Lean, Tom. "Hobbyists Create Microcomputers." *Electronic Dreams: How 1980s Britain Learned to Love the Computer*. London: Bloomsbury Sigma, 2016. 35–59. *Bloomsbury Collections*. Web. 26 Apr. 2023. <<http://dx.doi.org/10.5040/9781472936653.0005>>.

Downloaded from Bloomsbury Collections, www.bloomsburycollections.com, 26 April 2023, 13:23 UTC.

Copyright © Tom Lean 2016. You may share this work for non-commercial purposes only, provided you give attribution to the copyright holder and the publisher, and provide a link to the Creative Commons licence.

Hobbyists Create Microcomputers

The Altair 8800 did not look much like a real computer, even in 1975. True, it had the flashing lights that one would expect a computer to have, but it was far too small to really be one. A simple metal box with rows of lights and switches on its front, it was compact enough to fit on a tabletop, when even a so-called minicomputer was the size of a few filing cabinets. MITS (Micro Instrumentation and Telemetry Systems), the company that produced it, initially referred to Altair as a ‘minicomputer kit’, but really it was a *microcomputer*. The secret to how Altair could possibly be a ‘full blown computer’ in such a small package, which cost just \$397, was the tiny Intel 8080 microprocessor at the centre of it. Thanks to the microprocessor, MITS could build a machine small enough and cheap enough for individuals to own, even if they typically had to assemble the Altair from a kit themselves. Much to MITS great surprise, it sold by the thousand and triggered something seismic. Altair, historians generally agree, was the machine that sparked the personal computer revolution. It stands as the moment at which an underground interest in personal computing reached critical mass and began a chain reaction to bring information technology to the masses.

As with any breakthrough moment in technology, Altair had a number of precursors. By the early 1970s, several companies were grasping towards some sort of personal computing device. However, few of them were thinking of supplying home computers to the general public. Semiconductor-chip companies, for example, had started producing development systems intended to help engineers develop devices based around their microprocessors. Several business machine companies offered small computers, but they were expensive

and not aimed at personal sales. In 1964, Olivetti launched the Programma 101, a \$3,200 programmable calculator, which despite looking like an oversized cash register was architecturally a computer, albeit of limited power. The 1973 French Micral N was probably the first complete microprocessor-based *microcomputer* to be commercially available, but it sold as a sort of cut-price minicomputer not as a personal machine. In 1975, mainframe giant IBM produced a portable computer, the IBM5100. At a weight of 50 pounds, and priced at nearly \$9,000, the International Business Machine corporation was certainly not thinking of the home market. Even if it could make personal computing devices, the corporate computing world was not set up to think about supplying products to individuals. Indeed, many computing professionals regarded microprocessors as of laughably low power, possibly useful for running peripheral devices, but certainly not as the brains of serious computers.

While personal computing was being neglected by established computer manufacturers, calculator firms, small electronics companies and individuals were showing far more interest. In 1970, unemployed scientist John Blankenbaker began designing a simple educational computer, named the Kenbak-I, in his Los Angeles garage. The name took inspiration from the Kodak camera, which had made photography affordable to a wider audience, and Blankenbaker hoped his \$750 machine would do the same with computing. Aimed at introducing elementary programming, using switches and lights as an interface, it only sold about 40 units, mainly to educational establishments, but was probably the first commercially available personal computer.¹ Far more popular, with engineers and the mathematically curious at least, were programmable scientific calculators. Among the most significant was the 1974 Hewlett Packard HP-65, a \$795 calculator that allowed users to key in mathematical programs and store them on tiny magnetic strips. HP's advertising proclaimed it the 'smallest programmable computer ever', although its capabilities were largely limited to mathematical and scientific functions.

The driving force in opening up computing to a general audience came from electronics enthusiasts, or hobbyists – the sort of people who enjoyed technical hobbies such as building their own radios, electric organs or other electronic gadgets. To the hobbyists, the personal computer was a fantastic project, and even before Altair a few dedicated enthusiasts were cobbling together TTL logic chips* and other electronic components to create their own home-brewed computers. The latent demand became clear in 1974 when *Radio Electronics* magazine sold thousands of sets of plans for the Mark-8 Minicomputer. The Mark-8 was a fiendishly complicated do-it-yourself scheme for building a desktop computer around an early Intel 8008 microprocessor. Of the thousands of plans sold, probably only a fraction were converted into working Mark-8s by enthusiasts, who had to source most of the parts themselves. Nevertheless, it showed the extent of desire for a personal computer among technically interested people. In January 1975 Altair appeared on the cover of *Popular Electronics*. Not only was it more powerful machine than the Mark-8; it also sold as a relatively convenient kit, and thousands of electronics hobbyists eagerly ordered one.

‘The home computer is here!’

Altair’s producer, MITS, was a small company based in offices in a shopping centre in Albuquerque, New Mexico, US. Best known for producing calculators and telemetry systems for model rockets, it was about as far as possible to imagine from the corporate world of IBM. After MITS was bruised by the collapse of the calculator market, owner Ed Roberts, a former US Airforce research engineer, decided that a computer might save his company’s flagging fortunes. Announced in *Popular Electronics*, the machine was cleverly pitched by MITS and the magazine, which introduced it in an editorial headed

*TTL (Transistor-Transistor Logic), a family of integrated circuits, or chips, offering various logic gates and other circuits that could be built together to create more complex electronic devices.

'THE HOME COMPUTER IS HERE!' Apocryphally named by Roberts's daughter after the planet the starship *Enterprise* was visiting in that week's episode of *Star Trek*, the prototype Altair got lost in the post en route to *Popular Electronics*. Undaunted by the loss of the only machine, *Popular Electronics* and MITS mocked up a case with some lights on it for the front cover and announced Altair as a 'real, full-blown computer'.

According to *Popular Electronics*, it could be used for everything from a scientific calculator or machine controller, to an aircraft autopilot or a brain for a robot. In a further appeal to the tinkering mindset of the electronics enthusiast, its capabilities could be expanded even further with additional circuit boards. Thanks to Roberts negotiating a bulk discount on 8080 chips from Intel, \$75 down from the usual \$360, Altair was surprisingly affordable. The basic machine cost \$397, not much more than the list price of the 8080 itself, a ludicrous figure when even a basic minicomputer cost thousands of dollars. Altair was an appealing mix of technical capability, affordability and marketing. Roberts had hoped to sell a few hundred Altairs but, in a story to be repeated many times over the subsequent personal computer boom, MITS was overwhelmed with orders. However, the movement Altair sparked was a long way from truly bringing computers to the masses.

Altair was a hobbyist computer aimed largely at enthusiasts and scientific customers. Although available ready-made for \$498, most people assembled their own. Indeed, that was part of the attraction. Potential users sent off a cheque in the post and waited, frequently for months, so heavy was the demand and so small was MITS. Eventually a kit would arrive in the post, packed with hundreds of electronic components to solder together, assembly instructions and circuit diagrams. MITS' advertisements warned that building an Altair would not be a piece of cake, but that it would be a rewarding experience because at the end of it builders would have a real computer, albeit a rather basic one. The machine's interface was the rows of lights and toggle switches on the front panel. Using it was

not unlike programming Baby back in 1948. Programs were entered by laboriously clicking the switches on the front to input binary digits into the machines' tiny 256-byte memory.* A flick of another switch made the program run, and the result would appear in binary displayed on the lights; on for a one, off for a zero. Despite the rather grand claims of the adverts, the basic machine did little more than flash a few lights under computer control. However, Altair was not really a finished product, but a starting point for people to remake their machines into new forms that suited their interests by building on upgrades of various types, such as extra memory, video displays and keyboards. Indeed, a whole cottage industry soon emerged of hobbyists and electronics firms producing upgrades for the machine, and for hobbyists fitting upgrades was all part of the fun. Yet although Altairs could be made into useful tools, for most of those involved the appeal was as a technical hobby. Only a comparatively small group of people had the interest and the skills to enjoy it, but to those who did it was utterly amazing.

Before governments and big corporations had woken up to the great potential of the microprocessor, it had already fallen into the hands of electronics enthusiasts. To the hobbyists the chip was not a frightening and disruptive technology, but an object of fascination and excitement with a potential for changing the world. At a time when computers were widely associated with Big Business and Big Government, bringing computers to the people had a distinctly countercultural

*Computers have different types of memory. Simply put, Random Access Memory (RAM), often just referred to as 'memory', stores the program and data currently being used on the computer, and can be swiftly accessed and altered; Read Only Memory (ROM) chips cannot be altered, and are used to permanently store programs and data, such as the system software built into most computers; other types of memory, such as magnetic discs, paper tapes, punched cards and magnetic tapes, are slower to access and typically used for data storage when the computer is switched off.

appeal. Indeed, something of the freedom of the hippy years of the 1960s rubbed off on the early personal computer movement in the United States. At user groups, like the famous Homebrew Computer Club near the Silicon Valley area of California, enthusiasts met together to discuss their new hobby, shared ideas, swapped programs and helped each other out. Writing in the 1980s after interviewing many of its protagonists, technology journalist Steven Levy summed up the ideas behind the early computer movement as the Hacker Ethic; an ethos of making computers accessible and information openly available for the positive benefit of all.

Ironically, this egalitarian movement also spawned several corporate giants. In 1975, young programmers Bill Gates and Paul Allen approached MITS with a paper tape containing an Altair version of the BASIC programming language. BASIC freed Altair users from the tyranny of bruised fingers from toggle-switching in programs in ones and zeros, and allowed the machine to be instructed by keyboard using user-friendly commands like `PRINT` and `GOTO`. Altair BASIC was sold at prices starting from \$60, but the very idea of selling software was something of a culture shock. In the mainframe computer world, software was generally swapped freely between users, or part of the service that a company got by buying a computer. Hobbyists were used to sharing their efforts between each other too, freely copying and adapting their efforts. Very soon paper tapes of Altair BASIC were being widely shared and copied within the community. It was theft, complained Gates in his 1976 'Open Letter to the Hobbyists', published in enthusiast newsletters. By copying BASIC without paying for it, Gates argued that people were robbing developers of the incentive to develop new software. In the eyes of Gates and others like him, software was a commodity to be bought and sold, not something free to be shared. But if it could be bought and sold, there was the potential for a whole new industry to do just that. Micro-Soft, as Gates's new company was called, went on to develop BASIC for several other personal computers before moving

on to making operating systems, applications and vast sums of money in the 1980s.

There was entrepreneurship on the hardware side too. Among the members of the Homebrew Computer Club was electronics engineer Steve Wozniak. Like many others there, Wozniak built his own personal computer, a typical hobbyist machine that was simply a circuit board to plug a video display and keyboard into. After showing it to his more entrepreneurial friend Steve Jobs, the two decided to go into business together. Jobs sold his VW camper van, Wozniak his HP65 calculator. With the funds they started a business in Jobs's home, making and selling a kit based on Wozniak's machine for \$666.66 as the Apple computer. Through anecdotes such as these, the early history of personal computing is normally told as a quintessentially American success story – a tale of homespun ingenuity at the hands of quirky pioneers working in garages, of fortunes made from turning digital dreams into hit products and of great corporations founded on the visions of geek-entrepreneurs. Far less appreciated is how hobbyist computing was a more international story than is generally told.

Meanwhile, back in Britain

Just as *Radio Electronics* and *Popular Electronics* had enticed droves of Americans to build their own computers, articles on silicon chips and DIY computer projects were appearing in the pages of British magazines. Between adverts for amplifier kits and diagrams for circuitry, British enthusiasts began reading about microprocessors and computers in magazines like *Practical Wireless* and *Electronics Today International*, and started building their own. The Amateur Computer Club (ACC) was founded as early as 1972 to cater for a growing body of enthusiasts around the country. With around 600 members by 1976, it was admittedly a small start compared to the estimated 50,000 hobbyists in the USA by this point,² but it was an active one. Through the ACC's newsletter, typewritten with crudely hand-drawn diagrams, members read about computer science topics, followed plans to build hardware projects and compared notes

about their new hobby. The club's members were not just concerned with microprocessors, but with building computers from scratch using discrete integrated circuits. A few even purchased old mainframe computers at scrap value and set themselves up as computing bureaus, free from the tyranny of organisational control. Among the ACC's most ambitious projects was the Weeny-Bitter, a basic £50 DIY computer project useful, so the newsletter said, for everything from simple games and education, to controlling household devices and running train sets. In Britain, just as in the United States, the appetite for personal computing was there among those with the technical know-how to make it work.

'It started out with Mike Lord, who designed a computer for the amateur computer club called the Weeny-Bitter, made up of discrete components, switches, gates, buffers, logic,' recalled computer journalist Guy Kewney in a 2008 interview. 'With relatively little expertise you could put together a Weeny-Bitter that could process data in and out. And people were prepared to go to that sort of trouble to get their hands on a piece of working data-processing equipment.' Kewney was one of the earliest journalists to pay significant attention to personal computing in its own right, not just as the sum of its electronic parts. 'The chip business was a component story,' he explained. 'I thought this was a short-sighted and stupid approach.' Kewney began writing about microcomputers in electronics and science magazines, bringing a wry humour to what could have been a very technically dry subject, and becoming one of the most influential early figures to propagate personal computing in Britain.

It was only a matter of time before personal computing outgrew the electronics press it had started in. In 1978, *Personal Computer World* (PCW) began appearing on the shelves of newsagents, joining American imports such as *Byte*.³ Like so much of the microcomputing scene, PCW started as a grassroots effort. Its first issue was assembled in a London cafe by Angelo Zgorelec, a newsagent and occasional journalist who had become excited by computers and the potential for a

magazine about them. After making a trip to New York to attend a *Byte* magazine computer show, where he witnessed people queuing for hours to get in, Zgorelec was convinced that a British computer magazine would be a success. His instinct was spot on. The first issue's print run promptly sold out and *PCW*, soon to feature the long-running 'NewsPrint' column by Guy Kewney, became an established institution of the microcomputing world. It soon had competition from another new starter, *Practical Computing*, which began in a similarly low-key way, but had a slightly different editorial line. 'We were rather austere, middle class and intellectual. *PCW* was much more downmarket. It would happily write about any old shoebox with lights,' observes *Practical Computing's* editor Peter Laurie mischievously. The enthusiastic *PCW* and higher-brow *Practical Computing* were both quickly joined by a great variety of other computer magazines, many with unique characters of their own, but with a largely male readership. Guy Kewney recalled a call to *PCW* from BMW, inquiring about placing advertising: 'We said, "we're not a car magazine," and they said, "no, but we've looked at your demographic and you have by far the highest ratio of male to female of any publication in the UK." And we looked at our figures and it was something like 99.6 per cent male.' To Kewney and others the discrepancy was unusual given how many women worked in professional programming, but microcomputing was undoubtedly a largely male pursuit at first.

Computer magazines were vital to the spread of personal computing. Without their informing and nurturing of computer users it is hard to see how such a technical and open-ended hobby could have developed in the way it did. There may have also been computer clubs and shows, but the reach of magazines was far greater. 'We were information glue that held an amorphous mass of people, each at his own desk, each working on his own problem together,' explains Peter Laurie. 'If we had not existed no one would have known what was going on.' To readers who wanted to learn more about their new hobby, magazines were a godsend. They printed

things that readers could do with their computer, answered technical questions and advised on the pros and cons of new products. Magazines even published software in the form of pages of computer code to type into a machine and run – provided, that is, they avoided typos, or the magazine had not misprinted anything or the program was not buggy to begin with. In which case the next issue might carry some corrections or an outraged letter to the editor asking what was wrong with it. There was often a certain unpolished enthusiasm to computer journalism at first. It was the handiwork of small teams reporting on a fast-moving sector, and making up the idea of what a computer magazine was as they went along, often with many contributions from readers. ‘We couldn’t afford to employ reporters who went out to look for stories, so we relied on stuff that was sent in, and on persuading people who were in the business and could write to do pieces for us,’ remembers Peter Laurie.

As much as anything else magazines were avidly read just for the sake of interest by an enthusiastic readership. ‘A magazine like this has a new, obsessive readership that will forgive a lot of journalistic ineptitudes,’ observes Peter Laurie. As well as feeding the interests of a community of users, to the cottage industry springing up to produce things to go with personal computers, the advert pages of magazines were the only reasonable marketplace there was to lay out their wares. Journalists also played a role spreading news through the various personalities and small companies that made up the industry. ‘We all knew each other,’ explained Guy Kewney. ‘I knew Adam Osborne,* the guru of the industry then. He and I used to chat two or three times a week, and then he’d say “have you seen what so and so is

*Although British, Adam Osborne was an influential figure of the early American hobbyist computer scene, producing many technical books on microcomputing and electronics in the 1970s, and later starting a computer company to produce the Osborne 1, one of the first portable computers.

doing?” And so I’d ring up so and so, saying “I’ve heard you’re doing x – have you tried doing y?”” Revolutions, political or technological, rely more than anything else on the circulation of ideas and information to get them started. The electronics and computer press was undoubtedly the nerves of the popular computer revolution, but they were not the only way that information got around.

‘There were lots of articles about what was happening with microprocessors and microcomputers in California and the US in general, and how this was the up and coming thing,’ recalls Bruce Everiss, the managing director of a computerised bookkeeping company in the late 1970s. ‘I read about these strange things called computer stores that were starting up. And I thought, “this is interesting, they’re in America now and they’ll come to the UK – I should start one.”’ In 1978, Everiss founded Microdigital in Liverpool, one of the very earliest computer shops in Europe, and soon found an untapped market of enthusiasts. ‘People turned up from Scotland and Cambridge to buy stuff. And people on the phone said, “I’ll just send you any money, put it in the post to me!”’ remembers Everiss. ‘We shipped huge amounts of stuff.’ Microdigital did far more than just sell computers. It soon branched out into publishing software, doing repairs, selling components, making gadgets to connect to computers and printing the *Liverpool Software Gazette*. The customer base was typical of the hobbyist computer world. ‘These people were electronics enthusiasts. They were able to build the kit computers,’ Everiss explains. ‘Then we had *Personal Computer World* start as the first home computer magazine, and then that created a much broader range of customers.’ At a time when there were few other direct sources of information, Microdigital became a focal point for enthusiasts, offering personal advice and expertise. ‘We were very sociable, because everybody was learning off everybody else,’ explains Everiss. ‘We’d make people a cup of coffee, then just chat for hours about how exciting it was, what’s happening and what’s going to happen next. It was a very convivial place.’

Computer clubs and user groups

Conviviality with other computer hobbyists was also on offer at computer clubs and user groups. In late 1978, *PCW* listed the contact details of 33 such groups across the UK. Some were national, united by newsletters and often catering for owners of particular types of computers. The majority were local clubs, sometimes in universities or companies, but mostly open to anyone with an interest. Among them was Cambridge University Processor Group (CUPG), a bunch of student hobbyists who met up to build computers for fun, listened to lectures on electronics and showed off their machines to each other. 'The real men used TTL chips and built their computers from logic gates, and the wimps like me used these new-fangled microprocessor things,' recalls Steve Furber, an aeronautical engineering student who originally joined the club with ideas of learning to build a flight simulator.⁴ Hobbyists could make a functional computer from integrated circuits without even needing a microprocessor, but it was akin to designing and building an engine to put in a car. And it probably would not go as fast anyway.

The microprocessor was a ready-built engine, but still needed the rest of the computer to be built around it, a rather involved process that benefited from bouncing ideas off others. 'You talk to people a lot and you scratch your head and you think about it,' explains Furber. 'The engine itself is a microprocessor and there were a number of 8-bit micros available in the late '70s. You'd look at their specs and pick one.' To the untrained eye, most microprocessors of the time, be they MOS 6502, Motorola 6800, Nat-Semi SC/MP, Intel 8080, Zilog Z80 or whatever, looked rather like each other. On the inside the architecture was quite different, leaving hobbyists to judge the comparative merits of speeds, the numbers of registers, the sizes of address or data buses, and how sophisticated the instruction sets to control them were. Despite the dry technicalities it inflamed the passions of computer hobbyists. 'There was a 6502 versus 6800 war going on in the microprocessor society at the

time,' recalls Sophie Wilson, another club member from the 1970s. 'The differences may seem small, but if you think about the wars that people have over different songs, different football teams, etc., it's like that, amongst fans of microprocessor design.'

With the basic parts selected, hobbyists would have to translate their understanding of how the computer might work into detailed plans. 'You have to understand how the microprocessor interfaces to the things you want it to talk to,' explains Steve Furber. 'You have to come up with a circuit diagram that connects the processor's address bus to the memory address pins, and the processor's data bus to the memory data pins.' Add a few components to generate timing strobes for the memory and a clock signal to step the processor along, and with plans complete the building began. And so began the work of soldering sockets and components to breadboards or home-made circuit boards, and wiring connections between different parts of the machine, gradually building up into something that could compute. Assuming it all worked, the result was typically a fairly simple machine with switches for entering data and instructions, and lights for reading off the results. If the builder got that far they probably had the skills to expand it, but if they did not British kit computers were on the horizon.

'Learn about microcomputers by owning one!'

Compared to his American counterpart, the British computer amateur was hard done by, complained a prominent article in the first edition of *Personal Computer World* in 1978. In Britain the personal computer scene was less organised, individual hobbyists had less money to spend on their enthusiasms and the electronics industry was doing little to introduce computer products. The British hobbyist was forced to build their own machine from scratch or to import a kit from the USA at great expense. However, that was about to change, thanks to a kit computer, the NASCOM-1, manufactured by Lynx, a company based north of London.

Lynx was the hobbyist subsidiary of electronic component seller North American Semiconductor, NASCO, run by John Marshall, a frequent visitor to the electronics industry in the United States. Impressed by the well-organised and well-supplied amateur computing scene on the West Coast, Marshall wondered if it would be possible to produce a kit computer within the reach of the British enthusiast, while also boosting his business's electronic component sales. 'He had a warehouse full of TTL* essentially, and he thought, "I've got enough stuff here that I'm sure I could make a computer,"' recalls Chris Shelton, the consultant electronics engineer approached to design the machine in 1977. 'He saw a computer as being a way of shifting some of the silicon that was in his warehouse.' To run the machine Shelton selected the Z80 microprocessor, whose built-in features meant fewer other components would be needed to support it, simplifying the design and reducing the cost.

'Marshall insisted on two things in the design,' recalls Shelton. 'He wanted a cracking keyboard and he sourced a quite big and cumbersome Cherry keyboard, a real, proper long travel electric keyboard.' Full-sized electric keyboards were a premium item for hobbyist computers and added to the expense of a machine, but this was a major selling point compared to the fiddly switches used as input on many home-built hobbyist machines. For output, the NASCOM had a television display adaptor built in, raising the machine's usability even higher. 'The second thing was he wanted to see home construction,' continues Shelton. 'That meant a hell of a lot of soldered joints, and indeed the board ended about A4 sized. Also due, in part, to his insistence that it had a CAD layout.'

While hobbyists were hand-sketching plans for their machines, the NASCOM-1's component and connecting circuitry were laid out using autorouted computer-aided design

*TTL, transistor-transistor logic, refers to a widespread family of integrated circuits, different sorts of chips that were often used as the building blocks of more sophisticated electronic devices.

(CAD), but with some rather unexpected consequences. 'I was not familiar with autorouting and it never occurred to me how awful it could be,' explains Shelton. 'Placement is the secret of success of an autoroute, and unless you've got a very cunning algorithm for your component placement the autoroute ends up running tracks everywhere.' The circuit board design that emerged from the CAD system was perfectly functional, but far larger and a bit more expensive than it should have been thanks to the quirks of autorouting. However, with the design money already spent it would have to do.

The resulting machine, an ungainly circuit board of components plugged into a large keyboard and television, was far from elegant, but it worked perfectly well and tapped an unmet demand for computer kits. At a little over £200 in basic form, it was far more affordable than American imports and a range of upgrades was soon available. 'It was very popular in its way,' recalls Shelton. 'Marshall thought it might sell one or two thousand and it rapidly got to five.' As many as 15,000 NASCOM-1s were eventually sold and according to Shelton, its success became a problem. 'It was so sudden. It was not what they had ever done before and was not what they were expecting.'

The problem was not just the scale of the machine's success, but the fact that it was a kit. While it may have been easier than designing a computer from scratch, building a machine from a kit of parts was a complicated business. There were 55 different integrated circuits and dozen of diodes, resistors and other components that needed to be attached to the board without damaging the delicate electronics. There were 1,300 joints to carefully solder on the NASCOM, and the construction notes warned against rushing the exercise and cautioned that it might take as long as 40 hours to build the machine. In practice, some people took months and even then it might not work. Among the few shops to sell NASCOM computers at first was Microdigital, which soon set up a mail-order sideline repairing kit computers, where Bruce Everiss recalls 'piles of dead NASCOMs arriving every day and going away fixed in

the evening'. Patience, skill and perhaps a bit of obsession were needed to build a computer kit, attributes not always possessed by the prospective NASCOM user. For a company used to supplying electronics components, it became difficult to deal with the number of returns of wrongly assembled computers, and the later NASCOM-2 was shipped ready-built, not only in kit form.

NASCOM was far from the only British company with an eye on the hobbyist computer market, and £200 was still more than many hobbyists could afford. Near Cambridge, in the small town of St Ives, the innovative electronics maker Sinclair Radionics was also looking at a computer project. Founded in 1962 by Clive Sinclair, a former electronics writer and journalist, Radionics had produced a varied line of kits for the hobbyist and ready-made goods for the consumer, including amplifiers, hi-fi stereos, miniature radios and calculators. By the late 1970s, Radionics, like many other companies, was in financial trouble as the calculator market was flooded by cheap Japanese imports. Bailed out by the Government's National Enterprise Board (NEB), at the cost of a controlling stake in the firm, Radionics was in a poor position to pursue an innovative computer project. However, Clive Sinclair had also set up another small company, Science of Cambridge, under the management of right-hand man Chris Curry.

Science of Cambridge's first product, a kit for a wrist calculator, was by most accounts a disaster, but then an electronics engineer named Ian Williamson approached them with the idea for a computer kit. Williamson's idea was to use a cheap National Semiconductor SC/MP microprocessor along with calculator parts to make a very cheap computer kit. After a bit of toing and froing, and a redesign to make more use of National Semiconductor parts, adverts for the Science of Cambridge MK14 microcomputer kit began appearing in the electronics press. To look at it was simply a circuit board studded with chips and fitted with a small keypad and calculator display. It was a very basic machine, programmed by typing in a list of arcane hexadecimal instructions, like 3A0F60, then

looking at the result on the display. The manual included a variety of programs to try out, simple mathematical functions, electronics utilities, and even moonlander and duck-shooting games, all squeezed into the 256-byte memory and played out on the glowing 8-digit display. It could not do very much without expansion, but at £39.95 it was about the cheapest way to own a computer that did not have to be built from scratch and was soon selling very well.

Inspired by the machine's success, Curry parted ways with Sinclair to found a computer consultancy firm with Hermann Hauser, an Austrian physics graduate from the prestigious Cavendish Laboratory at the university. Initially their company was called Cambridge Processor Unit (CPU), but was soon trading under the name Acorn. With few people around who knew that much about microprocessors, the University Processor Group was a handy source of recruits for the new company. Among them was Steve Furber, who, as he tells it, found Hauser in his office one day with an offer: "We're thinking of starting this company. Are you interested?" And I said, "Well, I've only ever done this as a hobby... but if you think I can help I'm happy to come and talk." Typical of the early days of new companies with uncertain futures and novel products, it was an informal sort of arrangement at first. 'In general Acorn did not pay me. The quid pro quo was I did this stuff for fun. I gave them the results when they were interested in them and they gave me bits to play with,' remembers Furber. CPU's earliest jobs included work on microprocessor-controlled fruit machines, fixing an unfortunate tendency of the machines to pay out when someone flicked an electrical cigarette lighter nearby. Another job was assisting the development of the MK14 for Science of Cambridge – ironic given the companies' later rivalry. 'Because of my connection with Chris through the embryonic CPU Limited, I actually did some prototyping of the MK14 and wired one together in my front room at home and debugged it,' says Furber, who also recalled that the two companies actually shared office space for a time.

Another recruit to the fledgling company was Sophie Wilson. She had already built several microprocessor-controlled devices, including an automated cow feeder during a holiday job, and was planning a new computer. 'The MK14 had been launched and there were magazine articles about it, and I was designing a single-board computer,' she recalls. 'It would become two boards, but at the time it was a single-board computer that would be much much better than the MK14.' At about this time, Hermann Hauser came up with the idea of a battery-powered 'electronic pocketbook' to remind him to go to meetings and asked Wilson to design it. She turned up with a portfolio of other schemes as well as the pocketbook plans to prove her design would work. Among the papers was a plan for a 6502 processor computer, then called the Hawk, which Wilson showed to Hauser as an example of how the pocketbook display could work. 'So that sort of ended with Hermann challenging me to build that machine rather than his pocketbook.'

With a few improvements, the Hawk became the basis for the Acorn Microcomputer System 1. When it was released in 1979 the little machine, a calculator-style display and keypad mounted atop a pair of circuit boards, was a perfectly respectable hobbyist computer kit. However, the enthusiasts were not exclusively the market it was aimed at. CPU had been founded as a technology consultancy with an emphasis on applications of microprocessors in control systems, such as fruit machines. The System 1 began a series of more capable rack-mounted systems aimed at controlling electronic equipment and use in laboratories. According to Wilson, catering to the hobbyist market was more of a sideline at first: 'The Acorn System range – there was a nod to the fact that people could build System range stuff for their own amusement, but the purpose of a lot of it was to be an electronic controller.' Probably the most famous use of the System 1 as an electronic controller was in the control panel of a spaceship in the BBC science fiction television series *Blake's Seven*. 'This was around the time that Clive Sinclair was boasting that his ZX80 could be used

to run a nuclear power station, which is something of an exaggeration,’* recalls Steve Furber. ‘Our counter to this was, well, this is nothing, you know the Acorn System 1 can be used to control a twenty-second century intergalactic spaceship.’

Computing for its own sake?

Making a modern PC do something requires little understanding of how the machine works. Users are insulated from the underlying hardware by layers of software that silently automate much of what the computer does, but disguise the complexity of what is going on within the machine. Hobbyist machines demanded that users had an intimate relationship with the computer’s operations, unfiltered by user-friendly operating systems. The line between software and hardware became blurred when users had to understand so much about the underlying machine to use a computer. At its most primitive, low-level programming could be a rather manual business of ordering data around the machine, and required a fundamental understanding of what was happening within the computer.

For those with the technical nous it was all great fun – a sort of puzzle game played in the logic of the machine, where finding the bugs in programs and hardware was part of the challenge. Yet beyond the technicalities of the hobby, just what were hobbyists using their machines for? ‘I never thought of that,’ recalls Chris Shelton of the NASCOM’s design phase. ‘Never crossed my mind what people would use it for.’ To those building their own computers, either from kits or to their own designs, much of the attraction was simply getting the machine to do something. ‘You did not use it necessarily for anything; you’re possessing a computer and that’s an end in itself,’ explains Sophie Wilson. A joy for its practitioners, early microcomputing was a niche activity far too complicated for everyone. ‘I think we probably still felt that computers were for

*The ZX80 computer was the successor to the Science of Cambridge MK14, launched in 1980.

people like us, right? Enthusiasts, hobbyists, people who were interested in computers for their own sake,' recalls Steve Furber of the end of the 1970s. 'People who'd be prepared to solder things together to connect them or write assembly code.'

The enthusiasts had invented the personal computer, but they had built it in their own image. The problem with microcomputers, mused *Practical Computing* late in 1979, was that they were too fragile for the real world. The small population of 'micro-freaks' may have delighted in the quirks of their machines, but for a larger industry to develop it needed to involve people who wanted computers for practical ends, not just for their own sake. That was never going to happen when computing required hexadecimal and soldering. Hobbyist computing was a movement rather than a mass activity, a loose grouping of enthusiasts, entrepreneurs and technical journalists. Being a part of it required mastering some arcane technical rituals, attractive to the micro-freak, but not to the man in the street. However, things were beginning to change. Over in the US a new concept of the personal computer as a more accessible machine had started to emerge, which would open up microcomputing to the masses.

The trinity

In 1977, three American companies, Commodore, Apple and Tandy, each launched a ready-made personal computer targeted at a wider market than just hobbyists. The Commodore PET 2001, Apple II and Tandy TRS-80 all looked rather different, but all shared a similar design philosophy. They were complete factory-built computers, shipped as boxes, not just bare circuitry. They allowed people to become computer users without having to become computer builders. Each had a keyboard and video-display output, elevating its user-friendliness above the toggle switches, calculator keypads and hexadecimal displays typical of kit machines. On each, the easy-to-use BASIC language was built in. They were ready-built appliance computers that just needed to be plugged in and switched on for their buyers to begin computing. The trinity

did not just make computing more accessible to a technically unskilled audience; they made it more convenient than ever before too.

Of the three, the Apple II is by far the best known. Its great success established Apple firmly in the consumer market, and updated versions were still being produced in the early 1990s. The Apple II established a common form followed by many other personal computers in the following years. The keyboard and computer were built into the same case, to be connected to a television set or monitor, along with disc drives, cassette recorders and other peripherals. Its place in the home was made clear by adverts that placed the computer on a kitchen table, with a wife gazing over from her chores at a husband engrossed in his new obsession. The hobbyist lineage was clear in the great expandability of the machine, and the top opened up to allow a range of expansion cards to be plugged in. It also offered the novelty of a colour display at a time when such things were rare, a boon for entertainment use and games. Its popularity benefited from a good supply of software. In particular, the first spreadsheet, *VisiCalc*, was initially only available on the Apple II, lending it some legitimacy as a business tool. Anecdotes abound of accountants and businessmen buying an Apple II just to run the spreadsheet. With prices starting from \$1,298, the Apple II was the most expensive of the trinity. Even then there was a certain prestige attached to Apple's product, it set a standard to which other machines were compared. Even if many prospective computer users could not afford an Apple, many aspired to do so.

The Tandy TRS-80 was the most underrated. Its lower build quality and design economics, such as using simplified Tiny BASIC as its built-in language, earned it the unfortunate nickname 'Trash 80' from its detractors.* Apple may have grown from small beginnings as a hobbyist company, but

*However, the improved Level II BASIC, available later as an upgrade, was a great improvement and among the better BASICs available for a home computer.

Tandy was already a major electronics business with a huge chain of Radio Shack electronics stores across the United States. However, the TRS-80 designers struggled to convince Tandy management of the potential for their idea, which at \$399 or \$599 with a black and white display screen was far more than most of their products. The cautious initial plan to provide a single machine for each of the 3,500 Radio Shack stores proved to be woefully inadequate. Tandy found its switchboards jammed with callers requesting one of the computers. As with Apple, Tandy's marketing presented the TRS-80 as a complete domestic appliance. 'NOT a kit', declared Tandy's adverts, which featured a family clustered around the TRS-80 looking delighted at all they could make it do. The TRS-80 was the first of a series of Tandy personal computers, largely sold through mail order and through its Radio Shack stores.

Although Apple stole much of the attention, the first of the trinity was actually the Commodore PET 2001, launched in January 1977. Established in 1954 by Polish-born Auschwitz survivor Jack Tramiel, a legendarily tough businessman and hands-on manager, Commodore was an established international producer of office equipment and calculators. Already a presence in Britain, it became the most significant American microcomputer company to operate in the British market over the 1970s and '80s. Tramiel's strategy stressed vertical integration, but Commodore's reliance on other firms for microchips left the company in serious difficulties in the mid-1970s as the calculator market became more cut-throat. In 1976, Commodore took over the struggling chip maker MOS Technology, a major supplier of calculator components. As Brian Bagnell's history of Commodore details, Tramiel's takeover of MOS was a brilliantly ruthless business manoeuvre.⁵ At the time MOS was heavily dependent on orders from Commodore and embroiled in an expensive legal battle over patent infringement with the far larger Motorola. Tramiel took advantage of the situation to purchase MOS for a mere three quarters of a million dollars, yet such were Commodore's

parlous finances that he had to scrape together funding from wherever he could. 'I remember him calling me up late one night saying, "Kit, I need to get half a million dollars by the end of the month." We were in horrible state, the company was struggling,' recalls Kit Spencer a marketing manager at Commodore UK at the time. "I don't care what you do," he says. "We've got a chance to buy a chip company; there'll never be a chance like this again..." I remember going up to Boots when we had about 20,000 watches in stock, saying, "Have I got a deal for you!"

Tramiel's search for funding to purchase MOS not only secured a degree of component self-sufficiency for Commodore's calculator business, but also the services of a first-rate chip-development team lead by Chuck Peddle. He had already led the design of the ubiquitous MOS 6502 microprocessor used in several hobbyist machines, not least MOS's own KIM-1 computer kit. By 1976 he had his sights set on making a very different sort of machine from both hobbyist kit computers and the versatile but essentially limited programmable calculators. 'I remember being over in Palo Alto saying, "When are we going to be able to get something like HP have got?"' recalls Kit Spencer, referring to Hewlett Packard's line of programmable calculators, which included magnetic cards for data storage. 'And Chuck says "We're going to go one stage further, we're going to use a VDU for a display, and a tape deck for the input." It was the Commodore PET.'

Initially priced at \$495 for the basic version, with 4k of RAM, the PET 2001 was a strikingly futuristic-looking machine. An angular all-in-one case contained the computer, keyboard and tape recorder, topped with a black and white display screen. The PET was developed in much haste, and Commodore wielded its vertical integration to keep the costs down by using things close to hand. The PET had a metal case because Commodore owned a filing cabinet factory. It used a 'chiclet' keyboard fitted with calculator-type keys, rather than a typewriter-style unit, because Commodore could

already make such calculator keyboards cheaply. The name PET 2001 was a portmanteau of the friendly and the futuristic: PET, officially an acronym for Personal Electronic Transactor, but originally a nod to the 1970s fad for pet rocks; 2001, inspired by *2001: A Space Odyssey*. Making its futuristic nature clear, William Shatner, better known as Captain Kirk from *Star Trek*, even fronted the PET's advertising campaign.

The PET was as wildly successful as the other machines of the trinity, and helped to propel Commodore out of its financial troubles. Selling at around £695 at first, the PET did better in the British market than the expensive Apple II or the TRS-80. Much of this success was down to the comprehensive marketing and support effort devised by Kit Spencer, now head of Commodore UK's computer division. 'It had no manuals, no nothing, no software – a pretty bare bones machine,' recalls Spencer of the PET's arrival in the UK. Spencer hired a pair of computer hobbyists to prepare a manual and software, built up a network of dealers and started a magazine, giving the PET the support it needed to flourish. By 1980 over 10,000 units had been sold and Commodore's adverts declared it Britain's 'best-selling microcomputer'.

With the trinity the computer became an appliance for the first time, accessible to people who did not have a detailed understanding of electronics or how a computer worked. Yet it was not quite the start of computing for the masses. Much of the appeal of computing was still among technically curious enthusiasts or people with a need for a computer, rather than the public at large. 'They tended to be quite a lot of technical people. Quite a lot of universities starting small computer departments. They actually used it as scientific controller,' recalls Kit Spencer of the sorts of people who became PET users. 'Simple little payroll packages... and hobbyists who just wanted one, everybody was pretty enthusiastic. And not just being users, they tended to be evangelists for it.'

As the 1970s ended personal computing was still a movement rather than a mass activity. Computing was now technically accessible to a larger market than ever before, but it had only

just started to become culturally accessible, as marketing targeted home users, professionals and small businessmen rather than just hobbyists. Most importantly, its uptake was limited by cost, especially in Britain. Not only were the trinity more expensive than typical hobbyist machines, but imported computers were often sold at a premium on their prices in the US. 1979 prices for the trinity began at around £380 for a TRS-80, £550 for a PET and £810 for an Apple II. With Britain suffering from a recession and with the average household income about £6,000, such computers were expensive luxuries. As 1980 dawned, personal computing was just on the cusp of becoming a mainstream activity. To increase its appeal would require a dramatic gesture to increase its affordability.