is known as 32-bit internal 'architecture' because their data registers (which hold the binary numbers during internal processing) can in fact handle binary numbers up to 32 bits long. But in both the 68000 and 68008, data are normally only manipulated internally in 16-bit chunks, so the most accurate way to describe them is as *16 bit* microprocessors.

The 68008 was a little faster as a processor than the Z800, but not by much. Its main advantage to Sinclair would be a marketing one: a new computer incorporating it could be advertised as having '32-bit architecture' (despite its slow, 8-bit input/output characteristics) and this would make it seem much more powerful than the 8-bit or 16-bit machines being offered by most of Sinclair's competitors. Moreover, the fact that Acorn, Sinclair's arch-rivals, were working on a 32-bit machine (based on a National Semiconductor chip) gave the Sinclair team an added incentive to opt for something that would seem equally powerful. Though the 68008 was not a low-power CMOS chip, it could still be used in a portable machine if the Sinclair 'power down' technique was employed.

However, other problems were undermining the original portable ZX83 concept. In mid-1983 it emerged that, contrary to earlier projections, the Sinclair-Timex plant at Dundee would not be capable of producing anything like the number of 'flat-screen' tubes that would be required to meet the expected demand for the ZX83. Nor did it seem likely that the tubes, at their current state of development, would be able to meet consistently the high resolution standards required for a microcomputer display. So the idea of incorporating a flat screen display into the ZX83 was reluctantly dropped. In any case, there was some opposition to the flat screen on marketing grounds: it was argued that a small, built-in display might make the machine look too much like a 'toy' – not something for serious users.

When the built-in flat screen was abandoned, the concept of the ZX83 as a portable went with it: there is little point in having a portable microcomputer if you still have to plug it into a conventional TV screen to use it. And when the portability requirement was dropped, the built-in modem was dropped with it, since in a machine which is not portable there is no particular need for the modem to be built-in.

3.1 CHOICE OF CENTRAL MICROPROCESSOR

Having decided to abandon the original ZX83 portable concept, the design team was still faced with the difficult decision of what central microprocessor should be chosen for the machine. The advantages of using the trusty Z80 were not only that it was a proven device, but that it would enable the equally proven operating system, 'CP/M' (short for 'Control Program/Microcomputer') to be used in the new machine – and this in turn would enable the machine to run the many thousands of ready-made applications programs that use CP/M. Alternatively, it could use an operating system compatible with that of the Spectrum, so enabling it to run the thousands of existing Spectrum programs.

The disadvantage of the Z80 chip was that it was only an 8-bit device, which contrasted unfavourably with the 16-bit chips being employed in the latest home computers, such as the IBM Personal Computer (IBM PC), and the 32-bit processors used in most minicomputers and large mainframe machines. Microchips with 16-bit and 32-bit internal 'architecture' can process data more quickly than 8-bit devices can. They are also usually designed to enable much larger amounts of Random Access Memory (RAM) to be used in any microcomputer of which they form a part. The ability to use larger amounts of memory enables larger and more sophisticated programs to be run on the machine.

The main advantage of the 68008 over the Z80 is not so much that it has a 32-bit data register, which should in theory enable it to process data more rapidly than an 8-bit chip can, but that it is designed to be able to address over a megabyte (one million bytes) of memory. This extra memory capability is the 68008's main advantage, because in practice it is not very much faster at data processing than a Z80. As already mentioned, this relative lack of speed is due to the fact that, despite its 32-bit data registers, the 68008 still uses an 8-bit data 'bus'. The effect is that, even though the data can be processed internally more speedily within the 68008 than within an 8-bit device, data input and output still takes just as long.

The Z800, however, with its 16-bit capability, would have had almost as good a processing speed and memory-addressing potential as the 68008, while giving the added advantage of 'upward compatibility' with existing Z80 software. However, there was some doubt as to whether the Z800 would be available in quantities sufficient for the mass-market machine the Sinclair designers had in mind.

What finally gave the 68008 the edge over the Z800 was simply its market appeal as a 'powerful, 32-bit' machine, coupled with its superior memory-addressing potential. So they decided provisionally to go for the 68008.

But there was still the problem that 68008 chips were priced at $20 apiece, compared with a price of around one dollar for the humble but plentiful Z80. There then ensued some nerve-wracking negotiations with Motorola in which Sinclair finally managed to get the price down to eight dollars in return for the promise of very large orders – on the assumption that the QL would turn out to be as successful as Sinclair's earlier computers, with sales in the millions.

3.2 MASS MEMORY STORAGE

The Sinclair designers seem to have had little difficulty in deciding to adopt the Sinclair Microdrive as the new computer's mass storage medium, instead of the floppy disks which were in use by virtually every other microcomputer company in the world. But why did they not opt for floppy disks like everyone else? Part of the answer, of course, is that for Sinclair the Microdrive was 'invented here': the company had put a lot of money and technical commitment into developing the Microdrive's tape loop technology, initially as an improved storage medium for the Spectrum.

One major difficulty with storage using tape loops (sometimes known as 'floppy tape drives') is that the tape loop usually requires a lubricant to avoid jamming, and this can accumulate in the read/write heads, leading to data errors. Sinclair claimed to have solved this problem by using high-quality, broadcast-standard videotape, which has a special low-friction coating that makes lubricant unnecessary. Another problem is that tape loops tend to stretch over time, causing timing errors which lead to garbled data. Sinclair claimed to have beaten this problem, too, by using a low-inertia drive mechanism to minimise strain on the tape, and by encoding the signals on the tape in such a way that they are not so affected by stretching.

The main advantage of tape loop storage over floppy disks is that it is very much cheaper. A Microdrive needs only a fairly simple and inexpensive drive motor, a tape read/write head, some electronic circuitry and a loop of thin (2 mm wide) tape about 5 metres long. By contrast, a floppy disk drive needs not only a disk drive motor, to rotate the disk, but a high-precision 'stepper motor' to position the read/write head exactly above the track at which the user wishes

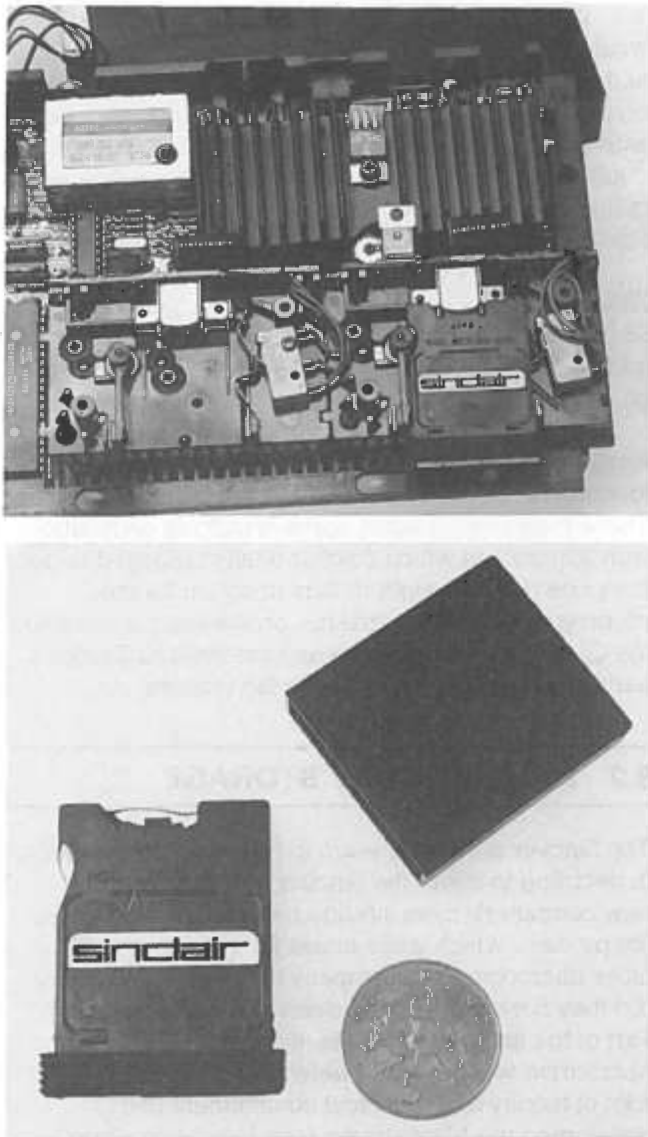


Figure 12 The Microdrive mechanism and cartridge

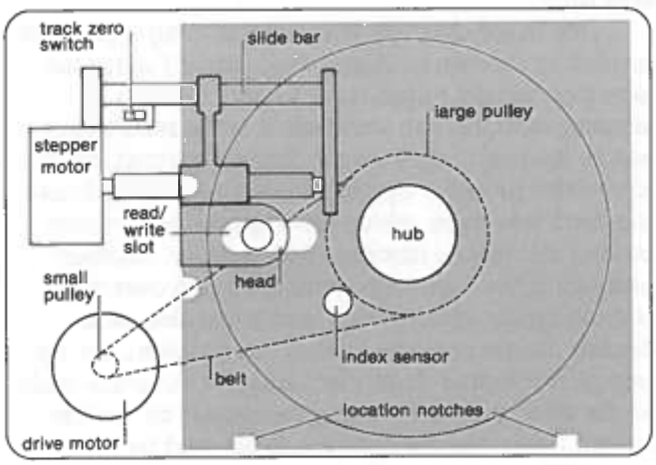


Figure 13 A floppy disc drive mechanism

to transfer data. The precision and solidity required of these mechanisms, together with the extra sophistication of the electronics required, make a floppy disk drive much more expensive to manufacture than a tape loop storage device.

On the other hand, floppy disk drives usually enable a user to access files much more rapidly than with tape-loops. Typically, a floppy disk drive can access a short file in a second or so, whereas a Microdrive takes about seven seconds to do the same thing. However, Sinclair argues that accessing long files takes no longer using Microdrives than it does on many of the slower floppy disk drives.

Floppy disk drives, however, can at present hold considerably more data than can Microdrives. A Microdrive can store up to 100k bytes of data, whereas a double-sided, double-density 80 track floppy disk drive can hold as much as 800k bytes of data.

In the end, Sinclair's choice of the Microdrive seems to have been dictated largely by cost considerations. By using Microdrive cartridges, it could give customers a mass-storage medium which was much cheaper than the floppy disk, although somewhat inferior to it in performance. Moreover, the Microdrive had a much better performance than the audio-cassette which, until the Microdrive came along, was the only form of mass storage Sinclair could offer.

There were other commercial considerations, too. Sinclair Research had invested considerable sums of money developing the Microdrive. These would have appeared to have been wasted if it had not been used – and the company would either have had to buy 'floppies' from another manufacturer or paid royalties to have them made under license for Sinclair. Such a situation would have been both costly and embarrassing for a company which prides itself on its ability to innovate.

However, adopting Microdrive technology still represented something of a gamble. Despite the company's claims to the contrary, the reliability of the Microdrives and their associated Microdrive cartridges still left a lot to be desired when the machine was launched – though their reliability was improved substantially later.

In addition, Sinclair had to persuade software suppliers to provide their software on Microdrive cartridge, rather than floppy disks: this faced the suppliers with additional costs which many were unwilling to bear until they were more certain of the potential market for the QL.

3.3 OPERATING SYSTEM

Having decided to use the 68008 as the QL's central microprocessor, and to use the Microdrive as its mass storage device, the Sinclair design team was faced with another, equally-important decision: what operating system should they use for the machine?

They could opt for one of the operating systems already developed by other manufacturers of 32-bit 68000-based micros – such as the Apple Macintosh – or they could go for Digital Research's 'CP/M 68K' operating system, written for general use with the Motorola 68000 series of microchips. They could write a similar operating system which would be compatible with one of the established systems, or they could write their own. [Incidentally, the reason why it is possible to have several different kinds of operating system for use with any given microprocessor is that there are a number of different ways in which the task of managing the microprocessor's various 'housekeeping' tasks can be approached. Each operating system has its strengths and weaknesses – tasks which it performs quickly and efficiently, and others which it performs slowly and inefficiently – depending partly on the skills of the systems programmers who have written it, and partly on the exact mixture of tasks which the system has been designed to perform.]

The Sinclair team decided to write their own, and they decided to call it 'QDOS'. The title is a pun: operating systems frequently have the abbreviation DOS in their titles, as shorthand for 'Disk Operating System'. Sinclair wanted to imply the superiority of its QL DOS by calling it 'QDOS', because it rhymes with 'kudos'. (Another, half-serious title for the operating system which was bandied about for a while was 'Domes-DOS' – a pun on the name of the well known household cleaning fluid 'Domestos', which is advertised on the basis that it 'kills all known germs'. 'Domes-DOS' was therefore reckoned to be a good name for an operating system, free of all the known 'bugs' that bedevil domestic computers.)

The main reason for the decision to 'go it alone' by developing QDOS was that Sinclair Research, as in the case of its Microdrives, prefers as a matter of policy to carve out its own market rather than compete directly with other manufacturers. Adopting an established operating system for the QL would also have meant implicitly acknowledging the superiority of the competition. And of course the Sinclair design team felt confident that QDOS would be a better operating system, for the QL, than the others that were available.

But adopting a unique operating system is risky: apart from the possibility that it may not turn out to work quite as well as others, there is the added problem that unless software houses have confidence in it (and in the machine to which it relates) they may not be willing to write, or rewrite, their software to suit it.

On the other hand, the benefits can be great if a new operating system does succeed in gaining acceptance. Software houses, and customers, then become committed to software packages written using the system, and become reluctant to switch to other peoples' operating systems.

Sinclair went some way towards solving the problem of software houses' wariness towards new operating systems when it decided to 'bundle' (i.e. to give away) four free software packages with the QL (see below). In effect, Sinclair was 'pump-priming' the market by commissioning its own QL-compatible software, in the hope that this would encourage others to follow suit. Also, the huge potential sales of the QL, which could be guessed at by examining the sales figures of its predecessor, the Spectrum, were probably enough to convince many software houses that an investment in producing QL-compatible software could be worth-while.

In short, the potential rewards of writing a new operating system for the QL were many, and the risks appeared to be relatively few.

However, Sinclair ended up developing not just one but two operating systems for the QL.

Tony Tebby, the systems programmer responsible for the QL's operating system, had commissioned the Cambridge software house GST to write it. The GST operating system eventually became known as '68-KOS' (meaning an operating system for the 68000 series – with the letters K.O.S. implying a mild pun on the word 'chaos'). But as a form of insurance in case GST failed, for any reason, to develop 68-KOS on time, Tebby decided to write his own operating system, and this was the one eventually christened 'QDOS' and used in the QL.

But '68-KOS' was written on time and was in fact the operating system use by Sir Clive Sinclair to impress the Press with the QL's 'multi-tasking' capabilities at the January 1984 launch (QDOS being used to demonstrate the QL's other capabilities). Moreover, in addition to QDOS and 68-KOS, there is a third operating system available for the QL, namely Digital Research's 'CP/M-68K' (mentioned above), the world-wide rights to which have been acquired by the UK firm Quest Electronics for use with the QL. But although CP/M-68K is similar to Digital Research's earlier and enormously successful 8-bit operating system CP/M-80, there is as yet very little software available that uses this system.

3.4 SOFTWARE PACKAGES

At an early stage during the QL's evolution, the Sinclair team decided that it would adopt the increasingly popular marketing ploy of giving away free software with the new machine – a practice known in the trade as 'bundling'.

The advantages of 'bundling' are considerable. It offers the customer better value for money, in that he or she does not have to pay extra for applications software. It helps the manufacturer to overcome sales resistance amongst users who already have another manufacturer's computer and may be tempted to 'upgrade' it by buying another 'compatible' machine in order to be able to run their existing software. It also helps software houses because, if the machine is successful, they will have a large income in royalties, even though they may have to offer the manufacturer large discounts on their normal software prices.

Sinclair decided to commission the software company Psion, which had already written several best-selling programs for the Spectrum, to write the software 'bundle' for the QL. It commissioned four packages, covering the four most popular business microcomputer applications: a word processor, a spreadsheet package, a database and a graphics package. The packages were eventually entitled 'Quill', 'Abacus', 'Archive' and 'Easel' respectively, and all are QL versions of software in an 'integrated software package' written by Psion for the IBM

Personal Computer, entitled the 'Psion Xchange Suite'.

Initially, users were impressed by the power and sophistication of the four Psion packages, although this enthusiasm in many cases gave way to irritation at their many bugs and documentation errors. (To be fair to Psion, however, much of their software had had to be written in haste and in the absence of a final version of the QL and its operating system.)

Quill, in its original version, was not only unreliable but occupied more memory space than the machine had available; it therefore had to be read from Microdrive into the memory in segments which were automatically called up as required. Though this technique works (and is used on other word processing programs) it is slow – particularly when using Microdrives.

Abacus was described by one early reviewer as

> ... a run-of-the-mill spreadsheet which ... contains a number of good features and some unattractive ones. Its use of memory is profligate, and this probably stems from the fact that the QL itself and the operating system were not available to the software designers when they designed this package. (...) I can't help making comparisons with spreadsheets operating on 8-bit computers with only 64K of memory available which have vastly greater memory capacity than Abacus and indeed operate just as quickly. (*QL User*, August/September 1984)

The reviewers' verdict on Archive was somewhat kinder:

> QL Archive is potentially a very powerful database program, equal in many respects to the well-known market leader, dBase II.

On the other hand, its initial version was apparently 'filled with a fascinating fauna of bugs', and the manuals were judged to be not very 'accessible'. (*QL User*, August/September 1984)

Of all the packages, Easel was received with the greatest degree of enthusiasm:

> All in all Easel is an extraordinarily comprehensive business graphics package the like of which has yet to be seen on any computer remotely near the same price. (...) Deceptively named, Easel is not the tool of the artist but of a businessman, being both cosmetic and functional. By itself it provides a useful analytical tool, providing graphic insights into relationships between different sets of figures. As part of an overall package it is the icing on Psion's cake, by far the easiest to use, and some remarkable effects may be achieved with a minimum of effort. Ideally it should be used to add the finishing touches to a report or forecast generated with the help of Quill or Abacus. (*QL User*, October 1984)

In view of the substantial criticisms which greeted the initial versions of Psion's QL packages (with the exception of Easel) Sinclair promised that new, improved versions would soon be available. These finally arrived in early 1985, when Version 2.00 of Abacus, Archive, Easel and Quill became available as free upgrades to early purchasers of the QL. They were also sent out with all new QLs after the beginning of March 1985.

User reaction to these was much more favourable:

> With this upgrade Psion have put right all the major bugs which marred the early versions, speeded up and compressed the code to improve performance significantly, and improved the already substantial documentation that accompanies them. Version 2.00, unlike its predecessor, is worthy of the title 'professional software'. What a shame it wasn't this version that arrived with the machines this time last year! (*QL User*, April 1985)

3.5 SUPERBASIC

QL users were not, of course limited to using only the four software packages provided free with the machine. On the QL, as on most computers, users can write their own programs, and Sinclair decided to provide 'SuperBasic', its own version of the well-known Basic programming language, to enable them to do so.

At one stage, however, the option of not providing Basic or any other high-level programming language as a standard feature was seriously considered. Some members of the design team argued that the QL should be aimed mainly at people who would want simply to run ready-made applications software, such as the Psion packages, on the machine: such people would not be interested in writing their own software in Basic, so there was no need to provide it. Others argued that a significant number of users would want Basic provided on their QLs, either to write programs straight away if they had programming experience, or simply to learn Basic programming.

In the event, those in favour of built-in Basic prevailed, mainly because the inclusion of Basic was thought likely to improve the machine's educational sales prospects. But it was decided that the version of Basic incorporated into the QL would only be a 'shell', providing many but not all of the features of the language that could be provided. The idea behind this was that experienced programmers require a lot more features in a Basic interpreter than those which a novice would demand. The 'shell' version would provide a core of essential features, whilst experienced programmers would buy an extra 'Toolkit', on a ROM cartridge, which when plugged into the machine would give them the additional programming 'tools' they required.

The task of writing the QL version of Basic, 'SuperBasic', was given to Jan Jones, another programmer on Sinclair's staff who worked closely with Tony Tebby, author of QDOS.

The original Basic was developed at Dartmouth College in the United States in the 1960s, with the aim of making programming easy for beginners. (There is still considerable controversy about whether or not Basic is in fact a good programming language for beginners, but I don't intend to get involved in that controversy here.) Since the 1960s, numerous companies have added 'enhancements' to Basic – often borrowing features from other, more sophisticated languages such as 'Pascal' – in order to improve Basic's performance and make it even easier to use. The main enhancement has been the creation of various forms of 'structured' Basic. In these versions of Basic, programmers can create what are called 'procedures' which carry out specialised sub-tasks within the overall program. These procedures can be 'named' and then simply 'called', by name, whenever the program needs to perform the specific tasks to which the names refer. This avoids the cumbersome business, necessary in ordinary versions of Basic, of writing numerous commands telling the computer to 'GO TO' a particular numbered line in a program (at which point are written the instructions relating to a specific sub-task): the proliferation of 'GO TOs' and associated line numbers makes the resulting program very confusing to read – especially if it is a long one. It also makes the task of finding the almost-inevitable 'bugs' very difficult.

SuperBasic offers structured programming and other features to make Basic programs easy to write. However, while writing SuperBasic, Jan Jones kept being asked to add extra features to what was originally intended only to be a 'shell' Basic. This pressure, together with delays in finalising the hardware for the machine, meant that SuperBasic was still not, by the January 1984 launch date, able to fit alongside QDOS into the on-board ROMs in the QL. On the first machines, therefore, SuperBasic and QDOS were accommodated on three 16k EPROMs, one of them occupying the ROM expansion slot. But on later machines, by re-writing the machine code in more compact form, they were able to be incorporated into the two ROMs, one of 16k and one of 32k, originally allocated to them.

User reaction to SuperBasic, at least in the form in which it appeared in early QL machines, was mixed.

> SuperBasic is powerful and extensive, offering a wide range of control structures and affording a wide range of control via QDOS of the machine's various functions. Despite all this, however, the QL's Basic appears to be a tool without a definite application. (...)
>
> For the beginner ... the language is hardly ideal: its syntax is idiosyncratic, characterised by long and cumbersome commands and ambiguous error messages. It is also slow!
>
> Shortcomings in the QL's SuperBasic indicate that the machine was never intended to run serious applications in that language. (*QL User*, October 1984)

However, many initial critics of SuperBasic were probably unaware that it was not intended to be a fully fledged implementation of Basic. But in any case, to provide many of the features that were said to be lacking, Sinclair made available its 'Programmer's Toolkit', written by Tony Tebby, in late 1984.

Sinclair Research, unsurprisingly, disputed such criticisms. The company contended that criticisms of SuperBasic's speed of operation arose from the use of 'benchmarks' (standard programs used for comparing one machine with another) that were designed to suit other machines. It also maintained that the language was in fact very easy to program in and superior in some respects not only to other versions of Basic but also to many other supposedly superior languages, and pointed out that complicated applications programs (such as accounting packages) can be, and have been, written in SuperBasic.

Sinclair's defence of SuperBasic's structure is supported by Allan (1984) for example, who argues that

> ... the most important feature of the QL is its programming language, SuperBasic, which is so sophisticated in conception that it makes many other versions of Basic seem absurdly constricting. (...) In a very real sense it can be said that SuperBasic is more powerful than Pascal.

3.6 PHYSICAL DESIGN

The designers of the QL had little trouble in choosing a colour for their new product: it had to be black because Sinclair's policy, like that of Henry Ford, was that all products should be black. The overall styling of the machine was the responsibility of industrial designer Rick Dickinson, who worked with David Southward, a mechanical engineer and one of Sinclair's technical directors.

An important feature of the QL, one which dominates its physical appearance, is its keyboard. Earlier Sinclair computers, such as the Spectrum and the ZX81, were widely criticised for the inadequacy of their keyboards. The company was determined to give the QL a keyboard that looked and felt 'real' – i.e., similar to a conventional electric typewriter keyboard. But it was not prepared to abandon the endless Sinclair quest for cost saving, so the QL keyboard, though it looks 'real', is not of the kind found in most home computers, in which each key rests on a small spring. It has a keyboard of the 'membrane' type, in which the keys rest on 'blips' in a sheet of rubber. The keyboard is also integrated with the case top. Such a keyboard is much cheaper to manufacture than one using springs, but it has a 'feel' which most users still find slightly 'spongy'.

After the new QL keyboard had been designed, the company was offered a similar low-cost keyboard by the Japanese firm Mitsumi. The Mitsumi keyboard had a better 'feel' than Sinclair's in-house design, and cost almost the same. But Sinclair decided to stick with its own keyboard, presumably because it had invested considerable resources in developing it. Subsequently the in-house keyboard was improved a little further, but although it 'feels' much better than earlier Sinclair keyboards, it still compares unfavourably (except on price) with a 'conventional' design.

The keys on the QL keyboard lie flat, rather than sloping slightly upwards in successive rows as they do on most keyboards. Professional keyboard operators find this feature a little off-putting – though it saves money in manufacture by allowing the keyboard to be integrated with the case top. To compensate partially for the flat keyboard, Sinclair provides some small plastic 'feet' which can be used to prop up the rear of the computer and make the entire case slope gently downwards.

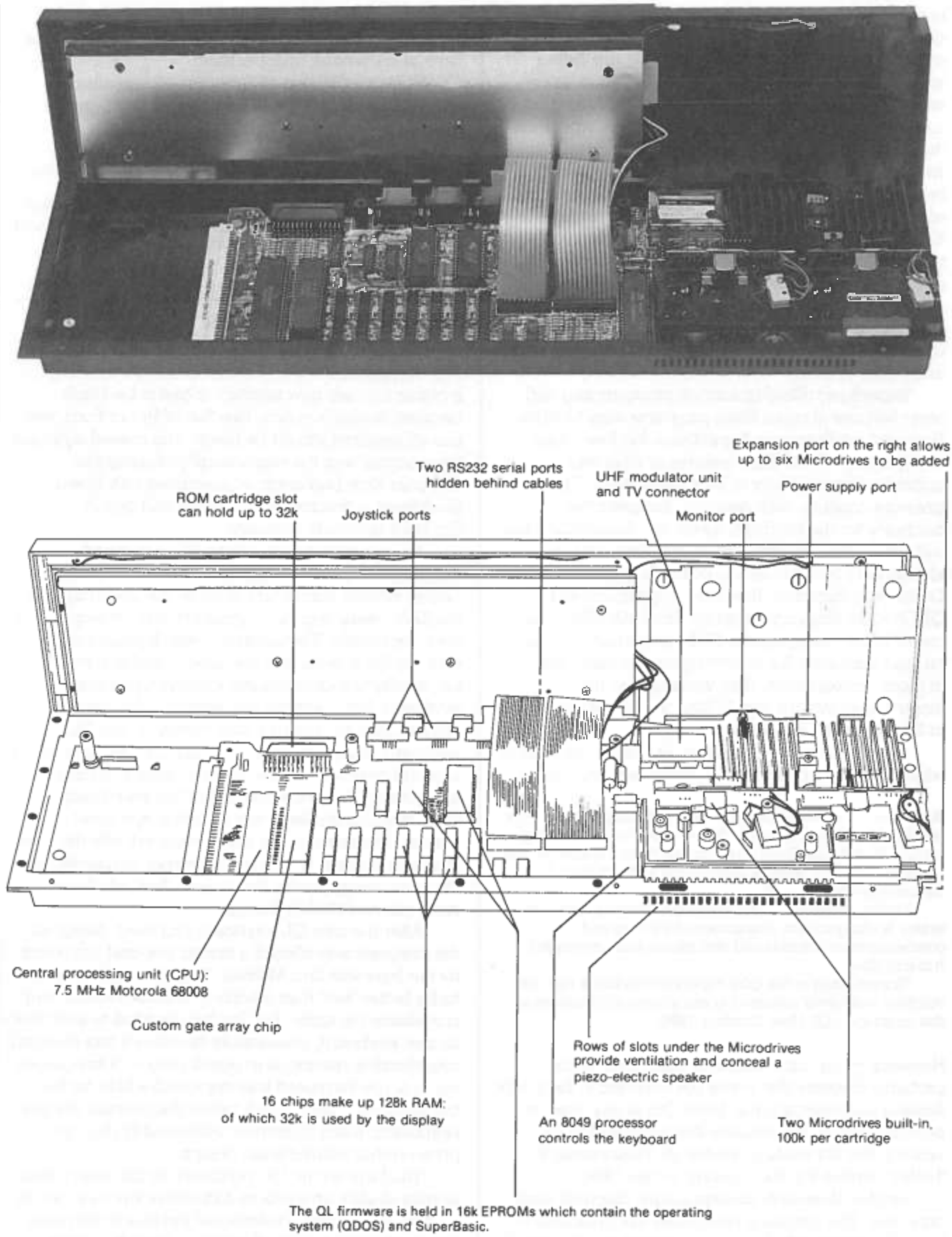


Figure 14 The physical layout of the QL

The keys themselves are of 'continental' design, with circular dished key-tops sitting on square bases.

To the right of the keyboard is the housing for the Microdrives, together with a connector for adding more Microdrives externally; to the left is a large multipin connector, the 'expansion port', for adding up to 512k of extra memory chips, a disk drive interface, or other accessories. Fitting extra circuit boards at the side like this adds considerably to the width of the machine, and means that connectors and cables protrude in an ungainly fashion from the side, occupying more usable desk space than necessary. One of the designers subsequently admitted informally that it would have been better to have placed the expansion port at the back, with the other sockets, where cables and connectors would have been less obtrusive.

The QL's power supply is not contained inside the main casing. It is housed in a separate small case which can be tucked away out of sight near the user's mains socket. This enables the main casing to be smaller and neater than it would otherwise be and avoids some problems such as overheating or mains interference that might occur with a built-in power supply.

Since the QL does not have a built-in monitor screen, it needs an external monitor. Although a standard black-and-white, or colour, TV set can be used, it is not capable of reproducing text or graphic images with very good definition, especially if the computer is operating in the high-resolution 80-column mode (i.e. with 80 characters per line on the screen). For this users need a 'monitor' – essentially a TV set without all the complicated circuitry which detects and decodes 'off-air' TV signals.

The QL produces extremely clear and steady pictures on monitors designed for it. But most of the monochrome or colour monitors designed for other computers cannot be used to display the full 80-column wide screen generated by a QL. This is because in the QL the electronic timing circuitry, controlling the 'electron gun' which paints the picture on the screen, is designed to operate with a slightly different 'line flyback time' to that adopted by many other manufacturers. ('Line flyback time' is the time taken for the electron beam, having 'painted' a line of the picture, to 'fly back' to the beginning of the next line.) This has the effect that not all of the 80 columns can be seen on a 'normal' monitor, and most users will have to buy a monitor especially designed for the QL – which is fine for the many companies eager to supply QL accessories, but irritating to many purchasers.

You will find some self-assessment questions relating to the design of the QL in the Block 2 Study Guide.

4 MARKETING THE QL

4.1 MARKET RESEARCH

It has become the conventional wisdom in business that companies, before designing new products, should carry out detailed market research to find out who their potential customers are, what kinds of products they want, what price they are prepared to pay for certain features, and so on.

But Clive Sinclair did none of these things when he designed his first microcomputer, the ZX80, in 1980 – yet the ZX80 was a runaway success.

One might have imagined that by 1983, when his company had grown much larger and more sophisticated, the conception and design of the QL would have been preceded by considerable market research effort. But this was not the case. The design of the QL, like that of its predecessors, seems to have been 'driven' mainly by the imperatives of technology, and by the design team's qualitative perceptions of what people want, rather than by the results of conventional market research.

Sinclair's explanation for the company's unwillingness to carry out formal market research for the QL is that microcomputer technology is advancing so rapidly that lay people cannot be expected to offer detailed opinions on what features they would like to see in a new computer. They simply don't know what the possibilities are.

Of course lay users can and do express general desires, such as the desire for more power for less money, or for faster processing or more mass memory storage; and they do offer useful comments on hardware or software that is already available on expensive machines, which can help mass-market manufacturers like Sinclair Research to decide whether or not it may be worth bringing out cheaper versions. But when it comes to drawing up a detailed specification for a new computer, Sinclair Research relies mainly on its engineers and software specialists.

However, in spite of this apparent unwillingness to seek the views of the man or woman in the street directly, by carrying out its own market surveys for example, Sinclair Research claims to be very conscious of the needs and wishes of its customers. It observes market trends and statistics, as published in magazines and journals, or in publicly available reports, noting for example what kinds of people are buying IBM Personal Computers and why, or what are the top-selling software packages in the USA. It also pays close attention to what the buyers of its existing products have to say, through its dealers and distributors, and through the various 'clubs' that have been set up for users of particular microcomputers, such as the Spectrum.

As a result of this process, the company decided to aim the QL at people who would like to have the

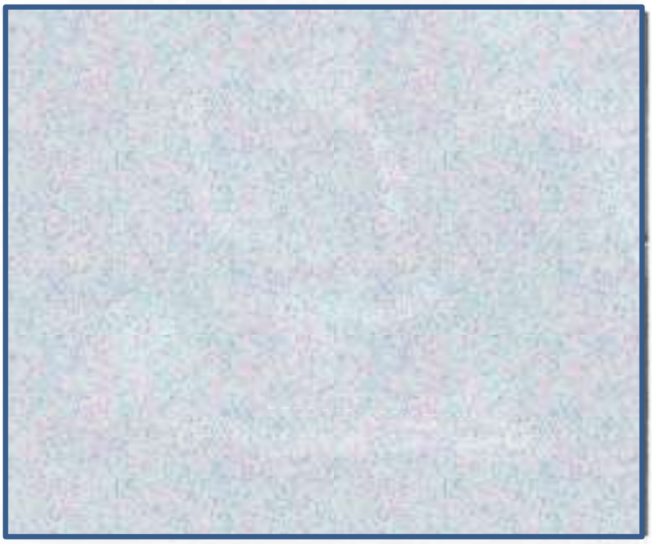


Figure 15 TV advertisement for the IBM personal computer

Figure 16 The Apple MacIntosh

power and facilities of an IBM Personal Computer, or an Apple MacIntosh, but who could afford only a few hundred pounds rather than the few thousand which such machines cost.

Thus the QL offers colour graphic displays, fast data processing potential, large random access memory (RAM) capacity and built-in mass storage for programs and data. And although some of these features are achieved 'on the cheap' (notably by the use of Microdrives) they are nevertheless comparable in many respects (and superior in a few) to those found on much more expensive machines. Its four software packages, Abacus, Archive, Quill and Easel, were tailored to perform most of the functions featured in the world's top-selling software – spreadsheet calculations, database management, word processing and graphics. In short, the Sinclair recipe for market success with the QL was a simple one: offer customers more power for less money.

The QL also represented an attempt by Sinclair Research to break away from the 'bottom-end' of the microcomputer market. Although the company dominated this segment of the market with its top-selling Spectrum machine, and although the Spectrum looked fairly safe in the short term, its technology was relatively easy to copy, which made its long-term sales vulnerable to attack by machines designed and assembled at even lower cost in the low-wage areas of the Third World.

But with a machine like the QL, very much more technically sophisticated than the Spectrum, the company hoped it could keep at least a couple of years ahead of the competition. The Spectrum would, of course, sell alongside the QL (though at a much cheaper price), just as earlier Sinclair models like the ZX81 had sold alongside the Spectrum, until such time as market demand declined to the point where they were no longer worth producing.

Although Sinclair Research did not see the QL as competing directly with the Spectrum (since the two machines were clearly in different price and performance leagues) it is worth noting that the company normally has no qualms about introducing new products which make its own earlier products obsolete. It justifies this policy on the grounds that in a highly competitive business like microcomputers, a company has to risk antagonising its existing customers by introducing new products as rapidly as possible: otherwise, a competitor may 'obsolete' the product first. Another reason for this policy may be that Sinclair computers, being considerably cheaper than most others on the market, may be regarded by many users almost as 'throwaway' items.

4.2 TARGET MARKETS

The outcome of Sinclair's assessment of the market potential of the QL was that the company decided to aim it at three different markets:

- firstly, the first-time buyer interested in a 'serious' home computer (i.e., not simply one for games use);
- secondly, users with some experience of an existing low-cost home micro, such as the Spectrum or the Commodore 64, who wanted to 'trade-up' to a more powerful machine; and
- thirdly, people, such as businessmen and professionals, who might buy a computer for 'serious' uses, but who had not yet bought one because they seemed too expensive.

The first two of these categories were fairly obvious, given that the QL was to be a low-cost, high-performance machine. But in the third, Sinclair was heading into much more uncertain territory.

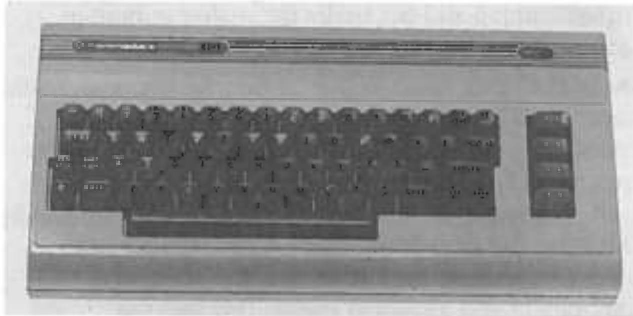


Figure 17 The Commodore 64

'Serious' users would, it was hoped, buy the machine either for business or home use. For businesses, Sinclair hoped that the QL would appeal to small firms (one example they quoted was the 'corner newsagents' shop') who would previously never have contemplated computerising their operations because of the cost: with the QL they could buy a complete system for well under £1000, compared to the several thousand pounds that a business computer system would normally cost to set up.

For home use, Sinclair hoped that the QL would sell to professional people who, although perhaps using computers at work, would like to have their own personal computer at home for tasks like word processing and domestic accounts, but who had hitherto not purchased a microcomputer because 'serious' machines were too expensive – especially if you had to pay for it out of your own pocket.

But since the company had not carried out detailed market research into the actual needs of these two groups of 'serious' users before the design of the QL was finalised, the company's expectation that the machine would appeal to them was based on little more than commonsense conjecture – and commonsense can often mislead. As we shall see, it appears with hindsight that business users were probably much more concerned with reliability and quality in choosing a microcomputer, and less concerned with initial price, than Sinclair expected.

The 'home professional' user, too, was a species of customer about whom Sinclair – and everyone else – really knew little. As Simon Craven put it:

> The home professional user is a semi-mythical creature like the Loch Ness Monster or Bigfoot – no one is sure if he exists or not and since there are no specimens in captivity, little if anything is known about his computer needs. Some independent observers claim that the home professional user is a creation of over-imaginative marketing executives, the product of wishful thinking from home computer manufacturers whose market has inconveniently stopped doubling once a fortnight. Others believe that the creature does exist, but is an endangered species, trapped between the sparse pickings of the BBC Micro and the vast admission fee to the lush IBM-PC meadow. (Simon Craven, 'Business or Pleasure?' *QL User*, May 1985)

Another Sinclair categorisation of the potential market for the QL divided it into two sections:

- on one hand there would be the computing enthusiasts, mainly interested in doing their own programming and not really interested in built-in software packages;

- on the other there would be people who knew little and cared even less about programming, but who would want the machine only because it can run ready-made software.

When the QL was launched in 1984, it was initially aimed at the 'enthusiast' market and sold by mail-order through advertisements in the specialist computing and technical press. This had the advantage that the 'enthusiasts', being much more knowledgeable technically than other buyers, would be better able to cope with the 'bugs' which bedevil the early versions of most computers – Sinclair computers being, to say the least, not exempt from this tendency. The enthusiasts would also be better able to offer informed feedback to the Sinclair engineers and programmers who were still working on eliminating the bugs from later versions.

4.3 MARKETING

Following the launch of the QL to the computer enthusiasts, Sinclair commissioned a formal market research exercise to determine how best to 'position' (i.e., to describe and promote) the QL in the market, in order to maximise its appeal to novice users and non-specialist business or professional users, whilst not giving the computer enthusiasts the impression that the machine was too simple for them.

Market research is normally carried out at a much earlier stage, and intended to influence the design of the product before it reaches final form. But the aim of this exercise was mainly cosmetic: to find the best 'image' for the already designed product to maximise its appeal in the market-place.

Nine small groups of potential users were recruited. They fell into three categories: people who had not yet bought a microcomputer; people who had already bought an inexpensive home computer (such as a Spectrum or Commodore 64); and people who already owned a 'serious' home computer, such as a BBC micro. (These three groups correspond roughly to the categories given at the beginning of section 4.1.) These potential users were not shown the computer itself (probably because too few were available at the time), but they were shown various specimen advertisements for the QL and encouraged to talk about which features of the machine impressed them and which features they found off-putting.

A number of very useful results and conclusions emerged from this research.

One was the advertising slogan with which the QL was later to be marketed to the general public:

'... the most enjoyable introduction to serious computing'.

The idea behind this slogan was to convey an image of the QL as a 'serious' machine which was, nevertheless, fun to use and suitable for beginners.

Another conclusion was that some users did not understand what, for example, a 'spreadsheet' or a 'database' package actually did: so a series of 'icons' (graphic images) were devised for use in advertisements to clarify what the functions of these software packages were.

Some users also had the impression that all Sinclair computers were very small and had unorthodox keyboards, like the Spectrum. So to emphasise the fact that the QL was a proper, full-size machine, it was decided to use large, full-page advertisements and to emphasise the fact that it had a 'real' keyboard. Also, although the machine itself was black, it was decided to use full-colour advertisements where possible, to emphasise the machine's colour display capability.

Most potential customers, it was discovered, did not really understand what technical terms like '128k RAM' and '32-bit processor' meant; so in advertisements these features were turned into more-understandable benefits by adding adjectives like 'massive' and 'powerful'.

It also emerged that customers liked the reassurance of the QL's impressive-looking manual, so this was also featured prominently in advertisements.

The Microdrive cartridges were seen as a weak point by many potential purchasers. Since the cartridges use a tape loop, some users felt they would be as slow and inconvenient as tape cassettes; and since they were physically very small, users suspected they might not hold very much information.

In advertising, the company therefore highlighted the Microdrive's relative speed of access to data, stressing for instance that a large 90k program can be loaded as quickly as on some of the slower floppy disk drives (though it omitted to mention that Microdrives are much slower for short files). Also emphasised was the fact that a cartridge's 100k-capacity means it can store the equivalent of about 40 A4 pages of information. (This sounds a lot, but in fact it is considerably less than the capacity of all but the cheapest floppy disk drives.)

Following the QL's initial release to the computer 'enthusiast' market, Sinclair's next target markets were, first, the home user, and second, the business/professional user.

4.4 THE HOME USER

The obvious route to selling computers to the domestic consumer is via the large High Street retail outlets, such as Boots, W. H. Smiths and Dixons. Although the percentage profit involved in selling through retail outlets like these is not as great as that achievable by mail-order selling, since the retailer creams off a substantial profit margin, the huge numbers of machines that can be sold in High Street shops enable manufacturers to cut their unit production costs very considerably. Overall, these production cost savings usually more than outweigh the discounts required to give the retailers their profits.

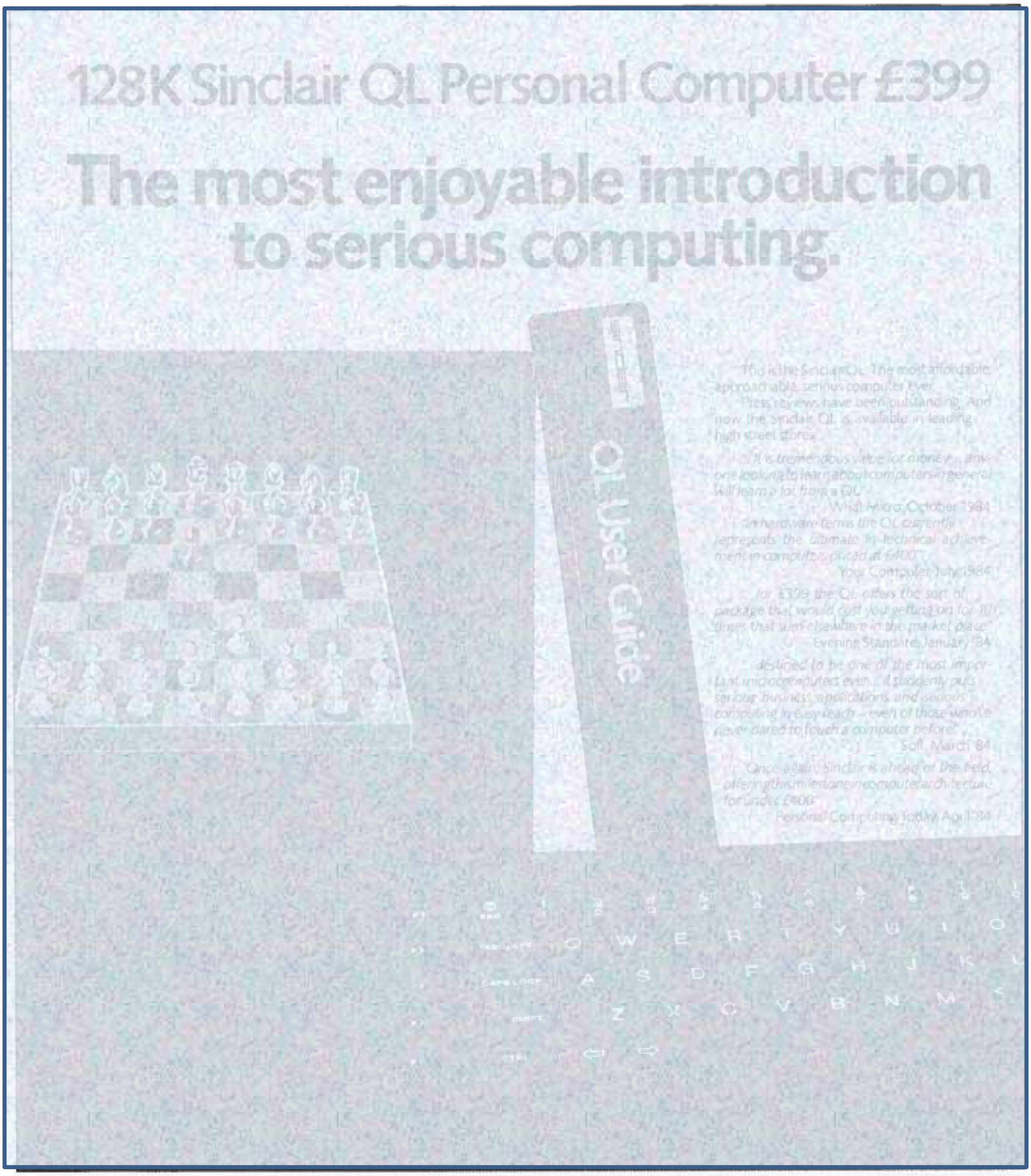


Figure 18 Advertisement for the QL, based on market research findings

Sinclair sold QLs directly to only about a dozen of the major High Street chain stores, however. Other smaller retailers had to buy their machines from one of two distributors: Prism Microproducts, and Terry Blood Distribution, part of the John Menzies newsagents chain. (Prism Microproducts, however, went into receivership early in 1985.) And in contrast to earlier Sinclair computers which could be sold by almost any retailer, QL retailers were initially asked to satisfy various conditions before they were allowed to stock the machine. These conditions were not particularly stringent: shops needed for example to have demonstration facilities, and to have adequately trained staff.

Though in the short term Sinclair expected the QL to sell to non-enthusiast users mainly on the basis of its four built-in software packages, in the long term the company hoped that the quality and quantity of the additional software that would become available for the QL would be what would give it the edge in the domestic and business markets. Because of its 128k memory, 32-bit processor and Microdrives, the QL was capable of running games and entertainment software of much greater sophistication than most low-cost machines were at that time capable of handling. 'Scrabble' on the QL, for example, was planned to have a built-in dictionary of 25 000 words, compared with only a few thousand in its Spectrum equivalent; and games like 'Flight Simulator' could be made much more realistic. Eventually, Sinclair hoped the QL's software catalogue would match that of the Spectrum, which has 5000 titles. So although the QL could not compete on price grounds alone with machines like the Commodore 64 and the Electron, which cost less than half as much, Sinclair expected to convince a substantial fraction of the market that by paying just a bit more (in fact, twice as much) they would get much better value for money.

4.5 BUSINESS USERS

In software terms, the business and professional market represented a rather greater challenge in many respects than the domestic market, businesses being more conscious of quality and reliability (and less concerned with initial price) than home users.

In 1985, a selection of business-oriented software, including the 'QL Cash Trader' package and the 'QL Integrated Accounts' package, was announced. Much of this software was written and sold by 'third parties', but some (like Cash Trader) was commissioned and sold by Sinclair Research itself. In order not to jeopardise their desired image of the machine as one intended for 'serious' users, the company concentrated its efforts on bringing out business software as rapidly as possible – even to the extent of delaying the introduction of games software that might give too frivolous an impression.

In its pricing policy, the company was aiming at business software priced in the £50 to £90 range – substantially lower than the several hundred pounds being charged for business software for machines like the IBM-PC, but substantially more expensive than the £6 to £20 price range of the company's games software. However, included in the cost of Sinclair business software was some 'software support' – advice available by telephone or letter if a user has software problems – to reassure potential buyers that, despite the relatively low price, the software was of high quality. Certainly, the initial reaction to QL Cash Trader suggested that this policy could well prove successful:

> As the first piece of true business software for the QL, Cash Trader is likely to take the market by storm. The product is of a particularly high standard (...). Furthermore, it entirely supports the notion of the QL as the affordable small business computer, even without disk drives (though we look forward to a disk version). Targeted at the sole trader or small concern where business is for the most part run on a cash basis and record-keeping is haphazard, it finds its mark precisely. The bane of fly-by-night book-keepers, it will be welcomed by accountants and auditors alike and should pay for itself within a month. (R. Vernon, 'Cash Trader, *QL User*, May 1985)

The reaction to 'QL Integrated Accounts', written for Sinclair by Sagesoft, was similar:

> Sagesoft's accounting software is something of a breakthrough on the QL. The ease with which accounts may be maintained and reports extracted belies its sophistication. Priced at £89.50, it represents exceedingly good value, especially against other dearer packages. (P. Bacanello, *QL User*, July 1985)

To increase the QL's appeal to business and professional users still further, a number of hardware enhancements for the machine became available in 1985 – most of them supplied by independent companies. These included additional RAM packs, a hard disk drive, floppy disks for users who disliked Microdrives (or wanted more than 100k of storage) and modems giving access to Prestel and electronic mail services.

Selling to the business/professional user can be undertaken in various ways. A company can employ a travelling sales force, as do large computer firms such as IBM and Digital; or it can concentrate on selling at exhibitions, conferences and trade shows; or it can sell through specialist dealers and retail outlets. Sinclair chose the last of these three options, in order to take advantage of a relatively new development in computer retailing.

In Britain in the mid-1980s a considerable number of specialist business computer shops opened up, mainly located in prime city-centre sites and aiming to sell 'serious' machines to 'serious' users. These businesses traded under names like 'Computerland', 'Interface', 'Businessland' and 'First Computer', and most of them were run on a franchise basis. Under the franchise system a local business buys from a larger (often American) company the right to market certain computer products in a particular locality; in return, it gains the advantage of the large company's ability to negotiate big discounts from manufacturers, and its expertise in nationwide advertising and marketing. Such operations had become successful enough to encourage at least one large High Street retailer, W. H. Smith, to open a few of its own similar specialist shops, called 'W. H. Smith Business Centres'.

The emergence of these new business computer stores reflected a change in the use of computers in business. No longer was it a company's 'data processing manager' who alone decided what computing facilities a company would buy – usually choosing a large, expensive mainframe machine to be accessed by users from terminals in their offices. With the advent of low-priced microcomputers, the purchase of computing power could be authorised within the budgets controlled by middle managers. Such executives were increasingly buying the equipment they themselves wanted, often regardless of the policies of their company's data processing management, and it was to the specialist computer stores that they increasingly turned for advice, sales and backup.

The market for the QL at the small-business end of the market should have been very substantial since,

Figure 19 Advertisement for the Acorn Electron

as I have already mentioned, a complete system for a small business user could be purchased for less than £1000, including a printer and colour monitor.

However, because of the machine's initial reliability problems and software defects, by mid-1985 it seemed doubtful that the QL would prove successful in establishing a sufficiently strong reputation for hardware and software quality to attract sales to customers in small businesses, for whom quality and performance are just as important as price. In particular, it seemed clear from user reactions that one major stumbling block to the machine's adoption by small business users was its lack of floppy disk drives.

Although such drives were beginning to appear on the market by 1985, from 'third-party' suppliers such as Quest, Computamate, Micro-Peripherals and Silicon Express, they were not available from Sinclair Research itself, which gave the impression that the machine (and Sinclair) did not support the use of floppy disks. To correct this impression, the company was by mid-1985 considering making available QL floppy disk drives carrying Sinclair's own label.

4.6 EDUCATION

Another important market for the QL was in education. Sinclair's competitors Acorn had shown with their BBC microcomputer, the most popular machine in UK schools, that having a machine which has the seal of approval of the educational authorities not only leads to substantial sales in itself, but also helps boost sales to home users who feel they are buying a computer which will assist their children's progress at school.

In 1985 Sinclair was developing 'packages', including education-oriented languages such as Logo and Prolog, aimed at 'targeting' the schools market later that year.

Equally important was the higher education sector, which includes universities, polytechnics, technical colleges and other institutions of advanced learning. Here Sinclair discussed with various universities (including the Open University) the possible adoption of the QL as a 'standard' or 'recommended' microcomputer for students. For example, the University of Strathclyde was in 1985 reported to be discussing an ambitious plan for a campus network of up to 7000 QLs, all linked to the university's main computer, and Sinclair had offered to contribute £250 000 to the project.

Eventually, Sinclair (like many other manufacturers) is hoping that personal computers will become as common amongst students as pocket calculators are today – or slide rules were yesterday. Some American universities are considering making it mandatory for students to have their own computer, just as they now have to buy textbooks. And even if UK institutions of higher education seem unlikely to go that far, it seems probable that one or two machines, which could include the QL, may be 'recommended' for use by students studying certain subjects.

4.7 PRICING THE QL

Many manufacturers catering for the mass market carry out sophisticated market research and computer modelling exercises to determine what is the correct price at which to 'pitch' their products.

But Sinclair adopted a much simpler, seat-of-the-pants approach. The price of the QL was essentially the lowest price at which the company thought it could be sold at a profit, in the quantities in which it was expected to sell. The calculations were not difficult.

An expert assessment of a UK-assembled QL in 1985 put its likely 'ex-works' cost at around £120. The rule-of-thumb in the industry is that you have to multiply the cost price of a product by a factor of approximately three to arrive at the minimum selling price – which gives a minimum QL price of £360. (A breakdown of the various factors that make up this 300 per cent mark-up is shown in Figure 20, generated on a QL using the 'Easel' package.) This figure was then rounded up to allow an additional margin for

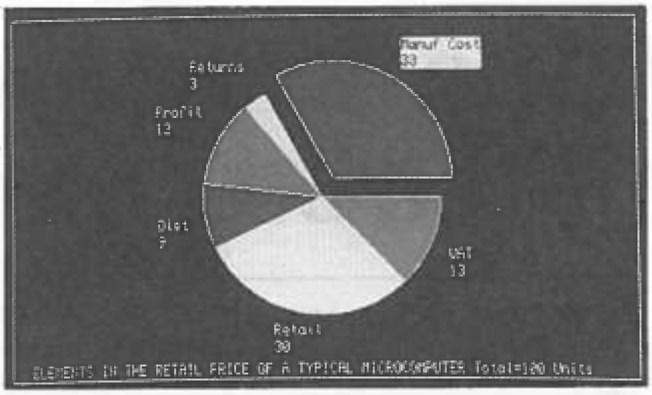


Figure 20 A breakdown of the percentage costs of the various elements in the final price of a typical microcomputer

error (remembering that a £10 error in costing means a £30 error in final price) and the final £399 selling price of the QL thus emerged.

However, the problem with this simple approach to pricing is that it ignores one of the crucial variables: *production quantity*. When the Sinclair team originally estimated the ex-works cost of the QL, the calculation assumed that the machine would be produced (and would sell) in the very substantial quantities that were typical of previous Sinclair microcomputers. And of course if a company is buying microchips and other components in their hundreds of thousands, or even millions, the prices it pays for such parts will be very substantially lower than if the order is in the tens of thousands, or thousands, range.

As we shall see, sales of the QL fell far short of the company's optimistic expectations. But in later production runs the company was able to off-set the tendency for unit production costs to increase by transferring production of the machine to the Far East, where labour costs are much lower than in the UK, and by taking advantage of the rapid fall in world prices of memory chips and similar components during 1985 – a drop in price largely caused, ironically, by the slump in microcomputer sales.

4.8 LAUNCHING THE QL: MATCHING SUPPLY AND DEMAND

Having overcome the formidable obstacles of designing and developing a microcomputer, and having estimated who the likely customers for it are and how they might be reached by various forms of publicity, how do firms like Sinclair Research decide how many machines to produce and when to produce them? In the mass-marketing of consumer products, when sales of hundreds of thousands or millions of units are in prospect, the financial survivial of a company can depend on whether it gets such calculations right. And, as we shall see, Sinclair did not get it right.

Calculations of market size and timing are usually based on a mixture of careful calculation and shrewd but crude 'guesstimation'. In assessing the demand for the QL, Sinclair's marketing people used the experience of the Spectrum as their guide. They knew not only the annual sales figures for the Spectrum, but also how sales varied, month-by-month and season-by-season. As one might expect, roughly 50 per cent of the sales of Spectrums occur in the last 3 to 4 months of the year, in the 'run-up' to Christmas. In the following months of January, February and March, demand is still strong: people still buy computers to help while away the long, cold winter evenings. But as spring approaches, sales start to decline, reaching a trough during the summer months of June, July and August. Then once again, when September comes, the weather begins to turn chilly and the children go back to school, sales begin to pick up again and the cycle repeats itself.

It seemed reasonable to assume that the pattern (though not necessarily the magnitude) of sales of the QL, month-by-month, would be similar to the sales pattern of the Spectrum. But how could the likely magnitude of QL sales be estimated? In other words, although the shape of the sales curve over time could be assessed with reasonable confidence, its size could not.

One of the main reasons for selling the QL initially by mail order through advertisements in the specialist computer press was precisely to try to overcome this problem. It is relatively easy to assess the demand for a product when it is being sold by mail order: the orders are clearly visible, on paper, and it is a simple matter to calculate precisely what the demand for the product is. (In selling a product through High Street retailers, by contrast, there can be very long delays before manufacturers discover whether their product is selling well or badly.) Of course a manufacturer will still have to guesstimate what should be the size of the very first production run, even for mail-order sales, if customers are not to be kept waiting more than the customary 28 days for their machines. But such a production run can be relatively small (in the QL's case, around 50000 units) and it is easy to estimate, from the rate at which the initial orders are building up, whether or not it will be necessary to bring additional production rapidly on stream to meet demand. A firm like Sinclair Research, which sub-contracts all its production, will have to have made arrangements with its sub-contractors rapidly to increase (or decrease) production volume once the magnitude of demand becomes clear.

When the initial level of demand for the QL, by mail order, had become evident (some 15000 machines had been sold between February and August 1984) it was then possible to compare these initial sales figures with those for the Spectrum during its similar launch period some years previously. Then, on the knowledge that the initial mail-order sales of the Spectrum had been followed by a now-known retail demand, it was possible to assess what the likely magnitude of High Street sales of the QL would be, and to plan production schedules accordingly.

Of course, since all these calculations are based on assumptions of varying plausibility, and since it would be unwise to plan production solely on the basis of a single method of market estimation, Sinclair tried to assess the likely market demand for the QL in other ways. Statistics from national market research organisations enabled estimates to be made of the overall size of the UK home computer market, and of the share of the market accounted for by various QL target groups – domestic consumers, businessmen, professional people, educational institutions, and so on. Such statistics also revealed the annual rate of market growth and the share of the market held by the main microcomputer suppliers. Then, on the basis of plausible estimates of the potential sales to new target groups, together with estimates of the 'market share' likely to be achieved by the QL in competition with other machines, it was possible to calculate the machine's likely sales figures.

Taking all these factors into consideration, Sinclair initially estimated that it should be able to sell some 750000 QLs in the UK during 1984 and 1985. But even if these calculations proved to be substantially inaccurate – and, with the benefit of hindsight, it is clear that they were extremely wide of the mark – the company was confident that it would be able to sell any surplus QLs in the rapidly expanding overseas markets.

4.9 OVERSEAS MARKETS

Although the country with the largest number of home computers per head of population is Britain, the second-largest market is the USA, followed by Japan and West Germany. On the other hand, the use of microcomputers in business is much more advanced in the USA than in Britain, Japan or Europe.

Sinclair planned to enter the US market with the QL in 1985. Previous Sinclair products had been marketed in the USA by the watch company Timex, under the 'Sinclair-Timex' label. But following the withdrawal of Timex from its marketing agreement with Sinclair, the QL was to be marketed by Sinclair itself in the US, using its own brand name.

Details of how the QL fared in America are given towards the end of the next section, which tells what happened when the QL, after its initial failure, was re-launched.

You will find some self-assessment questions on the marketing of the QL in the Block 2 Study Guide.

5 RE-LAUNCHING THE QL

5.1 MARKET SATURATION AND PRICE WAR

Christmas 1984 was 'crunch' time for the home computer industry, in both Britain and America. It was then that the exaggerated claims and expectations of those who had predicted continuing massive growth in the home computer market were confronted with the cold fact that the market was not an unlimited one.

The previous Christmas, by contrast, home computer manufacturers had been unable to deliver enough machines to keep up with what seemed like an insatiable demand. So as Christmas 1984 approached, UK retailers, anxious to have enough machines to meet the enormous projected demand, placed very large orders. In retrospect, it is clear that they over-reacted to the previous year's undersupply, and as New Year 1985 dawned, they were left with thousands of unsold machines.

For example Acorn, Sinclair's main UK competitor, had anticipated selling some 300000 of its Electron and BBC computers during 1984, but in the event only 200000 machines were sold. Other manufacturers, such as Commodore, took a similar beating, with only the Commodore 64 model continuing to sell in reasonable numbers. However, in one respect Sinclair fared relatively well during the Christmas 1984 period. The Spectrum, enhanced a few months previously by the substitution of a better keyboard and dubbed the Spectrum PLUS, continued to sell in large numbers, mainly because of its low price and the vast range of software available for it. Without the benef t of these Spectrum sales, indeed, it is doubtful whether Sinclair would have survived the Christmas '84 down-turn – for sales of the QL, on which the company had pinned such hopes, were little short of disastrous.

The immediate reaction of the major microcomputer manufacturers to the 1985 New Year glut was to cut prices sharply. Over Christmas 1984 the Spectrum Plus, Acorn Electron and Commodore 64 had all been priced at around £199. In February, Sinclair moved first by cutting the price of the Spectrum Plus to £129; Acorn responded (the following day) by reducing the price of the Electron to £129. This price pressure then forced the trade to reduce the price of the Commodore 64 to £149 – though it was subsequently increased again to £199.

But the price war was only one symptom of the deep trouble in which many micro manufacturers now found themselves. Commodore laid off a substantial fraction of its work-force and eliminated several models from its range. And Acorn, which only the previous year had been one of Britain's high-tech glamour companies, raising over £100 million when launched on the Stock Exchange's Unlisted Securities Market, fought a losing battle to quash rumours of imminent bankruptcy. Eventually, the company was forced to have dealings in its shares suspended and to appoint a new acting chief executive, Alex Reid (whom you will meet in the accompanying Prestel case study), as part of a scheme to re-organise and re-finance the ailing firm. A few weeks later, Acorn was rescued by the Italian multinational company Olivetti, which acquired a 49 per cent holding in Acorn from its founders, Chris Curry and Hermann Hauser. (Later in 1985, when the company encountered further cash flow difficulties, Olivetti took over the majority of Acorn Shares.)

In America, meanwhile, the Apple corporation shut several of its factories for a few weeks in an attempt to cope with the over-supply of its MacIntosh computer, and virtually the only healthy company in the microcomputer business seemed to be the enormous IBM Corporation, with its best-selling IBM-PC – though even here there were rumours of unhealthily large numbers of unsold machines.

However at least one major US microcomputer manufacturer provided a contrast to the prevailing mood of pessimism and retrenchment. The Atari corporation, which had had substantial success in the early 1980s with its games-based microcomputers but had suffered severely in later years mainly due to competition from Commodore, had recruited a new chief executive as part of an attempt to revive its flagging fortunes. His name was Jack Tramiel, a legendary figure in the US microcomputer business, who had founded the spectacularly successful Commodore Business Machines Inc., but had left the company after a boardroom row in 1982. Tramiel soon made it known that he was out to repeat his earlier success. He then proceeded to trim the Atari work force by firing a sizeable proportion of its staff and announced that Atari would soon be producing a range of machines which would, it was claimed, surpass in hardware and software performance the Apple Macintosh, but would sell at less than half the price.

The cries of disbelief and disdain which greeted the announcement began to ring a little hollow, however, when the first Atari machine, the 520 ST, was unveiled on schedule at the Las Vegas consumer electronics show early in 1985. As Tramiel had predicted, the 520 ST offered hitherto-unrivalled value for money – 'power without price', as his advertising slogan put it. The machine was based on the Motorola 68000 chip of which, as we have seen, the 68008 chip used by Sinclair is a 'stripped-down' version.

At the UK price of £750, it came complete with 512k of RAM, a 350k floppy disk drive, interfaces for a hard disk, a music synthesiser and various other peripheral devices, and a high-resolution monochrome display – though the 520 ST, unlike the

Figure 21 Advertisement for the Atari 520 ST

Macintosh, could display its graphics in colour too. Also 'bundled' with the machine were packages for word processing and graphics, the Logo and Basic programming languages, and a new, user-friendly program called GEM (Graphics Environment Management) which enabled the user to employ 'icons' and a 'mouse', just like those used on the Apple Macintosh, to make the machine easier to operate. The main operating system of the 520 ST was a version of Digital Research's CP/M-68k which, as we have seen, was written for machines using the 68000 series of microprocessors. As used in the 520 ST it was nicknamed TOS (short for Tramiel Operating System). In addition, Atari included in the machine's software bundle a 'business operating system', BOS, which was claimed to give users 'access to dozens of business applications packages already available on the market'.

The quality and performance of the 520 ST's hardware appeared to be so good that it immediately received rave reviews on both sides of the Atlantic. This reaction was typical of many:

> There will be turmoil in an already troubled computer industry when the ST is launched in the States in June. The specification outstrips nearly all computers up to, and including the IBM-PC. The only UK machine in this bracket with a 68000 processor, the Sinclair QL, is in for a rough ride. ... if the ST lives up to its promise it will be the final nail in the coffin of the 8-bit- 64k micro, and may do everything Sinclair set out – but has as yet failed – to achieve with the QL. (J. Lambert 'The Atari Blueprints', *Electronics & Computing Monthly*, July 1985)

[Atari's approach to marketing the 520 ST is described in the television programme which accompanies this block.]

Unfortunately, the looming transAtlantic competition from Atari was not the only threat to what remained of Sinclair's market share. Jack Tramiel's former company, Commodore, could hardly have been expected to fail to respond to his 520 ST challenge – and it did not. While Tramiel was developing the 520 ST and banging the publicity drum, Commodore was working quietly away on an even more advanced, though rather more expensive, machine – the 'Amiga'.

The Amiga was due to be launched in America in the Autumn of 1985 and in the UK in early 1986. It was based on the 68000 chip, like the Atari 520 ST, but employed an even more sophisticated array of peripheral chips to boost its performance, and came with 256k of RAM, expandable to 8 Megabytes, and an internal 3½ inch floppy disk drive. In the words of Guy Kewney, reviewing one of the first available machines:

> The Amiga is a multi-tasking micro (it can run several programs at once). It runs them very, very fast. It has graphics animation in colour, not just high-resolution pictures. It has sound capabilities the match of most synthesisers (...). It can have more useful memory than anyone will plug in for a couple of years, and it will be expandable.
>
> And, to cap it all, it isn't expensive. (...) As an optional peripheral, a 5¼ inch disk can be plugged in (which includes) a program, bundled with the drive, that emulates an IBM-PC. (...) Astonishingly, this should sell for under $500. (...)
>
> The Amiga, at $1500 for a colour system, is obviously going to be a business machine first and foremost. Its massive memory capacity means that most people with $3000 to spend will do so, getting a machine which spending $6000 on an IBM wouldn't match, and which comfortably out-performs the Macintosh. Anyone who is comparing this with the Atari 520 ST will quickly decide that the only reason for buying the Atari is the price. If you can afford the Amiga, that is the one you will want. (*Personal Computer World*, August 1985)

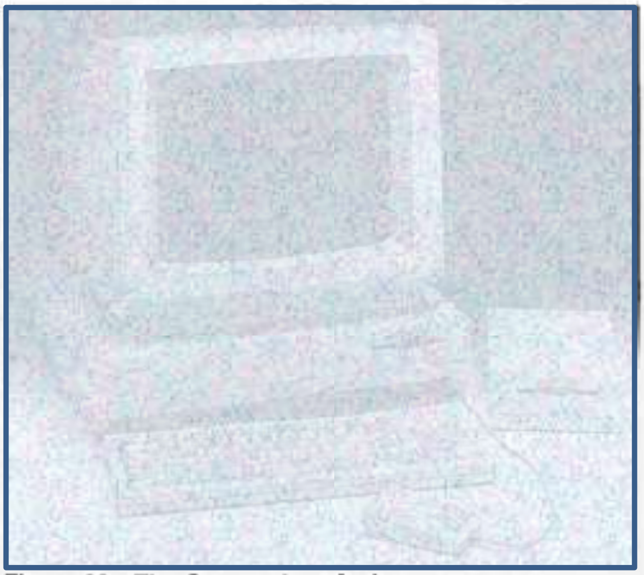


Figure 22 The Commodore Amiga

At home, Sinclair also faced stiff competition from a fast-rising UK rival, Amstrad, whose CPC 644 machine, selling at £450 complete with colour monitor and disk drive, had alrady begun to give the QL a hard time.

It was total war in the international microcomputer business. Even 'big blue' IBM, which usually stood aloof from the rough-and-tumble of the market-place, was developing in some haste a high-powered successor to the IBM-PC in order not to get left behind.

And it was decidedly not a good time for a small, under-financed company like Sinclair to have large stocks of a lame computer languishing in its warehouses and gathering dust on retailers' shelves.

Figure 23 The Amstrad CPC 644 home computer, pictured with Amstrad's managing director Alan Sugar

5.2 FINANCIAL DISASTER STRIKES

Financially, Sinclair Research was estimated to be losing about £1 million a month during the first few months of 1985, and some £30 million worth of unsold stock was reported to have accumulated by the middle of 1985.

Although only 10 per cent of shares in the company were held by outside shareholders (the 10 per cent which Sir Clive Sinclair had sold to institutional investors in 1983) these shares were reported to be selling to whoever would buy them at a fraction of the price at which they had been purchased little more than a year earlier. Sinclair's plans to float his company on the Unlisted Securities Market of the Stock Exchange, in order to raise additional capital to fund continued expansion, had to be abandoned.

To add further to Sir Clive's troubles, his own personal pet project, the C5 electric vehicle, which had been launched in January 1985, also seemed to be faring badly, with only about 9000 vehicles sold in the first half of the year – about one fifth of the sales predicted at launch. The C5 had encountered adverse public reaction to its apparent safety shortcomings and poor performance, and licensing difficulties in overseas markets.

As a result, the production line at the Merthyr Tydfil factory was slowed to a trickle in the vain hope that the summer weather would bring a resurgence in demand. And although Sinclair Vehicles was a totally separate company from Sinclair Research, the misfortunes of the former inevitably reflected further discredit on the reputation of the latter, since both were obviously controlled by Sir Clive Sinclair.

It was hardly surprising, therefore, that in the spring of 1985 Sinclair Research undertook a total re-assessment of the QL and of the company's internal organisation.

The QL's premature launch in early 1984 was now acknowledged to have been a major blunder, not merely an error of judgement. And Nigel Searle, who as Managing Director had been mainly responsible for the early launch, was sent off not to Siberia but to the rather more agreeable climes of the United States, to spearhead Sinclair's planned attack on the US market. Searle was replaced as Managing Director by David Chatten, formerly Production Director. A new executive, Hugo Davenport (another alumnus of Cambridge Consultants) was also brought in to strengthen the technical side of the company's management.

The company had already begun the task of analysing exactly why the QL had not sold well, and of working out a new marketing strategy to revive sales of the machine in order to help rescue Sinclair Research from the imminent peril of bankruptcy.

So why exactly had the QL not found favour with the buying public?

Some of the reasons did not, of course, take any great insight to discover.

The long initial delays between the announcement of the machine and its availability led to further disillusionment amongst a public that had already grown cynical following Sinclair's previous exaggerated claims.

Furthermore, the poor performance of the first machines, with their numerous hardware and software faults, led to yet deeper scepticism about the QL's claimed performance.

And even when production had begun to settle down, and machines were being produced which performed a lot better than their predecessors, a number of faults and short-comings remained to irritate prospective customers. The Psion packages, in their Version 1 form as supplied with all machines during 1984, were very slow and often awkward to use, and contained a number of bugs. It was only when Version 2 of the packages became available in early 1985 – unfortunately, too late to boost Christmas sales – that Abacus, Archive, Easel and Quill began to be usable with the ease and power originally intended.

Moreover, until 1985, a year after the QL's launch, the four Psion packages were virtually the only software available for the machine. This must have been a considerable deterrent to purchasers, given that BBC Micro users, for example, have hundreds of software packages to choose from, and even Sinclair's own Spectrum has, as we have seen, a software catalogue stretching to thousands of titles. In the early days after the first announcement of the QL, several software houses expressed interest in writing packages for it, but a number of snags slowed this process enormously.

One was that not many systems programmers were familiar with the machine code and assembly language programming necessary to write fast, efficient software for the QL's main 68008 microprocessor. Another problem was the initial scarcity of the Microdrive cartridges which, coupled with their initial high price and the fact that the Microdrive was (to put it mildly) a controversial storage medium, led many software houses to have second thoughts about writing new software, or adapting old, to run on the QL. And of course as it became clear that QL sales were not going to be quite as enormous as Sinclair had predicted, software firms became even more nervous about investing in the production of software for the machine.

Sinclair Research itself therefore had to go to considerable efforts, both in encouraging outside publishers (by offering them free software duplication on Microdrive, for example) and in setting up its own in-house software publishing activity, to counter these problems and build up an adequate software base for the machine.

At the time of writing (mid-1985) there is still not a large amount of software available for the QL, though the catalogue now includes small business accountancy packages and a sophisticated chess-playing program from Psion. It also includes three 'personal software' packages, written for Sinclair by

Triptych Publishing, entitled 'QL Entrepreneur', 'QL Project Planner' and 'QL Decision Maker': the trio is aimed at people interested in setting up their own businesses, and clearly represents an explicit attempt to help the QL cater for the 'home professional user' market – if it exists.

The QL's Microdrives were, or course, another continuing source of scepticism. The main problem here is that to perform to their specification, Microdrives and Microdrive cartridges have to be manufactured to very exacting production tolerances. And initially Sinclair's quality control (as implemented by its suppliers) was simply not good enough. This problem was compounded by the fact that the Microdrives are located inside the casing of the machine (in contrast to the Spectrum, which has external Microdrives), and in this location the heat given off by the chips can cause slight mechanical deformations in the Microdrive machinery of sufficient magnitude occasionally to cause serious errors in reading and writing data.

Gradually, during 1984, Sinclair engineers tried to sort this problem out, aided by some high-speed photography of Microdrives in action, carried out by International Computers Ltd. (ICL) who had decided to use Microdrives in their new 'One-Per-Desk' business microcomputer (see section 6).

By the beginning of 1985, when a number of small but important modifications had been carried out (including strengthening of the Microdrive casing) Sinclair claimed that the technology was now '99.5 per cent' reliable. However, as a significant concession to those who had all along been suspicious of Microdrives, the company was beginning to stress by mid-1985 the ease with which users could, if they wished, attach conventional floppy disk drives to their QLs.

Another apparent shortcoming of the QL, to those who had hoped to use it for Basic programming, was that its SuperBasic language, though very sophisticated in some respects, lacked a number of features (such as a 'screen editor', to make it easy to correct faults in programs) that in some other implementations of Basic are provided as standard. The reason for this, though most customers could hardly be expected to know it, was that SuperBasic was only intended to be a 'shell' version of Basic, to which various 'Programmers' Tool Kits' could be added, depending on the particular features wanted by particular programmers.

Finally, another feature of the QL that seemed irritating to many customers was its keyboard – the feel of which one reviewer contemptuously compared to 'dead flesh'.

However, following minor adjustments to the flexibility of the rubber membrane beneath the keys, the company claimed that in all machines from the beginning of 1985 onwards, the 'feel' of the key-boards had been considerably improved.

But with this formidable list of problems, both real and imaginary, to contend with, it is hardly surprising that sales of the QL for the whole of 1984 only reached the 40000 mark, and that in March 1985 QL production was temporarily suspended to avoid adding further surplus stocks.

Jack Schofield provides a useful list of the factors which are necessary for success in the competitive microcomputer market, against which the QL can be judged:

> In my view, the criteria for success are six, as follows. A micro needs (1) the support of the specialist computer press, (2) lots of cheap software, (3) about the 'going rate' of RAM, at (4) a fairly competitive price, plus (5) an acceptable keyboard. Finally comes (6), timing – it must be delivered at the right time and on time (. . .)
>
> The support of the specialist computer press is initially a crucial factor. (. . .) This is partly because the early buyers of new machines are still the cognoscenti – or, if not, those early buyers take advice from friends and dealers who are. Also, the dealers and software writers are still keen readers of the fan magazines, and this influences what they want to sell and write software for. (. . .)
>
> When it begins to reach a wider – but less sophisticated – market, a micro is judged mainly on how much RAM it offers for a given price. In the sophisticated technical jargon of the trade, this is known as 'bits per buck'.
>
> As for the keyboard, the market really does require something of reasonable quality. (. . .)
>
> But timing is perhaps the most difficult thing of all. Micros have an optimum lifespan of about six years – three years on the way up, and three years on the way down. On the way up they sell on their price/performance ratio and technical advantages. On the way down they continue to sell because of the advantages of having a large software base. (. . .) Timing is certainly the hardest thing to get right and it may, in the end, be the single most important factor. (Jack Schofield, the *Guardian*, 7th March 1985)

The QL clearly fails on Schofield's criteria five and six – keyboard and timing. It also fails on his third criterion, because of the unavailability of 'lots of cheap software'. On the other hand, the QL passes on Schofield's criteria three and four because it has a substantial amount of RAM and is priced competitively. On his first criterion, however, the verdict must be mixed, because the QL initially had the strong support of the specialist press – but lost it because of the poor performance of early machines.

5.3 RE-LAUNCHING AND RE-MARKETING

Despite the disappointing level of QL sales and the early teething troubles, by March 1985 Sinclair felt reasonably confident that the technical problems had largely been sorted out. So the company then announced what amounted to a re-launch of the QL, together with a package of new products, new services and price adjustments, all backed up by a £¾ million press and TV advertising campaign.

This re-launch was to be followed up by further market research to assist in the 're-positioning' of the QL in the market. In other words, to try to discover what features of the QL appealed most to the potential customers in various different markets, and what features were not appealing. The promotion of the machine (and, where possible, the machine itself) would then be adjusted to minimise its shortcomings and maximise its advantages.

This market research involved two main activities. One was 'quantitative' research, involving promotion of the QL using TV advertisements in the south of England only, and then comparing the sales figures for the QL in various southern markets with sales in the north, where no advertising had been carried out.

The other was 'qualitative' research, and involved setting up 'clinics' where several groups of a few people were asked to assess their perceptions of the QL, after using the machine and/or watching the TV advertisements. These exercises were similar to those carried out by Sinclair just after the initial QL launch, except that in this case the subjects were given access to the machine itself – and had, of course, been exposed to all the bad publicity which the QL had received during the previous year.

When the results of this quantitative and qualitative research had emerged, Sinclair hoped that it would be able more accurately to position the QL within its various target markets, and hence to tailor its advertising to maximum effect.

But even before all the results of this research had emerged, Sinclair had decided that the initial image it would create for the QL in 1985 was that of a 'serious machine for people who are price-sensitive'. Specifically, the company was aiming at people who were paying for a micro out of their own pockets, or at small businesses like the corner newsagent who would find it difficult to afford the capital outlay normally required to purchase a business micro, even though it might save them time and money by making it easier, for example, to prepare accounts or VAT returns.

The re-launching of the QL also involved adding various additional features and refinements to make the machine more attractive to business and professional users. As we have seen, the reliability of the hardware had been substantially enhanced, and the performance of the software much improved following the introduction of the Version 2 Psion packages. To add to users' confidence in the QL, and in its bundled software in particular, Sinclair modified the rules of the QLUB (QL Users' Bureau), the users' group it had formed on the launch of the QL and which by 1985 had 10 000 members. Membership, which originally cost £35 per annum but entitled members to free software upgrades, now became free to all QL purchasers – though software upgrades would in future be charged for. In addition, QLUB members were offered a new free 'help-line' service by the software company Psion, enabling them to obtain advice by telephone or letter if they were having any problems with Abacus, Archive, Easel or Quill.

The new software packages (like QL Entrepreneur) that were becoming available were also stressed in advertisements which appeared during this period.

Another new hardware addition for the machine, called 'Q-COM', featured prominently in the spring 1985 advertising. Q-COM was a series of three small black boxes which stacked on top of one another. The first, called Q-CON, enabled the QL to become a 'terminal emulator' – to mimic the behaviour of a standard (Digital VT100) computer terminal, when connected to a conventional main-frame or mini-computer. The second, called Q-COM, was a modem which, in conjunction with Q-CON, would give users access via telephone to Prestel and other electronic data services. The third, called Q-CALL, was an automatic telephone dialling and answering unit, which would allow data to be entered into and retrieved from electronic databases (such as Prestel) entirely automatically.

But unfortunately for Sinclair, the company which had been developing Q-COM, namely OEL Ltd. of Cumbria, went into receivership just as the product was being launched, thus inevitably adding a small amount of further discredit to the already tarnished QL image. However Sinclair, recognising the importance of a product like Q-COM to the QL's future, undertook to try to ensure that Q-COM would be taken up by another manufacturer. A few months later the modem manufacturers Tandata agreed to take over the rights

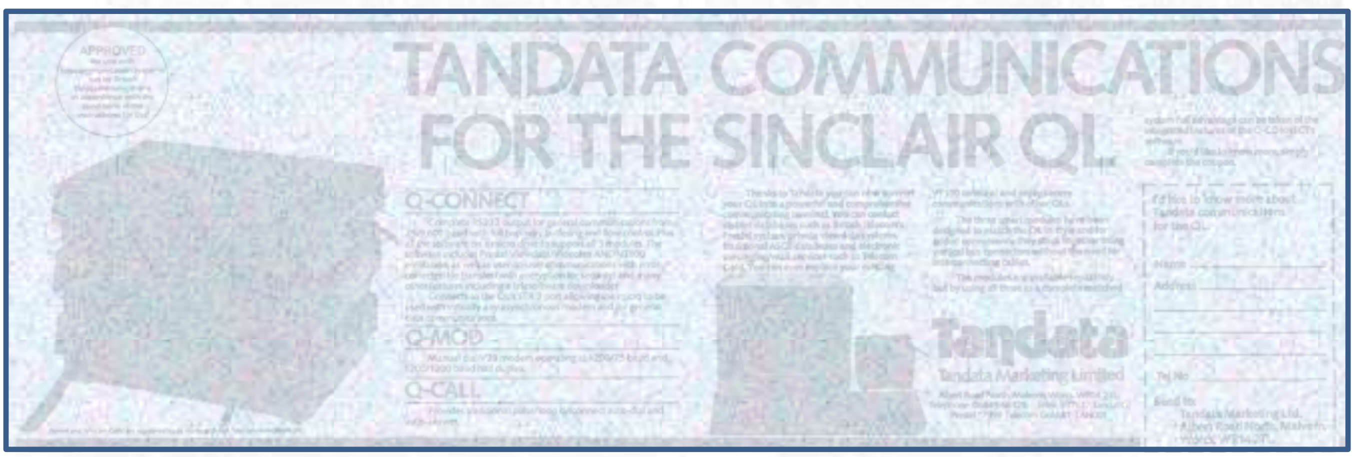


Figure 24 Communications equipment for the QL, originally designed by OEL Ltd., now manufactured by Tandata Ltd.

to manufacture Q-COM from the receiver of OEL Ltd.

As we have seen, to improve the appeal of the QL to those who, despite Sinclair's protestations, remained sceptical of Microdrives (either because of their unreliability or because they could only store 100k bytes), Sinclair encouraged the provision by 'third party' manufacturers of add-on floppy disk drive units. By mid-1985 there were at least five such packages available, from Quest, Computamate, Micro-Peripherals, Silicon Express and Medic Data Systems. Later in the year, Sinclair decided to endorse Micro-Peripherals' disk drives and inter-face as the recommended add-on disk system for the QL.

Additional RAM memory was another add-on-extra which Sinclair encouraged third party manufacturers to provide, and by mid-1985 various 'RAM Packs' were available.

Adding extra RAM and disk drives to the QL presents a problem, however. The QL's expansion port, at the left-hand side of the machine, can only cope with one extra device at a time. So several manufacturers began to make available 'expansion boxes' – units which, when plugged into the expansion port, enable up to four additional units (such as extra RAM, a disk drive interface and a couple of ROM cartridges) to be used simultaneously.

Other peripheral devices which became available for the QL during 1985 included interfaces to enable the machine to read and control laboratory instruments, and a 'second processor', made by PCML Ltd., running the long-established CP/M operating system and enabling QL users to gain access to the many thousands of 8-bit CP/M programs.

Still on the horizon in mid-1985 was a ROM cartridge (a small box with one or more ROMs inside) containing the four Psion programs. This, when plugged into the expansion port of the QL, would enable the programs to load and work together extremely rapidly.

Also promised, but not yet available, was a radically new 'silicon disk' (see Section 6) which would, it was claimed, provide over 500k of RAM on one 'wafer-scale integrated circuit'. Earlier in 1985, Sir Clive Sinclair had announced his intention of floating a £50 million company to manufacture such wafer-scale integrated circuitry. But despite attracting to the board of the proposed new firm Rob Wilmot, Chairman of the large and prestigious computer firm ICL, it seemed very unlikely that Sir Clive would be able to raise the £50 million he required, due to the down-turn in the microcomputer industry and the increasing scepticism about Sinclair Research and its products.

However, by mid-1985, despite all the bad publicity, it appeared that the sales prospects of the QL were improving slightly. Sales had edged up to around 5000 a month, and the QL had crept into the bottom of the UK top 10 sales charts. And although UK production of the machine had been suspended in March 1985 this was presumably partly in anticipation of the planned start-up of QL production in South Korea by Samsung Electronics for the US market, where the QL was scheduled for launch in June.

5.4 THE MAXWELL 'TAKEOVER'

But in spite of the relentless public optimism of Nigel Searle and Sir Clive Sinclair, and the slightly improved sales figures for the QL and the Microvision, the financial tide was still running strongly against their company.

The London firm of stockbrokers Wood Mackenzie, for example, was in May 1985 forecasting a down-turn in UK home computer sales from £350 million in 1984 to only £220 million in 1985. Sinclair itself was by then forecasting that UK home computer sales in 1985 would be around 1.2 million units, compared with around 1.5 million the previous year – not too serious a drop, perhaps. But the British Radio Equipment Manufacturers Association (BREMA) was less optimistic, predicting sales of 1 million to 1.1 million. And to make matters worse, most (around 65 per cent) of the reduced sales predicted for 1985 would of course come in the last three months of the year – and there were many lean months to go until the autumn. (Reported in the *Guardian*, 29th May 1985.)

By the end of May 1985, Sinclair admitted that it was running into financial problems too severe for it to solve with its own inadequate reserves. Initial help had been obtained from the company's main bankers, Barclays, who had agreed to extend the firm's £5 million overdraft limit, and from its main suppliers, Thorn-EMI, AB Electronics and Timex, who had agreed to grant an additional two months' credit. But these were just temporary measures, aimed at buying time while a much more substantial injection of cash was sought.

Sinclair's financial advisers, the merchant bank N. M. Rothschild, were reported to be seeking assistance for the firm from a number of large electronics companies, including not only Thorn-EMI and AB Electronics (who were already in effect financing Sinclair by extending credit to the company), but also GEC, STC and Philips.

Concern about the plight of Sinclair extended into high places. The Prime Minister was reported to be anxious to ensure that the company, which had hitherto been extolled as a leading example of the kind of adventurous, entrepreneurial, high-technology business which the Government wished to encourage in Britain, should not be allowed to go under. Even the Bank of England's industrial finance division became involved in the rescue talks, by providing a chairman for negotiations between Sinclair and its creditors.

Finally, in mid-June a deal which few had been expecting emerged. It seemed that Sinclair was to be rescued by the flamboyant financier and businessman Robert Maxwell, owner of the Daily Mirror and Chairman of the British Printing and Communications Corporation, Pergamon Press and numerous other companies. Maxwell and Sinclair were not unknown to each other. In the 1960s they had both been directors of Cambridge Consultants.

Figure 25 Sir Clive Sinclair and Mr Robert Maxwell pictured just after the proposed takeover was announced

Maxwell would, it was announced, take over from Sir Clive the Chairmanship of Sinclair Research, and Maxwell's company Hollis Brothers (a subsidiary of Pergamon Press) would purchase, for £12 million, some 75 per cent of Sinclair shares. Sir Clive Sinclair would become an independent consultant to Sinclair Research and its head of technical development, continuing to lead the company's advanced research and development work at Metalab aimed at developing sophisticated successors to the Spectrum and QL. A few weeks later Bill Jeffery, whom Clive Sinclair had recruited from Mars Electronics just over a year previously to head Sinclair's communications division, was appointed Chief Executive of Sinclair Research in Sir Clive Sinclair's place. However, Sir Clive remained as Chairman, pending the finalisation of the takeover.

Maxwell now hoped to acquire the rights to Metalab's controversial new wafer scale integrated circuit (WSI) technology (see Section 6 below) which the company initially intended to use to make a solid state ½ megabyte 'silicon disk' memory unit for the QL. But there was considerable controversy over whether or not Maxwell's company would also acquire the rights to Sir Clive's more advanced Metalab work, which had still not come to fruition, on wafer-scale integrated circuits incorporating the more complicated logic circuits that are required in order to create a complete microcomputer on a single 'megachip'. This advanced WSI technology was also central to Sinclair's long-term work on developing 'fifth generation' super-computers (see Section 6) and Sinclair was reported to be reluctant to allow the fruits of this work (if any) to belong to Maxwell.

5.5 SINCLAIR GOES IT ALONE

Attempts to resolve these and other contentious issues continued during July 1985.

During this period, Hollis Brothers sought advice on Sinclair's prospects from Maxwell's merchant bankers, Hill Samuel, who commissioned a study by the accountancy firm of Coopers and Lybrand. Its conclusions were pessimistic: Sinclair had £35 million worth of unsold stock, was still making losses, and its prospects were poor.

Hollis therefore announced on August 9th that the proposed takeover was not, after all, in the interests of its shareholders and would not proceed.

Sir Clive Sinclair, however, was undismayed. He claimed that his company no longer needed to be 'rescued' because its sales had in fact improved considerably since the takeover had first been mooted.

> Over the past few days it has become clear that as a result of recent sales successes the proposed refinancing of Sinclair Research is no longer necessary. Our share of the United Kingdom market has climbed over the past few months to a high of 40 per cent. In the United States, sales of our QL computer are increasing dramatically. (Sir Clive Sinclair, quoted in *Guardian*, August 10th 1985)

What he did not say was that this improvement had been achieved by heavy price cutting, that the increased sales were mainly of the Spectrum Plus and Microvision, and that UK sales of the QL were still relatively poor.

But Sir Clive also had an ace up his sleeve to confound the sceptics. Sinclair Research had, it appeared, concluded a deal with Dixons in which the High Street chain would buy some £10 million worth of the company's products – the Spectrum Plus, the Microvision, the QL and various accessories. Dixons had driven a hard bargain: they were acquiring some 160 000 units of unsold stock at an average price of just over £60 per unit. At prices like these, Sinclair could hardly be making a profit on the deal. But the large cash injection was just what the company desperately needed in order simply to keep going.

A few weeks later, Sinclair's distributors Terry Blood Distribution agreed to buy 50000 Sinclair products for sale to the retail trade, in a smaller but similar deal worth £4.5 million. It also emerged that, as part of the company's strategy to boost its sales, it was halving the retail price of the QL, to just £199.

Sir Clive Sinclair now maintained that his company had sufficient resources, and orders, to continue trading with its existing products, particularly during the crucial sales period of the 'run-up' to Christmas 1985. But he admitted that it still needed an injection of additional finance in order to develop and produce the new products that were essential to the company's long-term future.

Sinclair Research had, it seemed, pulled itself back from the brink of disaster, but it was by no means clear as this case study went to press (September 1985) that the company's strategy for survival would prove successful.

You will find some self-assessment questions on the QL's re-launch in the Block 2 Study Guide.

Figure 26 Dixons' newspaper advertisement for the now cut-price QL

6 BEYOND THE QL

6.1 THE 'ONE-PER-DESK'

Although the short-term future of Sinclair Research seemed reasonably secure, at least until the outcome of the crucial autumn 1985 sales period was known, it was clear that the longer-term future of the company lay in developing new products to succeed the QL and the Spectrum. But it seemed likely that in the medium term a 'super' or 'plus' version of the QL would be developed, to restore confidence in the machine and to enable it to compete more effectively with the new micros from Atari, Commodore and Amstrad.

In a sense, however, a new version of the QL had already been launched in late 1984 – though not by Sinclair. This was the 'One-per-desk' (OPD) computer, made by International Computers Limited (ICL). The OPD was a desk-top micro with built-in digital telephone, an answering machine (employing a voice synthesiser chip instead of a tape recorder) and other telecommunications features aimed at the business user. It used a substantial amount of Sinclair's QL technology, under a licensing agreement between ICL and Sinclair signed a couple of years previously.

The 'One-per-desk' was so called because ICL designed it in the hope that businesses would instal one machine per desk, to provide all their employees' computing and telecommunication devices in one compact machine. Like the QL, it used three Sinclair-designed 'custom' chips and the Motorola 68008 microprocessor, together with two Microdrives – though the latter were reputedly built by ICL to rather more exacting specifications than those originally used by Sinclair for the QL.

It also incorporated (as optional extras) the Psion 'Xchange' suite of programs – a set of four software packages very similar to those provided with the QL and also entitled Archive, Abacus, Easel and Quill. In the OPD, however, these programs were held in read-only memory (ROM) chips, rather than being stored on a Microdrive cartridge. This use of ROM for program storage made the applications packages much quicker to use than on the QL.

As already mentioned, Sinclair intended to make available a similar ROM cartridge for the QL. However, although providing an integrated suite of software on ROM in this way is attractive, it is fairly costly because ROM chips are quite expensive.

To make matters worse, by mid-1985 ROM chips

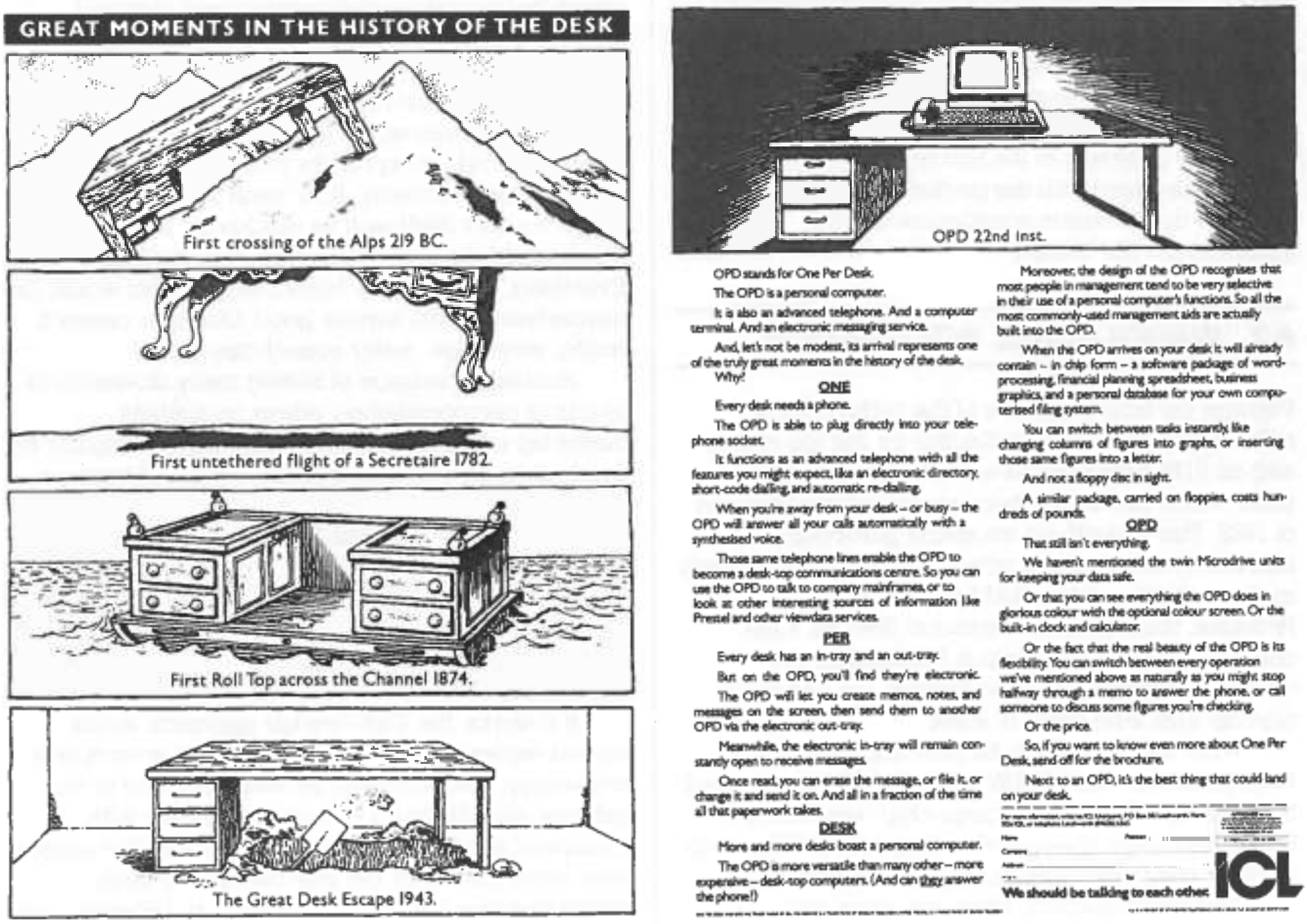


Figure 27 Advertisement for the ICL 'One-Per-Desk' telecommunicating microcomputer

had become considerably dearer than RAM chips, which had dropped dramatically in price. This meant that it would be much cheaper for a manufacturer to provide a suite of software on disk, to be loaded into RAM (where it would be instantly available, as if on ROM) than to provide it on ROM.

For Sinclair, however, this option was unattractive because the software (all four packages of it) would have to be loaded into RAM from microdrive – a tediously slow process. Of course if the expected 'Super' version of the QL included more RAM (a fairly cheap option considering the low price of RAM chips) and a disk drive, the Psion programs could be loaded en bloc and used as an integrated package.

The OPD used Sinclair's SuperBasic as its built-in programming language. But the ICL designers, instead of using Sinclair's QDOS operating system for the new machine, opted to write their own. This was partly due to the additional complexity of the tasks performed by the OPD (which include telecommunications and automatic telephone dialling and answering), but it was probably also because ICL wanted to be sure of having a reliable system.

ICL priced the OPD at around £1400 (a figure claimed to be half the price of the nearest equivalent product) and aimed to sell no less than a quarter of a million machines in 1985, not only to large and medium-sized businesses, but also direct to small businesses and home computer users – a market new to ICL.

Although it seems unlikely that the One-per-desk will be quite as successful as ICL's ambitious sales targets suggest, partly because of the adverse effect of the controversy over the QL, nevertheless the OPD managed to notch up quite respectable sales figures of around 5000 units a month during the first half of 1985.

[ICL's approach to the marketing of the One-per-desk is compared with the marketing of the Atari 520ST in the television programme which accompanies this block.]

6.2 WAFER-SCALE INTEGRATION

Perhaps the most ambitious of the technological refinements predicted by Sinclair for the QL was an add-on 512k byte random-access memory (RAM) pack, which was due to become available at the end of 1985. This in itself did not sound particularly innovative, since various other companies had already made available add-on RAM packs for the QL. However, these used conventional 256k bit RAM chips, no less than 16 of which (stacked on two double-sided printed circuit boards) are needed to provide 512k 8-bit bytes of RAM.

What was claimed to be new about Sinclair's RAM pack was that all 512k bytes would be crammed on to a single, very large 'mega-chip', employing a technique called Wafer-scale integration (WSI) which no other company in the world had yet perfected.

Conventional silicon chips are about half a centimetre square and are fabricated by the hundred (using processes like chemical diffusion and photographic etching which have already been referred to in Block 1) on thin, circular wafers of silicon about 10 centimetres in diameter. Because minute imperfections, caused by dust and flaws in the silicon crystal, inevitably find their way into the material, a high proportion of the chips made from any single wafer are found on testing to be defective, and have to be rejected.

It has long been the ambition of chip manufacturers to create much larger integrated circuits than those usually made at present. This would avoid the obvious disadvantages of the present system in which lots of small chips have to be laboriously wired together on a printed circuit board to make a complete computer. If WSI could be achieved, the electronic circuitry for an entire computer, complete with microprocessors, large amounts of RAM and ROM, and various input–output devices, could be contained on a single 10 centimetre wafer, making possible very substantial reductions in cost and size, and improvements in speed of operation.

Previous attempts to achieve WSI, notably those of the American company Trilogy, have ended in failure and huge losses. But Sir Clive Sinclair appeared confident that his approach, based on techniques patented by a British inventor, Ivor Catt, would be successful.

The Catt–Sinclair technique apparently involves creating perhaps as many as 10000 tiny 'blocks' of computing power on each 10 cm wafer, each 'block' equivalent to a very small conventional chip and consisting of a small microprocessor and a modest amount of memory. Inevitably, imperfections would exist in a substantial number of these blocks, but the blocks themselves would be programmed to 'interrogate' adjoining blocks to find out whether they were working properly. If so, each working block would connect itself with its neighbour; and if not, the block would try again with another neighbour. Eventually, all the 'good' blocks in the wafer would join themselves up with similar 'good' blocks to create a single, very large, wafer-scaled chip.

Another advantage of having many thousands of blocks of microcomputing power on a single megachip is that it facilitates designing a computer in which data are processed in many parallel streams simultaneously, rather than one-byte-at-a-time (in so-called serial form), which is how most computers today operate. Parallel processing is similar in some respects to how the human brain operates, and is likely to be a feature of advanced computers in which the aim is to achieve 'artificial intelligence' (see Section 6.4).

If it works, the Catt–Sinclair approach would indeed represent a major breakthrough in computer technology, though it must be said that many in the industry view Sinclair's chances of success with considerable scepticism, pointing out that Catt's ideas have been tried over the past decade by large companies like ICL, STC, Burroughs and Plessey, and have been found wanting. Moreover, the UK

Government's Alvey Directorate, which funds research into advanced, so-called 'Fifth generation' computers, has refused to contribute funding to the Sinclair WSI project, presumably because it believes it will be unsuccessful.

Nevertheless, it is just possible that Catt and Sinclair have found a new way of getting Catt's techniques to work. If they do prove successful, although in principle it would then be possible to construct almost an entire computer on one chip, the first commercial WSI product will be the much-more-modest 512k RAM pack for the QL, described above. In June 1985, Sir Clive Sinclair and his team announced that they had indeed successfully achieved this first WSI objective, and demonstrated a working prototype 512k WSI RAM chip to the press.

However, the economic obstacles to the success of the 512k WSI RAM may prove to be more formidable than the technical problems. Firstly, Sinclair needed to raise a reported £50 million to construct his proposed WSI fabrication plant – a tall order in view of the lack of City confidence in the UK microcomputer industry, and in Sinclair in particular, during 1985. Secondly, in view of the sharp drop in the price of conventional 256k bit RAM chips, which were reported to be selling as cheaply as £2.50 apiece (in large quantities) from manufacturers in the Far East, Sinclair's proposed 512k wafer-scale RAM would have to be very cheap indeed to be able to compete with its equivalent, namely sixteen 256k RAM chips priced at only £40.

6.3 THE 'FIFTH GENERATION'

Sinclair's 512k RAM pack will, if successful, be a fairly modest example of what WSI technology could accomplish. But the company had set its sights on very much more ambitious goals for the future. Sinclair was aiming, in essence, to beat the Japanese and the Americans in the race to develop a new generation of super-computers, the so-called 'fifth-generation', even though it has only a tiny fraction of its competitors' resources and does not have the backing of the UK Government's Alvey programme, which is funding and directing much of Britain's effort in this area (Alvey Committee, 1982).

Ultimately, the goal of fifth-generation computer research is to produce machines that are not only very much more powerful, in terms of memory and computing speed, than most of today's computers, but are also able to communicate with their human users in a manner that closely resembles ordinary face-to-face communication with a human being. Moreover, fifth generation computers will exhibit, it is hoped, a considerable degree of 'Artificial Intelligence' (AI) – that is, they will be able to reason for themselves, make deductions and inferences from available data, and perhaps even exercise some creative powers (see Feigenbaum and McCorduck, 1983).

Whether such machines, if they can be built, can

Figure 28 Sir Clive Sinclair demonstrates a working prototype of his wafer scale integrated 512k 'silicon disk' to the Press in June 1985

truly be said to think as we do is a highly controversial matter, which we do not have space to discuss here. Suffice it to say that Sir Clive Sinclair not only believes that a new generation of 'metacomputers', as he calls them, can indeed be created, but that such machines will soon outstrip in intelligence their human designers. As he put it in an address to a US Congressional committee:

> I think it certain that in decades, not centuries, machines of silicon will arise first to rival and then surpass their human progenitors. Once they surpass us they will be capable of their own design. In a real sense they will be reproductive. Silicon will have ended carbon's long monopoly. (Address to US Congressional hearing, March 1983, quoted in the *Sunday Times*, 4th November 1984. Also quoted in the introduction to Section 6(b) of the Course Reader).

Time will tell whether or not such bold predictions are realistic, or merely a skilful blend of science-fiction fantasising and marketing hyperbole. But even if the promised 'artificial intelligence' of the fifth generation of machines falls far short of Sinclair's expectations, it seems very probable that such machines will incorporate 'intelligent' software of a more modest, but still very useful kind.

6.4 EXPERT SYSTEMS

This software will take the form of so-called 'expert systems'. An expert system is a computer program which attempts to emulate the behaviour of a human expert when faced with a problem. The program contains, firstly, a database of information about the subject in question, compiled in collaboration with a human expert. Secondly, the program contains routines which enable it to infer conclusions about the likely solutions to specific problems, with the aid of the various items of information contained in its database and using the responses made by the user to a series of questions asked by the system.

For example, an expert system for simple medical diagnosis might have a database of information on common ailments such as colds, influenza or headaches, which would enable the program to ask a patient a series of simple questions about the ailment: 'do you have a high temperature?'; 'do you have a headache?'; 'a sore throat?'; 'a chest cough?' ... and so on. Then, given the responses to these questions and using the information on the symptoms of common ailments contained in its database, the expert-system software can calculate the most probable diagnosis indicated by a given set of symptoms. It can also suggest some possible though less probable diagnoses, together with further tests or questions that could be used to determine with greater certainty which ailment the patient is actually suffering from.

This type of simple expert system is not very sophisticated: all it is doing is making logical deductions from a set of pre-determined rules provided by an expert – rather as you might use a fault-finding chart to help you to discover the cause of a problem in your car.

But more sophisticated expert systems have been created in which the software itself can deduce some of the problem-solving rules, given only a set of examples of problems and their solutions provided by human experts. So even in a situation where the experts themselves are not clear that they are following rules in deducing a solution from a set of complex symptoms (they may say that they are simply following their own intuition) an expert system can in some cases deduce the inner logic which probably motivates the experts' conclusions.

Most expert-system software at the moment requires fairly large computers, and is used by large companies to aid in tasks like geological prospecting. But microcomputer-based versions are now becoming available, and Sinclair Research has stated its intention of making available 'mini' expert systems, such as a simple medical diagnosis package, for use with its future microcomputer products – perhaps including the QL in a later, augmented version.

Future Sinclair products, like those of other advanced microcomputer manufacturers, are also likely to include voice synthesis (a feature already incorporated, as we have seen, in the ICL One-per-desk, where it performs an automatic telephone answering function) and eventually voice recognition devices, although the latter are much more difficult to perfect than voice synthesisers. These facilities will enable future microcomputers to talk to their users in something approaching natural language. One of Sinclair's more fanciful suggestions is that future machines might incorporate a face to make conversation with them seem more natural. In general, the future Sir Clive foresees is one in which:

> Each of us will have a personal computer which, when artificial intelligence has fulfilled its promise, will inform us, guide us, entertain and educate us, minister to our ailments. (Quoted in the *Sunday Times*, 4th November 1984)

6.5 SOME QUESTIONS AND CONCLUSIONS

The story of Sinclair Research in general, and the QL in particular, raises a host of difficult questions about the innovation process. For example:

- What are the main problems encountered by small, technology-based firms like Sinclair in their attempts to achieve successful innovation, and how might these problems be overcome?
- What are the strengths and weaknesses of small firms compared to large firms in the innovation process?
- What is the role, and what are the limitations of, market research and marketing in general?
- What role should Government play in encouraging innovation?
- And how can the social benefits of technological innovation be maximised and the costs minimised?

These and many other questions will be raised in the Study Guide to this block, where you will be asked to consider the numerous academic and theoretical issues about innovation which are raised by this case study, and by the companion case study on Prestel.

However, at the time of going to press (September 1985) the future of Sinclair Research still seemed precarious, so it is a little early in our saga of Sinclair and the QL to draw any final conclusions.

But for the moment, to suggest some preliminary conclusions, and to stimulate some initial thoughts, let me conclude with the following Editorial from the *Guardian* (June 11th 1985), written at the height of Sinclair's crisis:

Too many chips for the chop

Two years ago Britain's home computer industry seemed to be rising like a phoenix from the ashes of industrial decline. The falling cost of microchips spawned an unusual (for Britain) breed of inventor–entrepreneurs, able successfully to challenge the divine right of the US and the Japanese to make such machines. It happened nowhere else in Europe. Now, as micro-mania both here and in America gives way to the new flavour of the year (compact discs and video cassettes in America) the fledgeling industry is counting the wounded and wondering what went wrong. Companies like Oric, Dragon and New Brain, each with home computers which could have made it big, fell by the wayside or were taken abroad by foreign predators. Of the big two, Acorn (makers of the BBC computer) ran into financial difficulties and was rescued by an Italian group, Olivetti: now Sinclair (with 40 per cent of the UK market), laden down with unsold stocks, is the subject of rescue talks involving the Bank of England, with Mrs. Thatcher's approval. Although one or two companies, like Amstrad and ACT (makers of smaller business machines) are still very much in the market there is no doubt that something has gone badly wrong. But whose fault is it?

Partly the companies themselves. Limited resources were thinly spread among dozens of companies instead of being concentrated on a few capable of making a concerted attack on world markets in order to reap economies of scale. Worse, nearly all of the computers have incompatible software (you can't run Sinclair programmes on a BBC or Dragon machine). And (nearly) all of them now admit that they didn't have the management skills to match their – extremely impressive – [inventive] ability. Sir Clive Sinclair said at the weekend that it was not the fault of the inventors, but of the managers who should be recognising and selling our bright ideas. Why then is Sir Clive, who has tasted failure before and ought to know better, not hiring better managers? He says they are 'extremely difficult to find', a chronic indictment of the past two decades of business school expansion. But the Acorns and Sinclairs of this world won't yield to the business managers. They are still finding markets for products instead of products for markets.

The City is part of the problem, with its short term horizons and inability to provide sufficient long term risk capital. Having ignored computers and hi-tech for a long time, the City suddenly 'discovered' its potential three years ago and went overboard. Now, at the first sight of red ink, it has withdrawn. What the punters want is short term profits performance. Long term potential is strictly for the birds. The City had better beware. If it cannot provide the money to finance high risk projects with long term returns then it will have only itself to blame if something like Labour's National Investment Bank rushes in to fill the gap.

Nor can the Government escape censure. It has stubbornly refused to talk about national strategy, or picking winners. Instead it is cutting support for civil research and development and encouraging the worst form of shareholder capitalism by offering double-your-money gains from privatised monopolies (like British Telecom). Why risk putting a penny piece in a risky situation like Sinclair when you can hang on for a safe gain in British Gas, none of the proceeds of which will be ploughed back into developing Britain's eroding technological base?

Yet fund the likes of Sinclair we must, even if only half of their products succeed. Information technology is the fundamental industry of the future. Sinclair is a microcosm of the British disease, strong on innovation, weak on development. If its problems could be solved a lot else might follow.

You will find some self-assessment questions relating to Sinclair's future prospects in the Block 2 Study Guide.

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The microcomputer business is a highly competitive one, as this case study confirms, so it is not surprising that I was occasionally not given access to information which was considered commercially confidential. Consequently, I have sometimes resorted to informed speculation in an attempt to fill obvious gaps – though I hasten to add that all conjectures are clearly labelled as such.

Finally, I need hardly say that whilst I repeat my thanks to the above-named people for their assistance, they are not responsible for the overall content and approach of the case study.

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Design and Innovation

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Block 1	Units 3–5	Invention: Water Turbines & Solar Cells
Block 2	Units 6–8	Marketing: Sinclair's QL Microcomputer & British Telecom's Prestel
Block 3	Units 9/10	Research & Development: British Rail's Fast Trains
Block 4	Units 11/12	Government: UK Renewable Energy Programme & Greater London Council's Innovation Initiative.
Block 5	Unit 13	Innovation Waves: Kondratieff Cycles & Defence Technology
	Units 14/15	Project work (no printed units)
	Unit 16	Design Criteria and Innovation: Some Conclusions

SINCLAIR QL Preservation Project (SQPP)

On January 12th 1984 Sir Clive Sinclair presented the Sinclair QL Professional Computer in a Hollywood-style launch event at the Intercontinental Hotel, Hyde Park Corner, London. This was exactly 12 days earlier than Steve Jobs presented the Apple Macintosh.

The QL still is a very good example of an innovative, stylish, powerful and underestimated product. On one hand it failed in the market in the long run but on the other it influenced many developments which ended in today's products.

In its 25th anniversary year 2009 every month a surprise will be unfold.

Jan 12th – Congratulation to the QL's 25th birthday. Message spread to VIP, community and media.
http://www.qlvsjaguar.homepage.bluewin.ch/SinclairQL_25th_anniversary_1984_to_2009.html

Check out this 25th anniversary presentation…
http://www.cowo.ch/downloads/SinclairQLis25-compressed.ppt

Try QPC, a virtual QL running under Windows…
http://www.cowo.ch/downloads/QPC_a_virtual_QL.zip

Feb 19th – Massive coverage (11 pages) of the QL in the April Issue of Personal Computer World (PCW) magazine.
http://www.pcw.co.uk

Mar 12th – SINCLAIR QL Preservation Project (SQPP) launched, starting with Documents/Publications from Sinclair Research Ltd and various computer magazines of the years 1984 to 1986.
http://www.qlvsjaguar.homepage.bluewin.ch/SinclairQLpreservationproject.html

Happy 25th anniversary and QL forever!

Urs König (aka cowo)
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