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SCIENCE MUSEUM

THE LEGACY OF THE BBC MICRO
EFFECTING CHANGE IN THE UK'S CULTURES OF COMPUTING

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CONTENTS

"Computers belong to all mankind."

Ted Nelson, Computer Lib/Dream Machines, 1974

"The aim was to democratise computing. We didn't want people to be controlled by it, but to control it."

David Allen, Project Editor, BBC Computer Literacy Project, 2012[1]

PREFACE

In August 2011, Google's Chairman Eric Schmidt gave the MacTaggart Lecture at the Edinburgh TV Festival. His speech contained a stark warning about how Britain was throwing away its great computer heritage by failing to teach programming in schools: *"Your IT curriculum focuses on teaching how to use software, but gives no insight into how it's made"*.[2]

Schmidt was not the only one concerned. Nesta's 'Next Gen.' report, outlining the findings of the Independent Review of Skills for Video Games and Visual Effects led by Ian Livingstone and Alex Hope, had called earlier that year for the reintroduction of computer science in the National Curriculum. Next Gen. Skills, a campaign bringing together the video games and visual effects industries with other digital sectors, the Sectors Skills Councils, professional bodies such as BCS, and the Computing At School teacher network had been formed with the aim of reintroducing creative computing into English schools. The Royal Society argued, in its 2012 'Shut down or restart?' report, that change was needed to "ensure that the next generation of young people in this country can be creators of technology – not just consumers of it". This would require reviewing the term ICT (Information and Communication Technology), and replacing it with more clearly defined terms such as Digital Literacy, Information Technology and Computer Science.

Concerns about the opacity of modern computers, how the user doesn't need to know programming (or be creative) in order to make them do things, has gone hand-in-hand with increased nostalgia for the BBC Computer Literacy Project (CLP). Many claim that this 1980s project illustrates a time when Britain had the right kind of enthusiasm for computing, and got the transparency of the machine right. The CLP backed a new microcomputer - the BBC Micro - and developed a broad portfolio of activities aimed at making computer programming and powerful computing tools accessible to everyone. This report stems from that renewed interest.

The CLP was undoubtedly a success for the BBC; millions of viewers watched the TV programmes, hundreds of thousands of users bought the machine and it was a fully integrated response across BBC Enterprises, Education and Engineering. In this report, we look at how that success came about. What can ongoing attempts at rebooting creative computing across the UK learn from the CLP?

The report also explores whether the CLP had any lasting legacy on the culture of computing in Britain. Did more people take up programming and become more confident around computers as a result of the project? Or would this have happened anyway, given the abundance of cheap home machines and an excitement in the perceived future of computing over the 1980s? Can we see any economic impact from the project, in the shape of new leading companies in digital sectors such as software, hardware or video games?

Although the BBC Micro is often referred to as an educational machine, this is not a report about computing and schools. The reason is that the major focus and impact of the CLP was in the home, not in formal education. Instead, the report documents a moment in history when a network of actors came together to enable change, discusses the legacy of that change today, and explores the lessons for bringing back an ambitious vision of technological literacy to today's Britain.

RESEARCH APPROACH

The research which has informed this report has been conducted in three ways:

1. Archives research at public sources such as the BBC Written Archives Centre at Caversham. This research provided invaluable primary evidence of the development and growth of the CLP that could then be cross-referenced against published papers, books and press articles.

2. Open-ended interviews and email correspondence with those involved in the BBC Micro project at the BBC and Acorn, with individuals related to the project and with entrepreneurs who have subsequently founded companies in areas such as software or video games development. The majority of the interviews were conducted over two periods, during 2007-2008 when the author first became interested in the people and ideas that had created the BBC Micro, and more recently in 2011-2012 as general interest in computer literacy increased. A full list of interviewees is given in Appendix A.

3. An online questionnaire targeted at individuals who were interested in computing in the 1980s and specifically individuals who may be founders or senior members of companies that were established in the 1960s/70s and early 1980s. The questionnaire was emailed to approximately 150 individuals and sent out on Twitter; 372 people started the survey and 292 (78.5 per cent of the total) completed it.

ACKNOWLEDGEMENTS

EXECUTIVE SUMMARY

The Computer Literacy Project (CLP) had the grand ambition to change the culture of computing in Britain's homes. The project received significant high-level support within the BBC and across government. This innovative backing by a broadcaster working with an entrepreneurial company - Acorn - led to the creation of an open technology, supported by a range of materials (programmes, courses, publications and software) delivered across a multitude of channels. The BBC Micro was complemented by activities that increased demand for computing generally, by promoting cultural shifts in attitudes towards computing and delivering learning into homes and schools.

The open and accessible nature of early home computers invited consumers to explore and experiment through activities such as programming and gaming. It was this use and pleasure that brought people together through the technology and defined the meaning of the computer for users in Britain's homes. At the same time, the wide-reaching literacy programme and an open machine stimulated a massive increase in the supply and diversity of education and training opportunities by course providers not directly associated with the CLP.

Not only did the CLP help transform the culture of computing in Britain, making computing acceptable and bringing it into many British homes, it also had positive repercussions for the UK high-tech sector. The impact of Acorn can be seen directly in high-tech companies such as ARM, and indirectly in the serial entrepreneurs, strong social networks and inspiration to others that were, in part, created by Acorn. The BBC also benefited: the CLP opened a 15-year period during which it explored a range of new opportunities for learning through broadcasting and computing, such as the Domesday Project and the Networking Club.

Many things have changed since the days of the CLP. What is clear is that predictions about the importance of computers for our economy and society have come to pass. Complex information systems are an inextricable part of our lives, at home and at work. Everyone needs a basic understanding of what computers are capable of, how to manage their own personal information and why programming is a significant skill for expression in a digital age. And our economy will rely on the creativity and entrepreneurialism of able programmers going forward.

Current concerns about the absence of creative computing in the classrooms have informed a plethora of initiatives, both from government (such as the disapplication of the Information, Communication and Technology – ICT – statutory Programme of Study in the school curriculum), industry (Next Gen. Skills), teachers (Computing at School) and technology providers (the Raspberry Pi). We have an amazing opportunity to enthuse a new generation in the creative uses of computing. We should learn the lessons from the CLP as we go forward.

Current initiatives lack the scale, aspiration or comprehensive approach of the original CLP. Few initiatives have the ambition of reaching into homes as well as schools, and no one organisation is using its brand to mobilise and inspire audiences. The fragmentation of technologies, supporting material and coding initiatives is an asset, but also a threat. There is a vital need for leadership and co-ordination to bring together information, training and support so that local learning can flourish both in the home and at school.

Recommendations:

There have been an enormous number of technological developments to engage people in the creative uses of computing. Any new CLP should consider the following seven points:

1. **A vision for computer literacy matters.**
   There is a need for a vision for computer literacy in the UK. The original CLP relied on personal vision to gather knowledge, mobilise action and elicit support across partners. The Government has an important role to play in setting out the vision for creative computing in 2012. UK industry also has an essential role to play in defining this vision, since employment is dependent on recruiting skilled people and it can provide the inspiration for real world challenges that will engage a new generation with creative computing.

2. **We need a systemic approach to computer literacy and leadership.**
   It is important to harness the potential synergies between the current initiatives. Co-ordination is needed to ensure that efforts to reengage the British public with creative computing are joined up.

3. **Delivering change means reaching homes as well as schools.**
   The impact of changing the culture of programming in the home should not be underestimated. This means a significant role for television and social media. The BBC remains a natural partner to drive this forward.

4. **There is a need to build networks with education.**
   A new CLP not only needs to develop a programme for schools, colleges and independent learners; it needs to develop two-way networks to access information from teachers and learners and convey it to those developing technology and supporting software and courses. Bodies such as Computing At School have an important role to play here.

5. **There are lots of potential platforms for creative computing; they need to be open and interoperable.**
   There are a range of potential hardware and software platforms to develop computer literacy; they need to be affordable, compatible and open so that users can develop and build skills.

6. **Kit, clubs and formal learning need to be augmented by support for individual learners; they may be the entrepreneurs of the future.**
   There is a need for supporting resources that can develop learning about computers outside the classroom. These may be delivered through online services or social networks, but must bring learning resources and interaction, not just software and hardware, into the home.

7. **We should actively aim to generate economic benefits.**
   The original CLP generated direct economic benefits from the increasingly skilled population it helped to create, as well as direct commercial benefits to the companies involved, such as Acorn. But perhaps equally important were the indirect benefits of stimulating a high-technology innovation cluster around Cambridge. Any future CLP should aim to deliver similar economic benefits.

1. BACKGROUND

The BBC Computer Literacy Project (CLP) came out of the BBC's Continuing Education Television Department. Based in Villiers House, the department was colloquially known as 'the place for people with ideas above their station' due to the number of bright young things working in a grey office block positioned over the railway line at Ealing Broadway.

The Head of Continuing Education Television, Sheila Innes, believed strongly in adult self-improvement and the BBC's role in *"bringing education to the people"*. For Innes, the power of television was its ability to educate the largest number of people in the broadest sense. Her department had strong networks across providers of adult and non-traditional learning and a good dialogue with the educational advisers. *"We needed them as much as they needed us,"* she recalled, *"if the BBC's programming and approach was to be adopted by the schools and colleges."*[3] Increasingly, with television programmes such as the BBC's *Horizon, Now the Chips are Down* in 1978 and ITV's *The Mighty Micro* with Dr Christopher Evans in 1979, the BBC was aware of concerns about the impact of microprocessors on the future of employment and work. The Continuing Education Advisory Council (CEAC) and the BBC's own team of education officers were saying that the BBC needed to take action.

In early 1980, Innes sent two people from her team, David Allen and Robert Albury, to *"go and see if there is anything in this microelectronics business"*.[4] Their work was backed by the British government's Department of Trade and Industry (DTI), the Department of Education and Science (DES) and the Manpower Services Commission (MSC), a quango responsible for identifying the national training needs of the country. The DTI were to help with the consultancy, and the MSC would finance a global fact-finding trip through a grant of £10,000 that included America, France, Germany, Holland, Norway, Sweden and Japan. The result of David Allen and Robert Albury's extensive research was a series of three television documentaries, *The Silicon Factor,*[5] which looked at the social impact of the microchip, and a report, *Microelectronics*, distributed in August 1980. The document was widely circulated to policymakers in Britain, and copied to all MPs.

As well as highlighting the need for changes to the form of employment and work ethic in Britain, the *Microelectronics* report suggested that there was a strong argument for educating children in computing, vocational training in Further Education, and Adult Education focused on the professions, so that at all levels there were advocates for computer literacy across society.[6] As a result of the report, the BBC's Continuing Education Department decided they should start a computer literacy project. They had previously launched an enormously successful adult literacy scheme, with associated TV series, *On the Move*, and training and activities. Continuing Education decided to base this project on a similar model, offering viewers not just television programmes, but also courses, supporting books and software, a strong liaison network for teachers and learners, and the licensed production of its own microcomputer.

2. CREATING THE BBC MICRO

The creation of the BBC Micro came from a desire to give audiences the chance to use a computer and a need for a software standard. At first, the BBC approached industry and asked it to adopt a particular programming language. It then approached the part-publicly owned company, Newbury, to develop a microcomputer. When both these approaches failed, it developed a specification for a microcomputer and contacted a range of companies to bid for the contract to develop the machine. The response from one company stood out above the rest.

As the CLP was scoped out, the same question kept arising: how would viewers learn to program without a standard language?

The team, now led by Executive Producer John Radcliffe, believed that if viewers wanted to learn about computing, they wouldn't just need to watch the programmes, they needed practical knowledge of using a microcomputer. Television programmes work brilliantly at capturing people's interests and teaching them a little, but the most important thing they do is to motivate people to go and build on this interest. Educational television can inspire people to buy books, or take a course in something, but in this case, the team felt the best possible way of learning what a computer could actually do was get your hands dirty by running a program, adapting it or learning to write it. The more the team looked into it, and looked at the plethora of different and incompatible programming languages in the market, the more strongly it felt there was a very real need for one consistent language that could support the television programmes, and offer a complete and integrated learning system across computing and television.

The team formulated the idea that learning to program in BASIC was the only way for people to learn to control the machines which were beginning to appear - either as hobbyist kits or in the shops. Machine code and languages like PASCAL were difficult, but BASIC seemed approachable. The problem was that there were many dialects and limitations even in the best commercial versions. This posed a conundrum: how could the BBC make programmes and have support material when there were so many variants? At this time, the thought of the BBC selling computers was out of the question - it was used to selling TV and radio programmes but only to merchandising modest programme-related spin-offs.

The BBC began to seek advice from outside bodies such as the Local Education Authorities, the Council for Educational Technology (CET) and SPRU (Science Policy Research Unit) at the University of Sussex. They also turned to Micro Users in Secondary Education (MUSE), where they found educational advisor John Coll. Coll had previously taught physics at Oundle school, and had strong views on the use of 'structured BASIC' as a software standard that was capable of supporting intricate programming, yet understandable to a beginner. The BBC aspired to using it and initially called their version ABC – Adopted BASIC for Computers.

With the help of the DTI, the BBC Education team brought together all the manufacturers into a room in Cavendish Square, in London and put forward the idea that their machines could be used as part of a project if they all implemented a common language - namely ABC. The response

from industry was that it was unwilling to do this unless the BBC or the government paid for the development of the microchips needed. The BBC and DTI were not prepared to do this, so they approached Newbury Laboratories, which was developing the NewBrain computer, and partly publicly owned by the NEB (National Enterprise Board), and asked it to develop a machine to meet the BBC's needs. The idea was that, by collaborating with a part publicly-funded company, the BBC would avoid getting tied to a big commercial manufacturer. Although Newbury agreed, by the end of 1980 it became clear that it would not produce something workable, to the despair of the BBC.

At this point, the internal and external debate around whether the BBC should develop its own machine was still raging. Many thought this was quite simply not the sort of thing the BBC should be doing.[7] Although John Radcliffe and Sheila Innes were backed by the advisory councils, they had to get BBC management on board and ensure that the BBC's efforts were part of a wider campaign for computer literacy in Britain. As another member of the team remembers, *"It was John's drive, determination and sheer brilliance that really pulled the whole thing off"*.[8] Radcliffe himself is more reserved about his role: *"Initially, I had to persuade BBC management it was a good idea, and could be done with credit to the Corporation, welcomed by government, and wouldn't give excessive commercial advantage to a company."* BBC management had confidence in the team's competence and also in the abilities of BBC Engineering to ensure it would work, but Radcliffe still credits senior BBC management for taking the chance and backing such an ambitious project: *"It was bold leap on their part, because it **had** to work."*[9]

Between Christmas 1980 and New Year, John Coll and David Allen drew up a functional description of the microcomputer.[10] It needed to work in a television studio, as well as being robust and reliable in the real world. They wanted the machine to be transparent to users, upwards expandable (so that it could work with future hardware) and downwards compatible (so that it worked with as much existing software as possible). It also had to give users the opportunity to program at different levels of complexity, so that entry-level programmers had as much fun as those with more developed skills. They wanted to create a machine that people could use to unpick the processes of a computer through real world examples, and gave them a chance to pull all those processes together in applications that were relevant to them.

The requirements of the specification were high, with some notable ambitions. The machine would:

- Have an unsurpassed range of outputs, including Ultra High Frequency (UHF) and composite video, so that it could feed into an ordinary domestic television and offer a direct feed into a television studio for the creation of TV programmes.

- Feature input and output for computer programs, e.g. via a cassette interface that could be controlled by the computer.

- Enable the development of a broad range of cross applications; for instance the machine needed to have the resolution to display text for word processing.

- Include a printer connection, expansion ports and a network connection as standard.

- Have the ability to mix graphics and text on a colour screen and offer state-of-the-art colour graphics and sound.

- Have analogue inputs, suitable for use with a joystick or for the classroom for analogue to digital conversion in science lessons.

The specification had "everything but the kitchen sink in it"[11], but just in case all that wasn't enough, it was agreed that the machine needed to be cheap enough to make it accessible to a large audience, yet sufficiently expandable to allow access to new technological innovations like telesoftware (the distribution of computer software by teletext directly into the memory of the computer, a pioneering idea for the distribution and liberalisation of computer programs by today's standards). This early use of telesoftware by BBC Research established its position in the market of sending code by TV signal to control devices in the home. It may have subsequently saved the BBC huge amounts in licences given that a number of devices, like TiVO boxes to TV tuners, use telesoftware today.[12]

The team also began to work with David Kitson, a senior engineer in the BBC Engineering Designs Department, and microcomputer specialist and BASIC language expert Richard Russell. The BBC had the strong belief that if they were going to endorse a microcomputer then the programming language it promoted had to be 'spot on'.[13] Russell helped define the language specification to ensure that it met the BBC's requirements. The most widely available language on microcomputers at the time was BASIC - the BBC wanted to create an approachable language to the layman that was structured appropriately to encourage good practice in programming, but was powerful enough to be developed in the future. Eventually, this became BBC BASIC.

The BBC team approached seven companies (Acorn, Tangerine, Newbury, Research Machines, Sinclair, Transam, and Nascom) to submit bids to build the BBC Micro. These companies were specially selected because of fears that an open tender would have resulted in an overwhelming number of bids. It was felt that many of these would have been from British companies with 'no reliable track-record', or from Japanese and American companies who threatened to out-compete British firms. There was a definite emphasis on this being a British microcomputer, and the companies approached were already manufacturing or developing microcomputers at a similar specification and price to the one the BBC wanted.

After a series of meetings with the six companies that had responded to the tender, the main contenders began to emerge. Acorn Computers had a proven track record of building rack-based machines for research laboratories and a reputation for producing reliable single-board machines. It had experience of manufacturing large numbers (having sold around 10,000 units of their Atom) and it was well known to be working on a successor machine, known as the Proton.

Nascom had produced its Nascom-1 computer kit as early as 1977, but disappointing sales of the Nascom-2 meant the company was running into trouble.

Tangerine Computer Systems had already created the successful Microtan 65 computer and was working on a new computer and an adaptor to work with the BT Prestel service. This put it in a good position to provide the teletext adaptor required in the specification. The name Tangerine was inspired by the popular Apple Computer company in the USA, and the Microtan computer was tagged 'the 65' in reference to its reliance on the 6502 processor.[14]

Newbury had the NewBrain concept - a hardware solution which the BBC had been discussing for over two years, yet the BBC had still not seen a prototype, so it was sceptical that a machine would ever materialise.

In contrast, Clive Sinclair had already produced one of the leading and most successful consumer machines, the ZX80. Sinclair's established position in the industry meant that he was not prepared to bend over backwards for the BBC. He had already developed, but had not yet launched, his new ZX81 machine, which was considerably more powerful than the ZX80 (and would go on to sell a massive 1.5 million units). Sinclair was unconvinced about the BBC's vision for telesoftware

and was unwilling to adapt the language developed for his machine to the one required by the BBC. Sinclair BASIC was becoming a standard, whereas BBC BASIC had yet to be created, let alone proven. Sinclair viewed yet another version of BASIC as a threat and a serious mistake, as it would tie TV viewers to the BBC machine. He was not prepared to dramatically adapt his already developed machine, or share his important contacts with retailers, unless the BBC adapted its specification. This was in direct contrast to the attitude of the Acorn team: *"Clive was much less inclined to accept outside input. I mean we were being absolute tarts about it. We were doing just what the BBC wanted us to do and Clive certainly wasn't doing that."*[15]

After a further round of meetings, the BBC gave the leading contenders less than a week to produce a prototype that went some of the way to meeting its specification. The Acorn team, including Hermann Hauser, Christopher Curry, Steve Furber, Sophie Wilson and Chris Turner, worked three days and two nights non-stop to put a working prototype together for the BBC visit on Friday. They called in Ram Banerjee, *"the fastest gun in the West"*,[16] to wire wrap (a simple way to prototype) the machine by Wednesday. The team started to debug it, but by Thursday night it was still not working.

As Steve Furber recollected, *"We were all getting very tired, but Hermann was very good at team motivation. It was always his job to go out and buy the kebabs and he would make the tea. He would do all these things just to keep people going. We were all staring at this thing that was still refusing to work and Hermann suggested something like, "cut the umbilical cord from the prototype to the development system and let it run on its own", which seemed completely daft but we were all out of ideas. So we tried it and the whole thing sprung into life. It was major irritation that Hermann made the final suggestion that caused it to work!"*[17]

By 7am Friday morning, the prototype was running and the BBC was coming at 10am. By the time they arrived, BASIC was running, with real programs, and by the afternoon some graphics were working too. As Hermann Hauser later recalled, *"I don't think the whole contract depended on this prototype. It probably made a much bigger impression on us than the BBC, who might have thought that everybody can do that. But we knew that this was pretty exceptional and we were very pleased with ourselves."*[18] The BBC was well aware that the Acorn team had made more progress in a week than the Newbury team had managed in two years. John Radcliffe later remembered that *"it was an impressive demonstration, which significantly influenced the BBC's subsequent decision".*[19]

As well as being impressed with the prototype, the BBC also liked the 'can do' attitude at Acorn[20] and got on well with the team. The two teams went for a drink in Cambridge after the demonstration. A few days later, there was an internal meeting of BBC staff and consultants, chaired by John Radcliffe, where the BBC made a careful comparison of the evidence from the preliminary meetings.[21] They promptly selected the Acorn-designed machine.

Although the decision was controversial, the BBC felt that the Sinclair machine (which was later released as the Spectrum) was not powerful enough, offering less memory and less room for expansion. There were also concerns that Sinclair would not design a new BBC machine but that they would end up with a 'Sinclair machine in BBC colours'. Despite being unsuccessful at this stage, Sinclair rebid in 1984 when the Acorn contract was up for renewal, and his machines continued to sit in constant competition to the BBC Micro, selling at far higher volumes than the BBC machine.

Lessons from the Computer Literacy Project

Individual vision and advocacy played an important part in the project's success. John Radcliffe's inspiration, resolve and managerial expertise was a major factor in initiating the project, in building support for it within government and at a senior level of the BBC and in delivering it.

The project began with modest ambitions, depending heavily on advisors and team enthusiasm, instinct and judgment. Eventually, the BBC team developed a clear specification for what would become the BBC Micro, following open standards, being direct and accessible, that encouraged good practice in programming, and was powerful enough to be developed in the future.

The BBC also sought out a strong commercial partner to define how the computer would work in reality. Acorn was a confident and resourceful team with a positive attitude that helped it to produce an impressive prototype to win the contract.

3. DELIVERING THE COMPUTER LITERACY PROJECT

The Computer Literacy Project (CLP) cut across several BBC departments, and utilised its external partnerships. It was aimed at increasing adult computer literacy and broadening the public's interest in the emerging computing age.

The CLP was launched on 11 January 1982 with the first transmission of the television series *The Computer Programme*. As described above, the aim of the project went way beyond simply creating a piece of hardware; it aimed to 'raise the level of public awareness of what computers are and of how they can contribute to life at home, work and at school.'[22]

As Figure 1 shows, responsibility for the CLP spread across several BBC departments. The box marked '????' on the right-hand side, represents the possible consumer market, first estimated at 12,000 machines.[23]

Figure 1: The BBC Computer Literacy Project
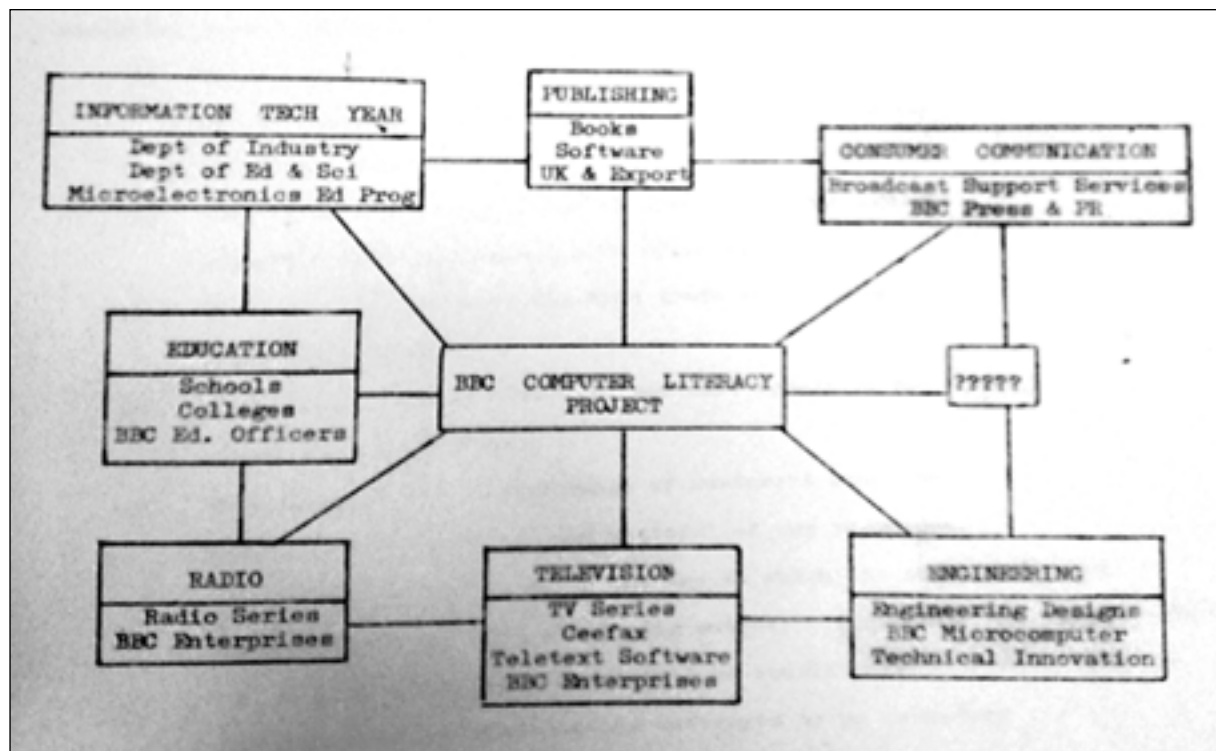
Initially, the CLP was squarely targeted at the home viewer and user. The team was aware of the growing curiosity around the development of computing, and the large number of cheaper personal machines, such as the Commodore PET and Sinclair ZX80, that were making computing more accessible. Through the TV programmes they wanted to inspire and enthuse people to get involved. The programmes would, *"Seize people's attention, explain a little, and perhaps cause people to feel differently about computers and computing. They could reach out to millions of people in their homes, capture their interest, and point them towards ways of learning if they wished."*[24]

The television series was a major part of the initiative, with the aim to make a considerable impact on adult audiences and the public consciousness across Britain. The television part of the CLP included series such as *The Computer Programme, Making the Most of the Micro* and *Micro Live*.[25] (See Appendix B for a list of the programmes developed as part of the CLP.)

Radio was also a part of the CLP through two programmes - *Chip Shop* and *Inside Information.* Later on, there were plans to expand a version of *Micro Live* into local radio, although staff changes and budget cuts put a premature end to this scheme.[26]

The BBC Education team also regularly liaised with BBC Publications, as together they co-ordinated the production of the software to accompany the BBC Micro. Originally, David Allen commissioned Welcome software on a cassette which came with the BBC Micro. This software tried to showcase many of the computer's features – including colour, sound, graphics, double height as well as single height teletext lettering, screen pages (not scrolling green text on a black background) and the ability of the computer to start and stop the cassette recorder.[27]

After this, BBC Publications became interested in designing its own software, as it believed that fascination with the technology would shift to critical engagement with the content and use of the machine:

> *"So far, public and educational interest in the BBC microcomputer has understandably focussed on the machine as a machine. Just as in the early days of radio and television there were enthusiasts obsessed with the hardware, so with personal computers. This must surely be a passing phase. As with television or radio the ultimate interest is in the message, the programme. And ultimately with personal micros - the programs, the application."*[28]

BBC Enterprises was responsible for liaising closely with Acorn about the development of the BBC Micro. In 1982, Roy Williams, Head of Merchandising in BBC Enterprises, ran the day-to-day aspects of the BBC's relationship with Acorn. BBC Enterprises, particularly John Harrison, was also responsible for overseeing and negotiating any subsequent contracts with Acorn. As part of BBC Enterprises, BBC Sales was involved in the marketing and selling of the BBC Micro, both at home and abroad. Later, they acted as a mediation point between other BBC departments and Acorn, particularly with the rise of public complaints following the launch of the BBC Micro when Acorn failed to deliver on orders.

The final, but very significant, role that the BBC played was one of co-ordination. It brought together a liaison network that centralised the provision of information about the project to viewers. Through its educational liaison officers, led by Roberts Salkeld, the BBC Continuing Education Officer for Leeds, the BBC had strong networks into educational networks, such as Local Education Authorities, colleges, universities, school teachers and computer club organisers. The role of the educational liaison officers was not just to encourage the use of BBC programmes in teaching, but to feed back into the BBC on the topic and modes of use in learning. Having told these broader networks about the project plans, it was clear there was a large amount of

enthusiasm, but there was also a vital need for a central organising body to co-ordinate resources and provide information.

This led to the creation of a referral service through the Broadcasting Support Services (BSS) (and its sister organisations, Network in Scotland and the Educational Guidance Service for Adults in Northern Ireland) which acted as a central information point for the CLP on software, on the computer and on the television programmes, and also put viewers in touch with local classes and clubs. Crucially, these bodies identified people and organisations that could become part of a bigger network of local sources of help and advice. Their activities are discussed further in Section 5: From Computer Literacy to Education in the 1980s.

Lessons from the Computer Literacy Project

The CLP was far more ambitious than the creation of a single piece of technology or a television programme; it was a multi-sided project aimed at preparing people for the perceived imminent changes brought about by microprocessors and home computers.

It did so through its television broadcasts, which gave the project a high profile, with a large number of viewers who were keen to get involved. It also provided those who were interested in computing with hardware – the BBC Micro – and software.

The project was aimed at adults and a broad section of the community, primarily at home.

The BBC's educational liaison officers' strong regional and two-way networks were vital for identifying and understanding the needs of audiences at different levels, and feeding these back into the BBC.

The BBC acted as co-ordinator for a broader liaison network which massively increased the reach of the project.

4. THE SUCCESS OF THE BBC MICRO

Sales of the BBC Micro were far higher than predicted. Acorn developed as a company with a unique culture, but ultimately the machine never broke into the international market.

Orders for the BBC Micro Model A (at £235) and the Model B (at £335) began to be taken in December 1981, but very few computers were delivered for the start of the CLP television programmes in January 1982. At the start of the project, the BBC had anticipated that it would sell 12,000 machines, but it quickly became apparent that, despite the machine only being initially being available via mail order, this was a massive underestimate of the market.

Steve Furber, one of the original team of designers of the BBC Micro at Acorn, knew the machine was going to be a big success when he was due to give a talk at what was then the Institution of Electrical Engineers (IEE) at Savoy Place in London (now the Institute of Engineering and Technology, IET) with fellow Acorn employees, Chris Turner and Sophie Wilson:

> *"The first sense I got that this thing might exceed our wildest dreams was when we were lined up to give a seminar at the (then) IEE Savoy Place in 1982. The main lecture theatre seats several hundred, but three times the capacity turned up. Coach-loads of people had come some distance, for example from Birmingham, to hear about the BBC Micro. A lot had to be sent away to avoid exceeding the safe capacity of the lecture theatre. We were booked to give the seminar two more times (and many other times around the UK and Ireland) just to meet demand."*[29]

The mass appeal of the machine came first and foremost because of the popularity of the various CLP television series. Individual programmes had audiences between 500,000 and 1.2 million late night on BBC One and the CLP reached 16 per cent of the adult population through one programme or another.[30] The BBC Micro - originally developed to support learning through the TV programmes - quickly became a phenomenon beyond the BBC, and was picked up by national newspapers, new computing magazines and software development companies.

David Braben, who wrote the game *Elite* for the BBC Micro and subsequently founded video games studio Frontier Developments, recalls the impact that tabloid newspaper coverage had on reaching a wider audience:

> *"The BBC Micro live television programmes helped broaden the impression. Also, dare I say it, the red tops at the time covered a lot of stories, "Get rich quick!" Which I actually thought were very tacky but I did think they raised the visibility... And so there was a lot of warmth towards it, amongst kids, amongst parents. That rarely happens, but when you get those two things together you get a real whirlwind, which turned into benefit."*[31]

Acorn saw this shift in the public's attitude towards computing as a massive sales opportunity. As Steve Furber remembered, *"We recognised that having the BBC name on our product put us in a different league from the Atom, which didn't. With the Atom we were just some small Cambridge start-up, nobody had heard of, that knocked out interesting little fun machines for hobbyists. But having the BBC badge on this meant we were clearly now playing with the big boys."*[32]

However, it wasn't all plain sailing. Initially, demand for the BBC Micro way outstripped the company's production capabilities. In December 1981, the production of the machine hit serious delays as there was an unexpected snag with one of the components; the video chips from Ferranti which controlled the high-definition screen display, known as ULAs (Uncommitted Logic Arrays),[33] failed when they got warm. Acorn had tested pre-production models of ceramic chips in Andy Hopper's aga, but when the first production run came in plastic cases it became clear that they didn't work as the machine heated up.[34] This wasn't just a small blip that Acorn could get away with - as the machine got warmer, the pixels blurred and the screen completely vanished. As Andy Hopper, now Professor of Computer Technology at University of Cambridge remembers, *"We were either delivering or going bust. The Ferranti salesman was on his knees, "Please, please!!" It was a big deal, this was the production run, not a pre-production model; 35,000 chips, and they weren't working."*[35]

The launch of the project in January 1982, and the start of the television transmissions did nothing to slow down public demand. Broadcasting Support Services (BSS) was soon answering over 2,000 letters a week, and a quarter of a million viewers were watching each TV transmission on Sunday mornings and Monday afternoons, with late-night gaining nearly one million viewers.[36] Acorn started to work through its production problems, with 1,000 machines being produced in January 1982, 2,500 in February and 5,000 in March. But by April, the order backlog still exceeded 20,000.[37]

By then, Acorn had improved its quality control procedures, after sales service and distribution agreements. The company grew fast, with its turnover increasing from less than £1 million in 1979-1980 to over £20 million in 1982.[38]

Acorn had created, through its open networks within Cambridge, a unique culture that allowed the transfer of ideas into and out of the company. Many individuals were loosely associated with Acorn well before they became employees. Steve Furber, who was a major part of the initial design team, originally became involved in Acorn when he was research student at the university. It was at least six months between the contract being signed for the BBC Micro and his formal employment by the company full-time.[39] Similarly, John Biggs, who worked at Acorn later during his university summer holidays and subsequently joined the semiconductor spin-out company ARM, recalled, *"I asked Acorn's Technical Director, John Horton, for a 'proper job'. His response was that he thought I already worked there – so yes!"*[40]

As the company grew, an 'open house' culture for sharing ideas developed. Management actively facilitated it, offering buns on a Friday afternoon at four o'clock, and attracting half of Cambridge Computer Lab in the process.[41] This culture, where people were at ease and accepting of one another, was one of the many things that attracted people to the company. As David Bell, Project Manager of the BBC Micro at Acorn, recalled, *"My arrival at Acorn from my previous jobs at two corporate companies was a culture shock. Here was a highly intelligent and diverse group of people, full of ideas, working hard as a team for a queue of customers but having fun at the same time! The result was the successful Acorn we knew for many years."*[42]

4.1 Who bought the BBC Micro?

It is difficult to tell exactly how many machines were sold and where they went, partly because records from Acorn and the distributors, BL Marketing and Vector Marketing, no longer exist, and partly because the machines were initially bought via mail order. This often meant that one person put in an order for multiple machines used in different places (at home, at school etc.).

Frequent references to sales figures in documents at the BBC's Written Archives Centre do give us an indication, however, of how many were sold:

- By May 1982, 13,385 had been sold.[43]

- By 3 October 1983, 160,000 BBC Micros had been sold in the UK.[44]

- By 28 November 1983, 200,000 Micros had been despatched.[45]

- In a subsequent interview, John Radcliffe recalled that the BBC had sold 250,000 Micros by 1984.[46]

- Finally, in January 1986, the BBC was arranging a celebration of the 500,000[th] Micro sold.

It is also unclear exactly how much profit the BBC made out of the sale of machines and other items relating to the CLP. In 1983, a document of the future BBC policy to be taken with regard to hardware and software estimated that:

"BBC profit on the sale of the machines amounts to £2.5 million at present. Worldwide sales of the two television series are expected to generate a further £200,000 by the end of 1983. Sales of books and software in the financial year ending March 1982 have produced a profit of £250,000 for BBC Publications."[47]

Sales continued well beyond 1983, with another 400,000 units selling in the next three years, so profits on the machines alone must have exceeded £6 million. Additional sales of software, books and television programmes, would have added to the profit for the BBC.

John Harrison, Deputy Sales Director for BBC Micro at BBC Enterprises, recounted his surprise at such a significant financial achievement: *"I do remember a cheque for over £1 million. It was the only time I had ever seen such a large cheque."*[48]

This unprecedented level of commercial success began to make things extremely fraught at the BBC. It was uncharted waters for the Corporation, as others questioned whether it should be making such large profits by aligning a commercial technological product so closely with the BBC brand.

Section 3 of this report has shown that although the BBC Micro is now perceived to have been the educational machine in the 1980s personal computer marketplace, it was initially targeted at the home-user and not at schools. In 1982, the main user of the machine tended to be middle-class men, who were under 45, and had some previous experience of using computers.[49] Ninety per cent of the main users of the computer were the person who had purchased it, with a minority (17 per cent) saying that others had also used the machine. When talking about who else used their BBC Micro, 41 per cent had mentioned their children.

Schools became a market for the BBC Micro when the Department of Trade and Industry launched the Micros in Schools scheme.[50] By October 1983, demand from schools had increased, with 25

per cent of the total sales coming from education, 35 per cent from home users, and 40 per cent from business users.[51] In 1985, a BBC paper entitled 'Micro Futures, Softwares and Delivery Systems' showed that the machine had become the standard computer in schools, with 80 per cent having adopted the more expensive Model B.[52] By 1986, a later version of the BBC Micro, the Master Compact, was marketed as being used in 82 per cent of primary schools and 92 per cent of secondary schools.[53]

The machine was also reputed to have sold well into universities. Although there are no historical data to confirm this, Christopher Curry, one of the founders of Acorn, recalled that Acorn's first and best customer was the Royal School of Mines, consisting of the departments of Earth Science, Engineering and Materials at Imperial College London.[54]

4.2 Sales overseas

The BBC and Acorn were both very keen to break into international markets; the BBC through sales of their television programme, and Acorn through sales of the BBC Micro.

In 1983, the American PBS (Public Broadcasting Service) network broadcast *The Computer Programme* series. In a similar vein to the UK CLP, the BBC had created a supporting telecourse that was offered through the PBS Adult Learning Service. It was designed to support the delivery of courses through educational institutions and take the learner beyond the television programmes.[55] Although the programmes were well received, they were competing in a much harder marketplace, with far more channels available to viewers than the three available in the UK. In addition, the BBC quickly found that, unlike the supporting liaison network in the UK, it did not have strong educational networks in the US.

Sales of the Micro were also poor in the USA, mainly due to an established and entrenched local supplier, namely Apple.[56] A BBC memo written in 1984 shows the slow progress:

> *USA No real use from Acorn…. Acorn still have to get machines into Computerland, the biggest chainstore group.*[57]

The BBC was concerned that Acorn had concentrated too heavily on promoting the BBC Micro as a machine for schools, and had neglected the more general home computer market.[58]

For Acorn, trying to break into the US consumer market by producing a US-specified version of the BBC Micro with US video timing and 'Americanised' BBC BASIC,[59] and setting up its own sales channels in the US, proved to be a hugely expensive, and near fatal, mistake.[60]

As well as broadcasting the television series through the PBS network in the United States, BBC Enterprises secured distribution deals in Australia and New Zealand, and in many other countries in Asia and Europe, with some accompanying sales of books and computer software.[61] Members of the BBC project team travelled all over the globe in order to promote the different components of the CLP, at conferences in North America, in Western Europe, in South East Asia, and in Latin America. Whilst it is clear that there was a great deal of interest in programmes, hardware and software, the sales of the machines varied wildly across countries.

Records for the exact figures of overseas sales have not survived, but based on a collection of sources, BBC Written Archives Centre gives an indication of the numbers and destination of BBC Micro sales between 1983-1985. These figures show high sales in Australia, South Africa and Holland. But in spite of the involvement of the British Council and the Department of Trade

and Industry in the promotion of the BBC Micro overseas, it experienced limited international success overall. This geographical pattern was due in part to a decision that marketing the BBC Micro would start in Australia[62] and South Africa, with distribution through a network of approved retailers and directly to large educational users.[63] The high sales volumes in Holland reflected the push in education and schools, as well as in the home.

It is likely that the BBC and Acorn took advantage of existing industrial networks through old colonial connections, but sales in other ex-colonial destinations such as India and New Zealand remained much lower than would have been expected. Exports to India seem to have been particularly complicated. A report in 1984 noted that, "The reports in the media concerning Acorn's chances of landing a huge contract with the Indian government were perhaps rather exaggerated and premature. The whole matter is rather political."[64] A letter from John Radcliffe recorded 'bureaucratic reasons' for the rescinding of 2,000 BBC machines.[65]

As well as employing a system of pre-existing BBC and Acorn local distributors, other agencies were involved in the promotion of the BBC Micro overseas. Chief among these was the British Council, making introductions for BBC staff, receiving donations to British Council Libraries[66] and establishing its own computer literacy classes.[67] The British Council was heavily involved in the Asian markets of Singapore and Malaysia.

The Department of Trade and Industry was also directly involved in the promotion of the BBC Micro abroad. The BBC approached it directly, following a positive reaction from Margaret Thatcher, the then Prime Minister.[68] It requested that the government increase its support for the BBC Micro, and David Allen, Project Editor, invited the Prime Minister to use her forthcoming visit to the Far East to promote the machine and the CLP further.[69]

As Minister for Information Technology in the early 1980s, Kenneth Baker was also an enthusiastic advocate for the project, appearing at launch events to promote the machine (Figure 2).

Figure 2: Kenneth Baker, Patrick Jenkin, and other Department of Trade and Industry ministers, promoting the use of BBC Micros

Credit: David Allen

But, despite senior government support, by 1984 the BBC team was beginning to feel despondent over the machine's lack of overseas success:

"Acorn's efforts to sell the BBC system overseas have so far been little short of a fiasco. It has been the old story of launching before an adequate infrastructure has been in place, coupled with underestimating the amount of effort required to produce the appropriate version to suit the market. Total sales overseas so far are little more than 3 per cent of UK sales. A point in favour of the new machine is that Acorn are designing it to meet foreign regulations which are, in general, more stringent than those which apply in the UK."[70]

In October 1985, David Bell passed on these sales figures for 1984-1985 during a meeting to discuss progress of the BBC Micro system:

Acorn Limited:	135,269
Acorn International:	9,978
Acorn Corporation (USA):	1,418
Acorn Far East:	5,173
Vector Marketing:	438

Some believe that this lack of international sales, particularly in America, was responsible for Acorn's demise. Both the company's extremely costly attempts to break into the US, and ambitious sales targets for their new machine, the Electron, just when the home computer market collapsed, meant that Acorn was massively financially overstretched. By February 1985, Olivetti took a 49 per cent stake in Acorn for £12 million.

Olivetti had little idea that it had just taken a major stake in a company with a small R&D project to develop a new type of processor, the Acorn RISC Machine (ARM). The technological legacy of Acorn is explored in Section 6.2 of this report.

Lessons from the Computer Literacy Project

The success of the CLP television programmes, together with press attention, heightened the public's interest in computing, and turned the BBC Micro into a commercial hit in the UK. The lack of strong international networks, and higher levels of competition limited the uptake of CLP (and Micro sales) overseas, however.

Acorn's open culture created strong social and technical networks that reached far beyond the company.

Support at government level, and acknowledgement of the computer as a British product with state support, played an important role in legitimising the project more broadly, although ultimately didn't lead to significant international sales.

Despite an aim to break into international markets with the CLP and supporting package, the BBC didn't have strong networks beyond the UK at that time.

5. FROM COMPUTER LITERACY TO EDUCATION IN THE 1980s

The BBC Micro was aimed at the education of adults and the general user, introducing computer literacy into the home environment. Due to the range of supporting materials, and the interest of the Department of Education and Science, it was quickly adopted as a standard in schools and in adult and continuing education, prompting a significant increase in the range and number of computing opportunities available.

It is a general misconception that the BBC Micro was aimed to be the educational machine. The CLP was targeted at a wide audience, particularly adults who did not have any previous experience of computers. As Richard Millwood, formerly of the the Computers in the Curriculum project at Chelsea College, University of London, which was sponsored by the Microelectronics Education Programme (MEP) puts it: *"They avoided young people – tried to encourage older people. Didn't want to scare people off with all the young geeks!"*

The BBC Micro was therefore aimed at the home market, as a companion to the television programmes and giving people a 'standard' model on which to learn.[71]

This section looks at how computer literacy was promoted for adults and in schools.

5.1 Before the Computer Literacy Project

Before the 1980s, the public's interaction with computers had generally been restricted to specialist environments such as university departments or research workplaces. The vast cost of mainframes and minicomputers meant that access was limited. Some respondents to our survey remember their limited access to such expensive machines, usually through an educational establishment or workplace:

> *"A £2 million mainframe fed by two smaller £1 million mainframes - owned by the British Coal Board. We did two hours processing a month and it cost the earth!"*
> Ken, Respondent 1744468337

> *"The very first programs (at 6th Form) were written on punch cards and sent away overnight to some mainframe - to be followed the next day by a pantechnican carrying forests of green lined paper which at the bottom had some remark like: EXECUTION FAILURE LINE 35."*
> **Richard, Respondent 1750763351**

Computing education in this period reflected this inaccessibility, being mainly offered in university maths and science departments. But during the late 1970s, interest began to spread. The Department of Education and Science (DES) and the Manpower Services Commission (MSC) began to take an interest in future training needs for the country, and they contributed time and money towards researching the BBC series *Silicon Factor*.

The beginnings of this new interest in computing teaching and learning are also visible in Floodlight magazine,[72] the Inner London Education Authority guide to part-time day and evening courses. Between 1978-1979, among the programming, career specific and research courses, we find eight colleges offering 'Computers for layman (introductory courses)'.

Government initiatives were also underway. In the 1980s, the MEP was set up. Designed to oversee local computer literacy initiatives, its stated aim was: *To help schools to prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive.*[73] Computers, such as the Research Machines 380Z, were being provided free to secondary schools through the MEP as early as 1981, where they were generally used to teach programming.[74]

The MEP consisted of a small national directorate and 14 regional centres: between them, it co-ordinated small initiatives with colleges and schools through Local Education Authorities. Much has already been written on the successes and failures of the MEP, so this report is only concerned with how the MEP worked alongside the CLP and the distribution of the BBC Micro.

5.2 Adult computer literacy

There were two main organisations that the BBC worked with to develop adult computer literacy: the Broadcasting Support Services (BSS) and the National Extension College (NEC).

i. Broadcasting Support Services (BSS)
The BSS acted as a co-ordinating body providing access to the CLP in multiple ways, so that viewers could follow up their interest in computing at whatever level they wished.

The BBC expected the television programmes to generate a huge interest, so it formed an agreement with the BSS (which was financially supported by the NEC, Acorn Computers and the Department of Trade and Industry). Interested organisations were asked to register; 800 agencies, including adult centres, universities and computer clubs registered within a month, with the final total being over 1,000. The BSS also enrolled other organisations to ensure other groups were empowered to get behind the project:

- The British Computer Society

- The Amateur Computer Club

- The National Computing Centre and its Microsystems Centre

- The Department of Trade and Industry Microprocessor Applications Project

- Construction Industry Computing Association

- Building Services Research and Information Association

- Distributive Industry Training Board

- Group for Technology and Disability[75]

The BSS hosted a helpline called the Computer Referral Service. The service was set up in 1981 as a central point for people seeking information about computers and computing. It was designed to meet various demands, with information on:

- Introductory computing courses, both general and in support of the BBC series or the NEC's '30 hour BASIC' course (see below for more information on the NEC).

- Informal advice, for those not yet ready to attend a course, referring them to individuals and workshops in their local area.

- Clubs and user groups. These catered for all levels of expertise and included specialist interest groups.

- Business support. Giving details of colleges running courses to support businesses and providing impartial consultancy.[76]

The referral information data were held on a computer for quick response to the large volume of enquiries and tailored to the enquirer's geographical location.

By November 1982, the Referral Service had received 120,000 enquiries. Over 8,000 were solely concerned with information and advice about local clubs and courses.[77]

ii. National Extension College (NEC) and 30 Hour BASIC

As well as the BSS and the Computer Referral Service, the BBC also worked closely with the NEC,[78] with the aim of developing an adult distance-learning course.

In 1979, the NEC produced a book for the BBC educational series *The Silicon Factor* which, much to its surprise, generated a high level of interest and sold 3,000 copies.[79]

On the back of this success, the NEC developed introductory computing courses, both in support of the BBC series and the '30 Hour BASIC' book. The book, and the course it accompanied, were publicised by the BSS. The NEC also developed flex-study arrangements through which students could visit local colleges to access machines.

30 Hour BASIC book and course

The 30 Hour BASIC course and book provided a simple introductory guide to programming with BBC BASIC. It had an important impact on adult computing education, as the numbers of people who registered for the course directly with the NEC rapidly increased as the CLP developed:

1981	714 students
1982	2,740 students
1983	1,500 students[80]

While these figures on their own are not particularly impressive, the course was used as a basis for individual computer literacy classes at over 200 other colleges, enrolling thousands of students.

Richard Freeman, former Director of NEC, recalled some qualities of the participants:

"There was one aspect of the participation that I mentioned in the Annual Report: this course brought, for the first time, a demand from employers for group enrolments with one tutor looking after a block of students on one work site… What was, of course distinctive about the people whom we attracted was that none of them had any experience of computers. We knew that this would be the case (as did the BBC in planning their programmes) so we designed the course to be as non-threatening as possible to the adult students."[81]

Sales of the '30 Hour BASIC' book provide a more accurate picture of the impact of the course. Between 150,000 - 250,000 copies of the book were sold across the whole period;[82] the NEC sold 100,000 copies in the first nine months of 1982[83] and 120,000 by the summer of 1983.[84]

Tracking adult computer literacy courses
Data from the Universities Statistical Record (USR) obtained through the Economic and Social Data Service, provides insight into the national picture for formal computer education.[85] Figure 3 details the number of Computer Studies-related A Levels taken by undergraduates between 1978 and 1984. The chart shows that between 1979-1984 the number of computer A Levels taken by university undergraduates increased significantly.

Figure 3: Computer studies-related A Levels taken by undergraduates between 1978 and 1984

Percentage of total A Levels that were computer-related
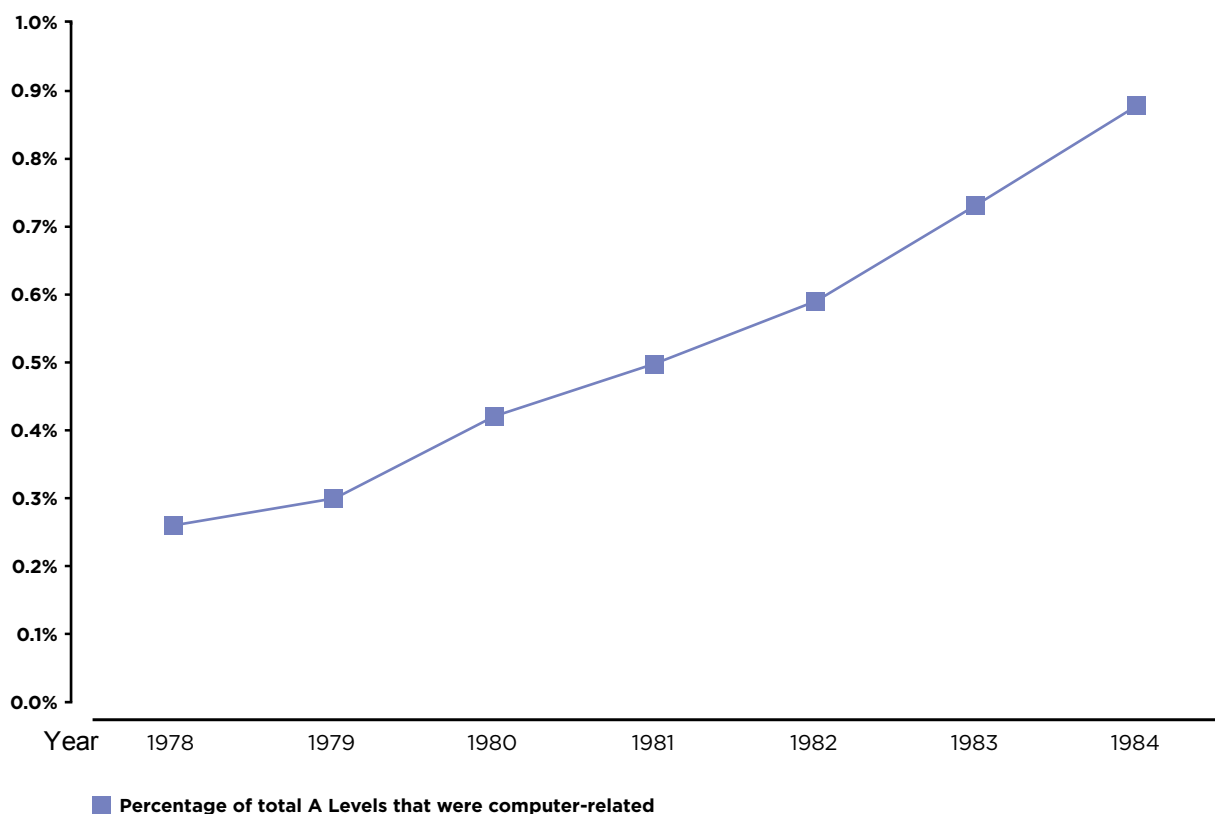
This chart clearly illustrates that the pipeline of skilled talent going into universities was increasing, whereas now there are serious concerns that it is dramatically decreasing. Recent figures from the Department for Business Innovation and Skills[86] show for example, that over the last decade there

was a 23.3 per cent drop in the number of students studying Computer Science at undergraduate level and a 33.8 per cent drop in the number of students entering at graduate level.

However, these data only provide a general picture of A Level study at the time; not training likely to be demanded by the wider segments of the population targeted by the CLP. Neither does it show any direct link between the CLP and growth in enrolment for computing-related A Levels.

By contrast, Floodlight magazine provides a much more detailed account of the kinds of courses available – such as the 30 Hour BASIC course - with the limitation of only covering one geographical area, London.

Figure 4: Total number of computer courses listed in Floodlight magazine, 1978-1985

Total computer courses
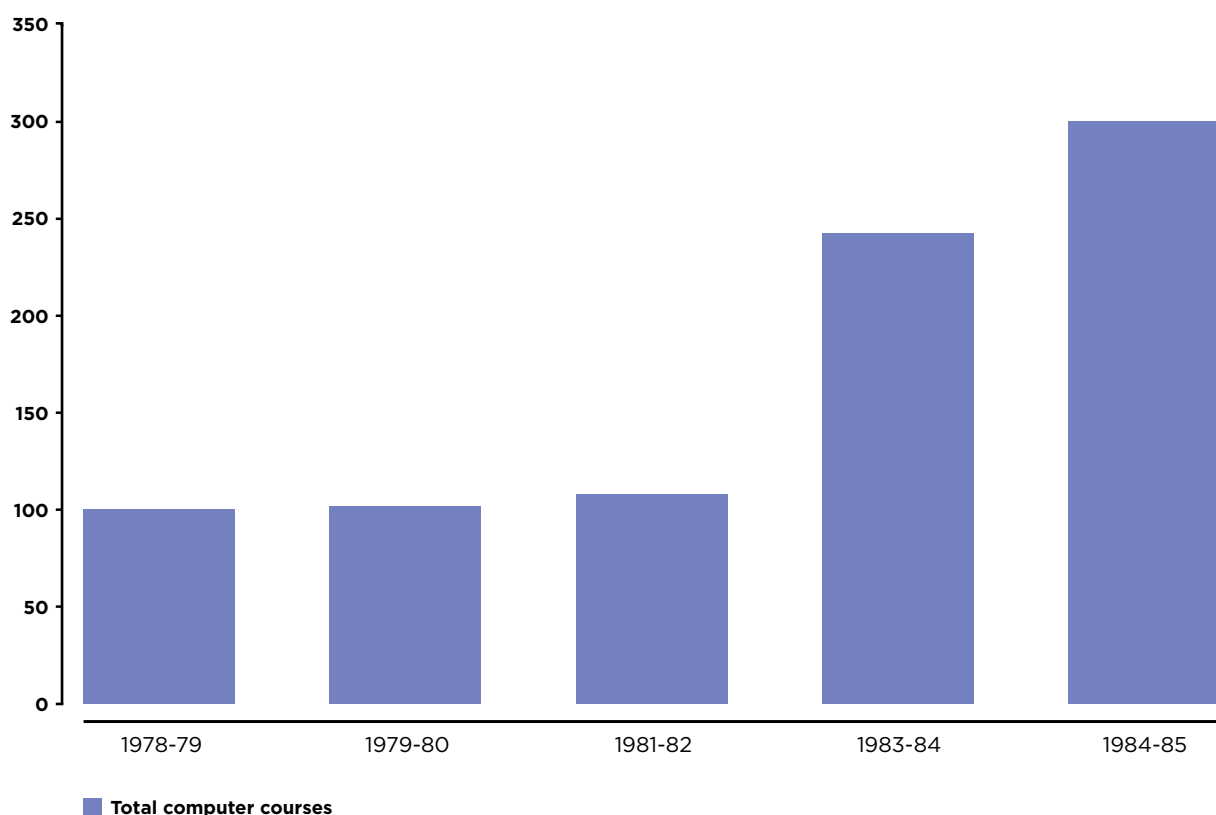
Figure 4 illustrates the increase in the kind of training the CLP was trying to stimulate. The number of courses remained fairly stable between 1978 and 1982, gradually increasing from 100 to 106. In the period 1983-1984, however, the numbers jumped to 241, and then 299 between 1984 and 1985. The leap in the number of courses seems to have been linked to the start of the CLP in January 1982, allowing time for viewing figures to build up, and the print runs of Floodlight magazine. These courses covered a range of specialisms within computer studies, with subjects ranging from GCE O Level Computer Science to ALGOL, COBOL and BASIC programming languages, to specialist courses for accountants, engineers, 'laymen' and teachers.

As well as increasing in number, the diversity of courses offered appeared to rise too. So, by 1985, the category 'Computer' had been split into computer and microcomputer, acknowledging the increasing presence of the microcomputer within society, and the specialist skills that this technology required. Of particular interest to us are the introductory courses, or those aimed at laypeople, as it was those with no experience of computers who the CLP was keenest to reach.

Figure 5: Total number of courses for laypeople and introductory Computer Courses, 1978-1985

■ Number of courses for laypeople and Introductory Computer Courses
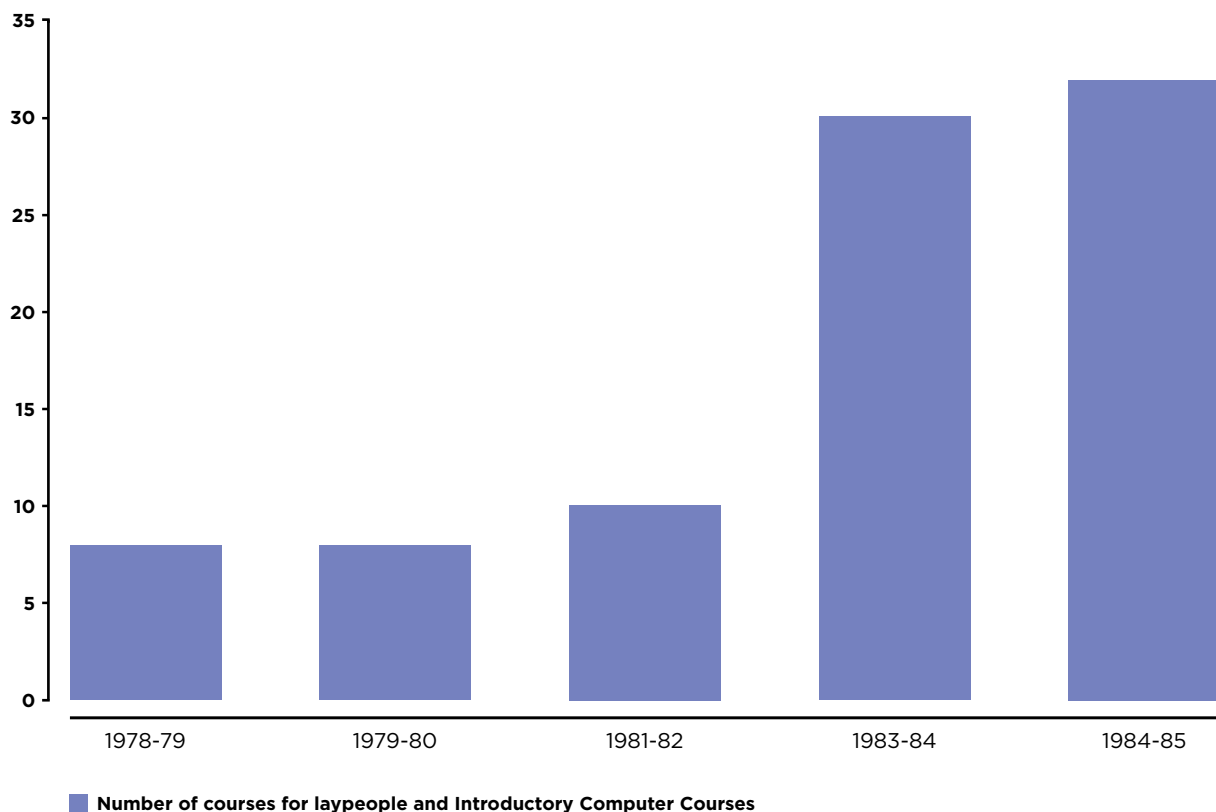
Figure 5 shows a three-fold increase in the number of courses aimed at non-experts between 1981-82 and 1983-84, following the release of the BBC Micro and CLP-related TV programmes. Noticeably, in the 1983-84 Floodlight volume, the category of these courses changed from 'Computers for layman (introductory courses)' to 'Computers for layman (introductory courses including BBC linked)'. Subsequently, a separate category, 'BBC Computer Course', appeared in the 1983-84 volume. The Floodlight data support the view that the CLP created strong demand for computing courses, particularly amongst those less experienced segments of the public that the BBC had chosen to target.

5.3 Micros in schools

As early as 1978, the Council for Educational Technology had began to stress the importance of teaching computing in schools.[87] Government departments, such as the DES and the DTI under Kenneth Baker, had looked at the desirability of computer-related learning and the promotion of new technology in schools as one strategy to tackle the economic recession.

By 1981, the DTI had set up the MEP. Headed by Richard Fothergill, it allocated £1.2 million in its first year and agreed a new strategy.[88] At the same time as this strategy appeared, the DTI announced a new Micros in Schools programme for secondary schools. This part funded a computer for each school, with the aim of invigorating British industry as well as education. A school taking part in the scheme could purchase a Research Machines 380Z (which had become a Local Education Authority (LEA) *de facto* standard) or a BBC Micro Model A or B. Some criticised the scheme for only supporting the cost of the computer equipment, but not acknowledging the true cost of maintenance, software and staff training.[89]

In October 1982, the scheme was extended to primary schools, with the opportunity to have the cost of the Research Machines 480Z, BBC Micro or a Sinclair Spectrum subsidised. In return, schools were expected to allow their teachers to attend a LEA in-service training programme.[90] Promoting and administering this was the responsibility of individual LEAs. However, this resulted in sporadic adoption of computers in schools, as Roger Broadie (formerly of the MEP) observed:

> *"Pressure from LEAs will have prised a teacher out of each school but quality of the training will have been all over the place as the LEAs had widely different capacities, varying from no one who knew what a computer was (therefore delegated to maths or science adviser) to the odd LEA that had someone with some insight."*[91]

The delivery of computer literacy in schools depended on the interest and enthusiasm of individual LEAs. While LEAs could not refuse to get involved, there was huge variation on who was sent on these courses and how much the courses were promoted. As Broadie says, "Some schools took it seriously and sent the right people, some just sent anybody, often very junior staff." Often efforts on the part of the MEP to contact schools directly were frustrated by LEA gatekeepers who did not know what to make of this new technology.

The degree of variation between LEAs, schools and even teachers, as well as the extent to which computing teaching depended on individual enthusiasm, impacted on the way computing was taught in the classroom. This mixed experience of computers in schools is consistent with the responses to our questionnaire (Section 6.1). It highlights the importance of a comprehensive, structured support system and Continuing Professional Development (CPD) for teachers in the delivery of classroom computer literacy.

Specific projects utilising the BBC Micro and its successive versions such as the BBC Master were developed for schools, including the BBC Domesday project, a unique crowdsourcing project, where 9,000 school children contributed information about their local area to be stored and accessed via a Laserdisc. This is discussed further in Section 6.3.

Lessons from the Computer Literacy Project

The CLP was initially aimed largely at adults, new to computers, and continuing education, not at schools.

The BBC Education department harnessed its external partnerships to reach the broadest range of people with various levels of skill. The level of response to the BSS, and the increase in the computing courses on offer (particularly in the 'computer literacy for laymen' category), supports the view that the BBC had a significant impact on its desired market.

The wide-reaching literacy programme and an open machine stimulated a massive increase in the supply and diversity of education and training opportunities by course providers not directly associated with the CLP.

Alongside Research Machines computers, the BBC Micro came to be used in a large number of primary and secondary schools. Teacher training to support the machines wasn't administrated consistently, however, leading to variable rates of adoption by schools.

6. THE LEGACY OF THE COMPUTER LITERACY PROJECT

Having described the history of the CLP, this section describes its legacy for individuals, technology, industry, and the BBC itself, drawing on the online survey exercise specifically conducted for this report.

6.1 The legacy for individuals

The BBC Micro was part of a landscape of cheap personal computers, such as the Sinclair, Commodore and Apple machines that played a crucial role in promoting computer literacy. The presence of the BBC Micro in the home, often introduced by parents, stimulated young people's wider engagement with the CLP through computer courses, clubs and magazines. The machine invited exploration and experimentation, and had an important impact on the lives of many of its young users.

The survey opened on 5 March 2012 and closed on 2 April 2012. Three hundred and seventy-two individuals began the questionnaire, and 292 completed it. The results do not reflect the population as a whole, but come from a self-selecting group of individuals who either responded to a direct email or to a more general call for people interested in 1980s computing and research around the BBC Micro. The questionnaire was sent out directly to 150 email respondents, identified as individuals who worked in digital or creative industries and were likely to have generated high economic value as innovators and entrepreneurs.

Who responded to the questionnaire?
The respondents to the questionnaire came from a range of different types of company: with the greatest numbers identifying software development (57.7 per cent), digital media/web agency (28.5 per cent), mobile/app development (24.1 per cent) and education (32.4 per cent). A smaller, but significant, number identified design (15 per cent), marketing/communications (13.8 per cent), publishing (8.7 per cent), computer and video games (8.3 per cent) and animation/CGI/VFX (7.9 per cent). (See Figure 6.)

Figure 6: What kind of company do you work for at present? Please select as many as are appropriate
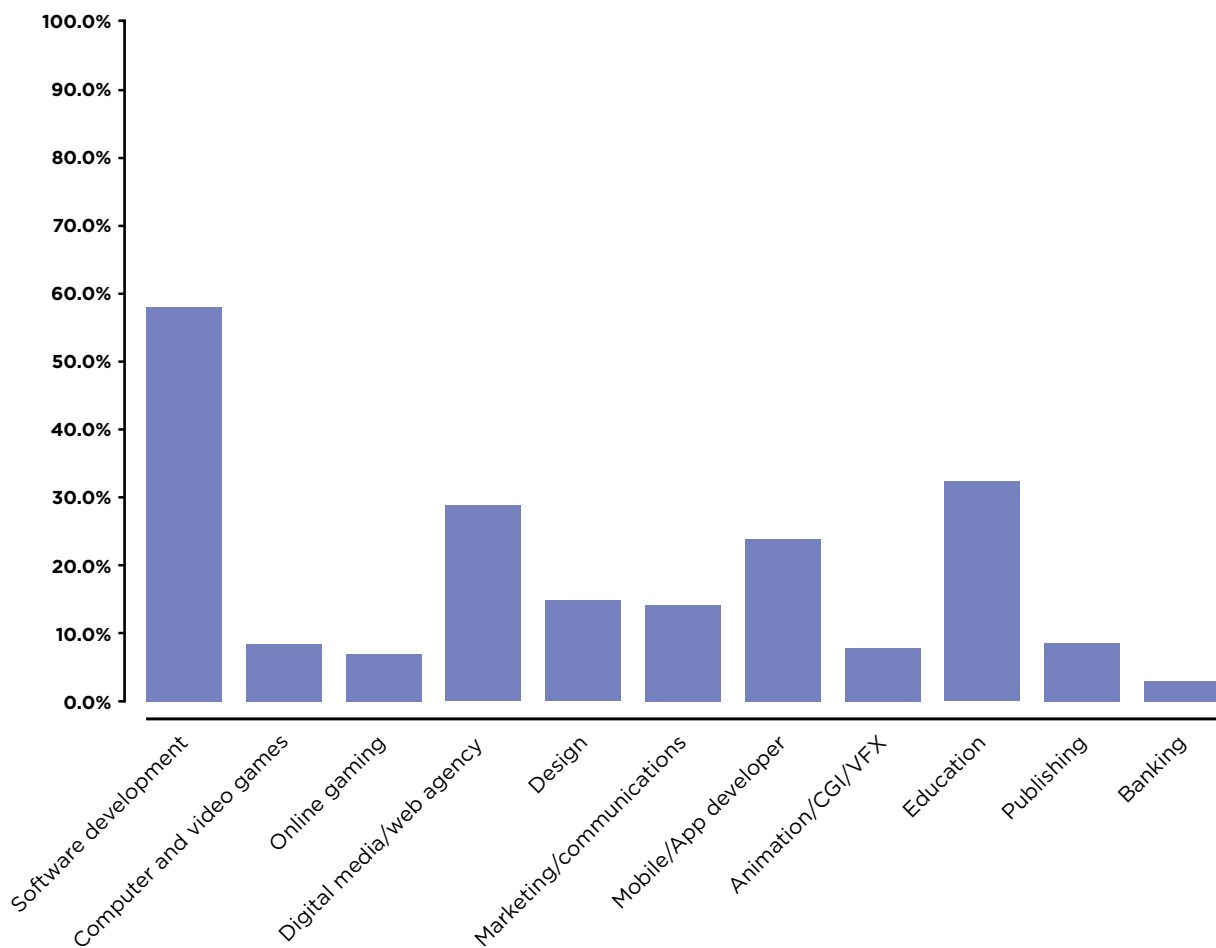
Respondents were split between those working for a small company with less than ten employees (34.4 per cent), and those working for large established companies, such as Nokia, media organisations such as The Guardian and the BBC, or universities, such as Cambridge University. (See Figure 7.)

Figure 7: How many people does this company employ?
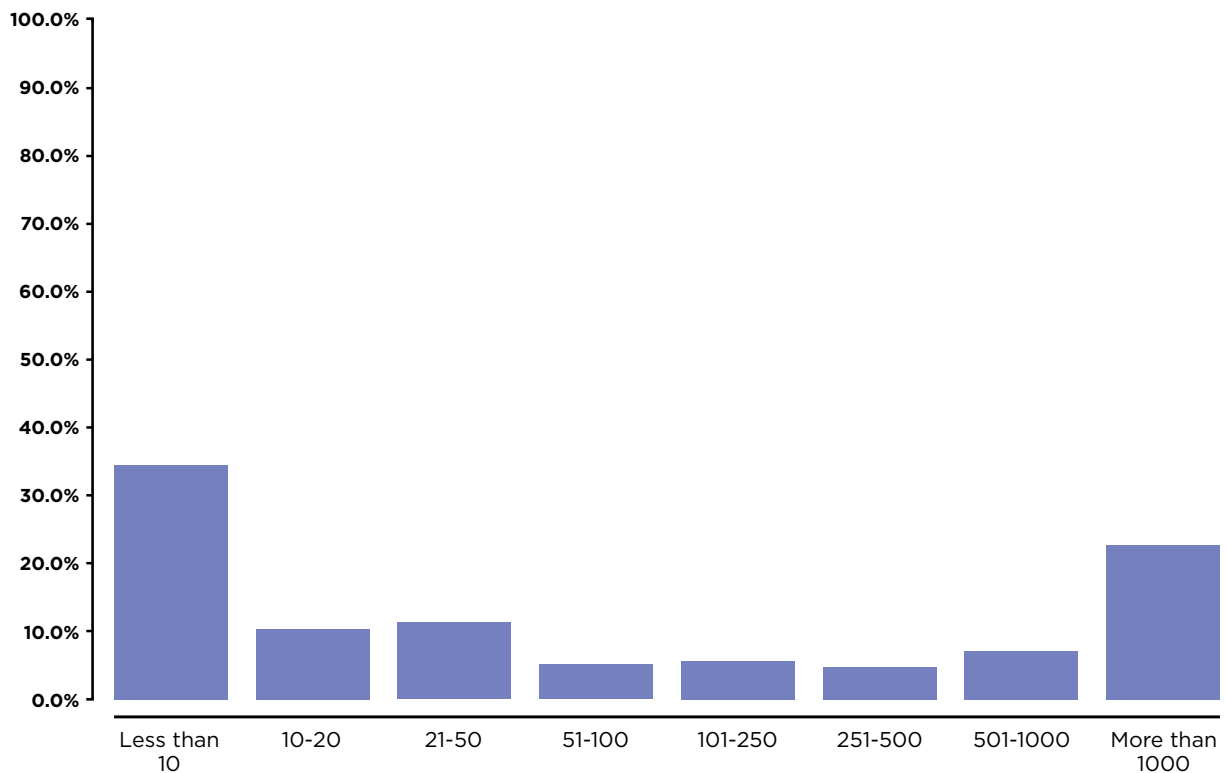
Interestingly, those people who said that they had owned a BBC Micro in the 1980s were slightly more likely to now work in Software development (67 per cent) or be a Mobile/App developer (27.4 per cent), indicating perhaps that ownership of the technology or access to it may have had a positive link to a future career path. They were slightly less likely to work in Digital media/web agency (18.9 per cent), Marketing/communications (8.5 per cent), and had a similar likelihood of working in Education (32.1 per cent), Design (14.2 per cent), and Computer/video games (8.3 per cent). (Figure 8.) However, these percentages are tentative at best as there were only 106 respondents who both answered this question and owned a BBC Micro.

Figure 8: Owned a BBC Micro: What kind of company do you work for at present? (Please select as many as are appropriate)
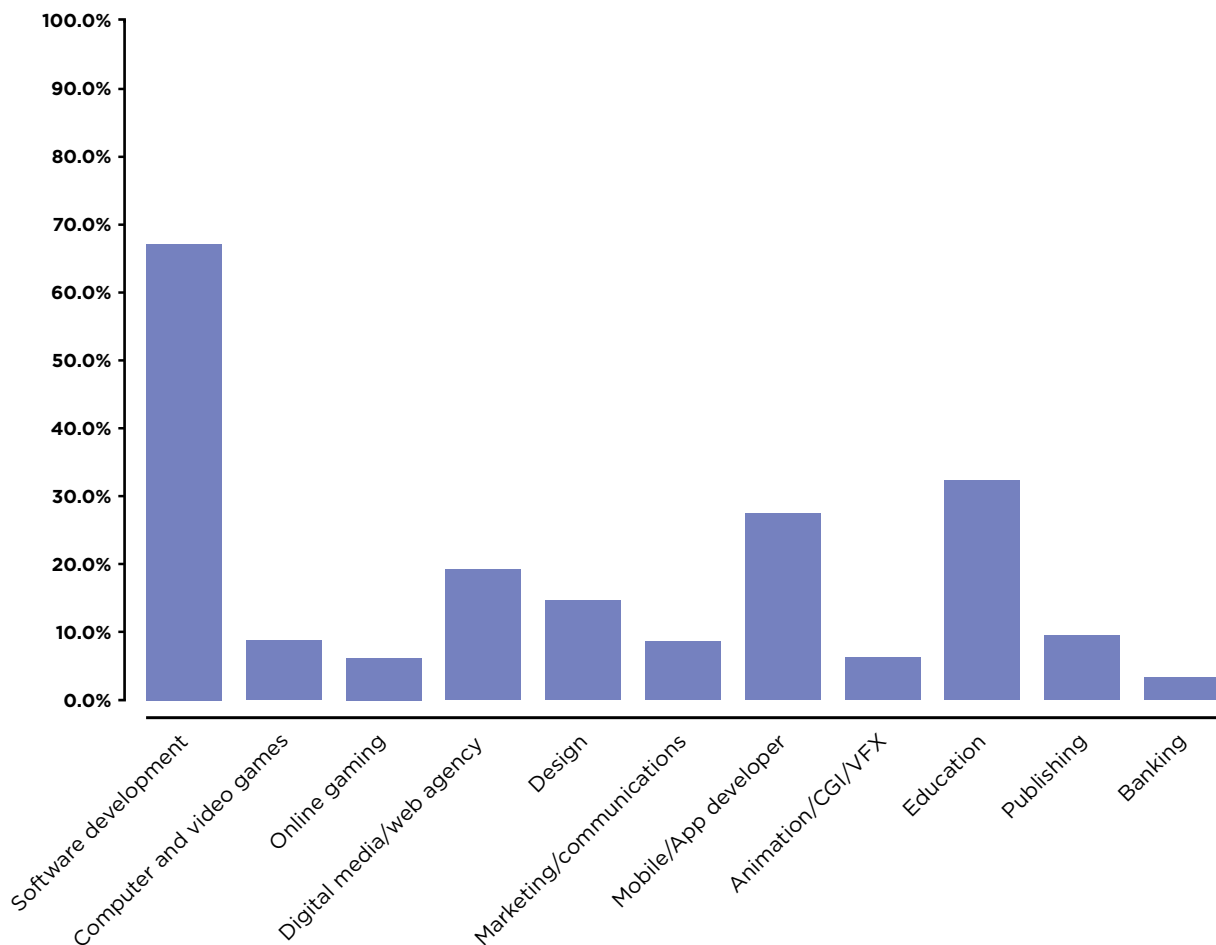
A very high 41.9 per cent of all respondents said that they had been involved in setting up their companies, reflecting the entrepreneurial bias of those who self-selected to complete the survey.

Of those respondents who were involved in founding their current company, a disproportionately high number were now involved in Software development (67.9 per cent), Digital media/web agency (40.4 per cent), Mobile/app developer (33 per cent), whereas significantly fewer were involved in Education (17.4 per cent) than all respondents to the questionnaire. A smaller, but significant number identified Design (23.9 per cent) and Computer/video games (13.8 per cent).

Using your first computer
We asked respondents what made them first take an interest in computers. This question was left as open text to encourage respondents to explain how they became interested in computers. Two-hundred and ninety-four respondents answered this question, and from the range of responses, five common themes emerge:

1. A parent's (usually the father's) enthusiasm. Experiencing a computer within the family home was the most frequent answer to this question.

    "My Dad brought home a Sharp MZ-700 computer from work when I was seven. It was literally the most incredible thing in the world. I became absolutely fascinated by it, and would sit with him as a kid while he entered some of the sample computer programs from the (extensive) manual. With time, and by studying the sample programs, I started to write my own. Initially they were extremely simple affairs: printing a word repeatedly, performing basic arithmetic on request, and so on. I then started implementing concepts I learned in maths at school as computer programs. By the time I was 10/11 I was writing fairly extensive self-contained programs, including some quite elaborate computer games. Over the next three to four years I pursued a course of self-study, teaching myself C, C++ and some Assembler, and continuing to write computer games throughout."
    Greg, Respondent 1752697753

2. An interest in science fiction, which helped them imagine the possibilities that computers offered.

    "Watching Doctor Who, I thought K9 was awesome (I was three going on four when he was first on TV). Then when Doctor Who weekly launched (when I was six going on seven), they published the blueprints to K9. Being six or seven I thought they were complete and proceeded to try and make K9 out of cereal boxes. (Worked on Blue Peter, right?) That got me interested in robots. That got me interested in computers. Our family was poor and so hearing about kids writing and selling a game for a £1,000 back then was amazing too. I wanted a robot though :-)"
    Michael, Respondent 1754838475

3. Novelty. Linked to science fiction, respondents describe being excited and aware that they were looking at the future. Several made references to the BBC television programme *Tomorrow's World*.

    "My Dad bought me a BBC Micro computer when I was about ten - that would have been around 1984. Me and my younger sister used to love to copy lists of code instructions from manuals for hours, until we got the end result of our names flashing in cyan and moving across the screen. The code we'd copy got more complicated, until we were moving objects across the screen! I think it gave me a love of finding out how things work, and how you could change code and control the output. I remember my Dad saying to us that we really should learn, as 'computers were the future'."
    Katherine, Respondent 1744306281

4. A sense of empowerment. It allowed users to take control by getting the technology to do what they wanted and it represented a type of freedom not previously experienced.

    "In 1982 my mum bought a ZX81 with her first paycheque from a part-time job. I was 13 at the time. As soon as she switched it on, I was fascinated. Here was a machine that could do anything and, even more impressive, I could make it do things."
    Dan, Respondent 1744975368

5. Games. Of all the possibilities offered by computers, it was often games that initially excited respondents the most.

    "Both Star Trek and Blake 7 made me interested in science fiction and the art of technology. Games arcades with Space Invaders in 1977 and watching Pong played on Crackerjack intrigued me as to how they actually worked."
    Ian, Respondent 1760350457

We then asked respondents about their first computer – including when and where they used it, what it was and what their experience was like.

Of all respondents, most used their first computer in the 1980s (73.5 per cent), whilst a significant minority had used theirs in the 1970s (18.2 per cent) and 1960s (5 per cent). Most respondents first accessed a computer at home (53.8 per cent) with a number accessing them at school (30.8 per cent), work (6.8 per cent), university (6.5 per cent) and college (2.2 per cent).

First experiences at school tended to mix excitement with the novelty, and frustration with the limited access.

    "The BBC Micro, if you were lucky you got 1/2-1 hour a week to do 'something' with it. Usually that was to play 'Lemonade' or write programs. I, alas, was unlucky, and got maybe two sessions a year :(This would have been 82/83."
    Steven, Respondent 1744346530

Of the types of computers that respondents remember using, two are predominant – BBC machines, and Sinclair (e.g. Spectrum or ZX81). Nearly 18 per cent remembered a BBC machine as being the first they had experienced, and 19 per cent remembered a Sinclair machine. Other popular machines included the Commodore Pet and the Apple II.

Using a BBC Micro
Out of all respondents, 86.6 per cent had used a BBC Micro, with 12.5 per cent saying they had never used one, and 1 per cent saying they couldn't remember (these numbers reinforce the point sample respondents were not representative of the wider population).

Those respondents who reported having used a BBC Micro were then asked about what they used it for. The most popular activities were writing programs (82.4 per cent), playing games (79.6 per cent) and using educational software (56.1 per cent), followed by word processing (38.4 per cent), copying programs (33.3 per cent), using bought software (10.6 per cent) and using the machine for finance (6.7 per cent). (Figure 9.)

Figure 9: What did you use the BBC Micro for? (Please select as many as are appropriate)
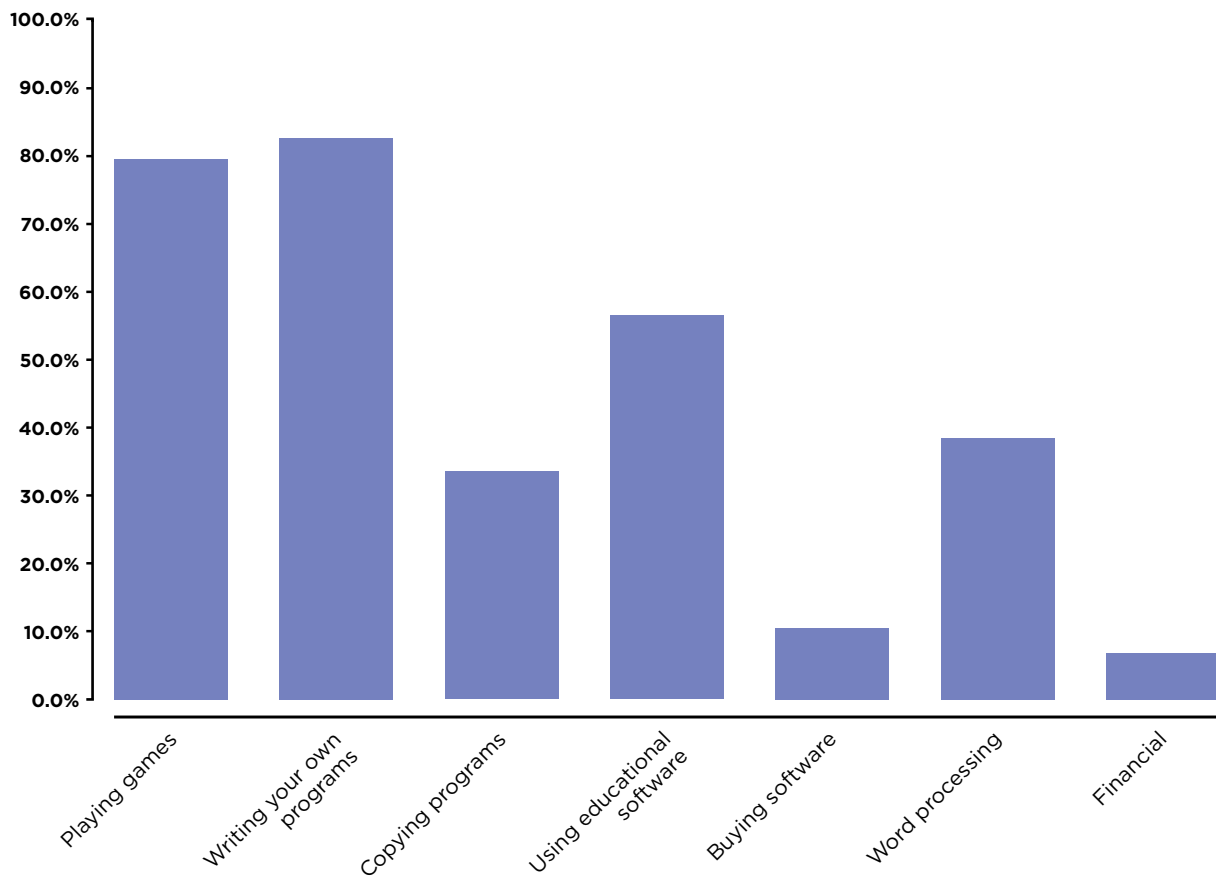
Those respondents who had answered 'yes' to using a BBC Micro were then asked where had they accessed it. The highest number were accessed at school (65.7 per cent), whereas slightly fewer accessed it at home (58.6 per cent) and very few accessed it at work (15.9 per cent). This shows quite a marked contrast to respondent's first computers ever used, for which only 30.8 per cent were accessed at school, but this is not surprising given the BBC Micro's reputation as the school's computer and its higher cost compared with other home computers such as the Sinclair machines. (Figure 10.)

Figure 10: Used a BBC Micro: Where did you access the BBC Micro? (Please select as many as are appropriate)
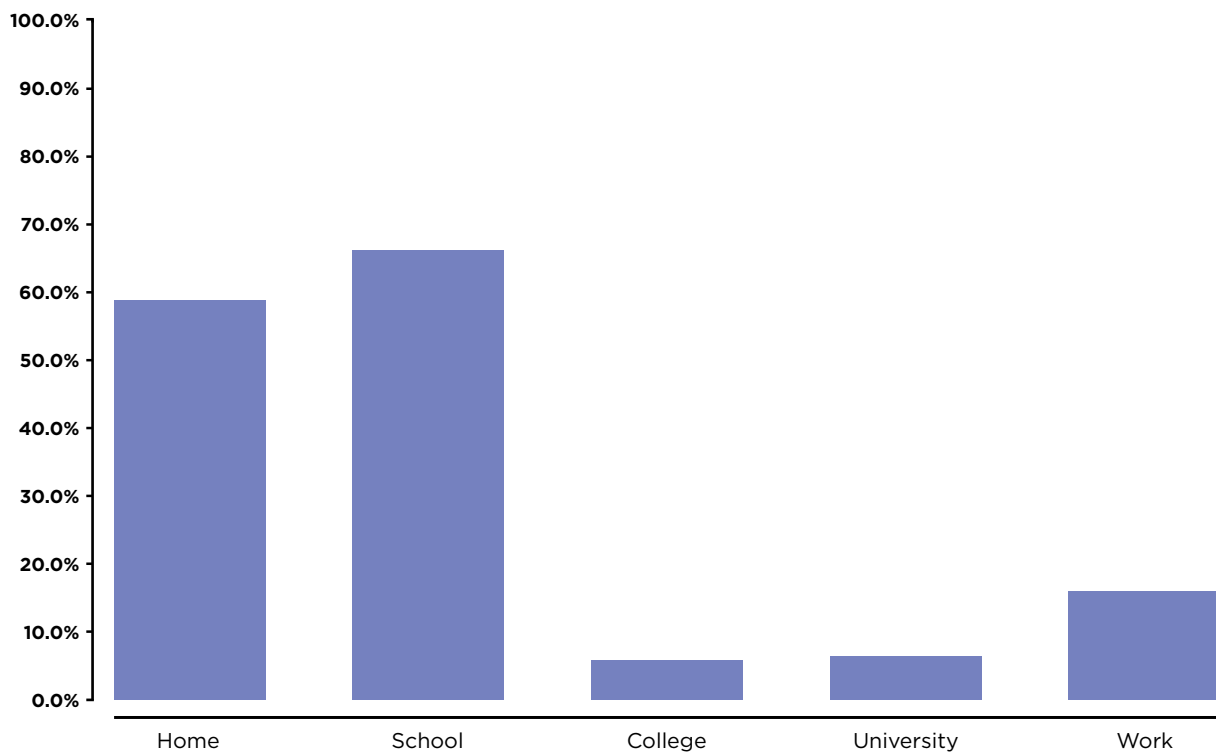
Using other computers in the 1980s

Whereas 84.7 per cent of all respondents had used a computer other than the BBC Micro in the early 1980s, 15.3 per cent had not (Figure 11). The most likely machines to have been accessed were the Sinclair ZX81 and Spectrum, Commodore 64 and the IBM PC. Of those machines not listed, respondents were most likely to specify their use of an Amstrad, Sinclair QL, Research Machines computer or minicomputer.

Figure 11: What computers did you use during the 1980s besides the BBC Micro? (Please select as many as are appropriate)
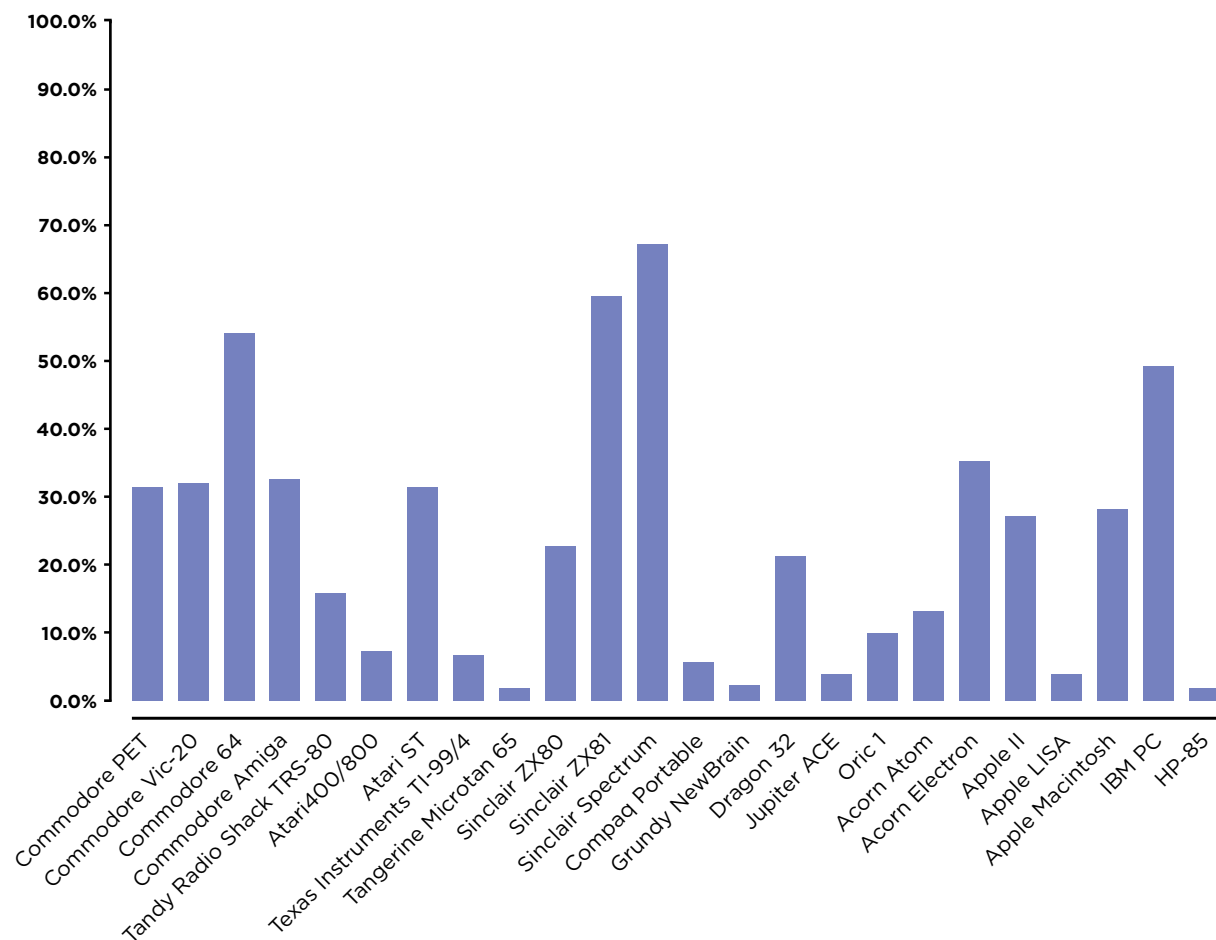
Of all respondents, 83.9 per cent had owned a computer, other than a BBC Micro, during the 1980s. The activities they had used this for were similar to those activities done on a BBC Micro, but a higher proportion wrote their own programs (88.2 per cent), played games (84.9 per cent), copied programs (45.3 per cent), word processed (42.9 per cent), used bought software (15.6 per cent) and used the machine for finance (12.7 per cent). However, a considerably smaller proportion of respondents had used these machines for educational software (28.3 per cent). (Figure 12.) This may have been because there were fewer educational programs available for the other computers.

Figure 12: What did you use the computer(s) that you owned for? (Please select as many as are appropriate)
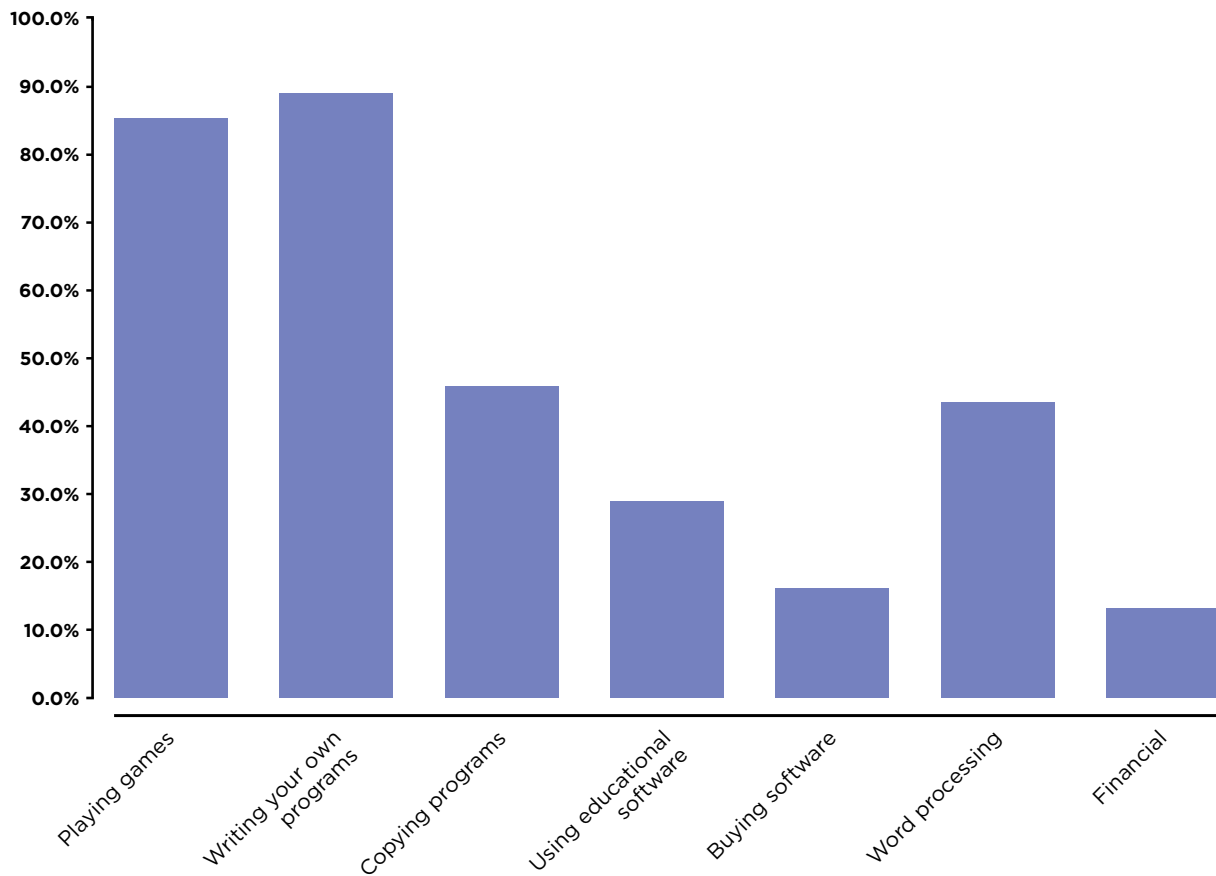
The questionnaire also asked about the type of programming language that people used in the 1980s. Nearly 90 per cent of respondents had learnt how to program, the majority in BASIC, though respondents were quick to remind us that there were various versions of BASIC long before the existence of BBC BASIC. Other types of programming that people listed included machine code, Assembler, Algol, LISP, Prolog, Forth, ADA , SNOBOL, Pascal, and many more. (Figure 13.)

Figure 13: Did you learn to program a computer during the 1980s and if so which language did you use? (Please select as many as are appropriate)
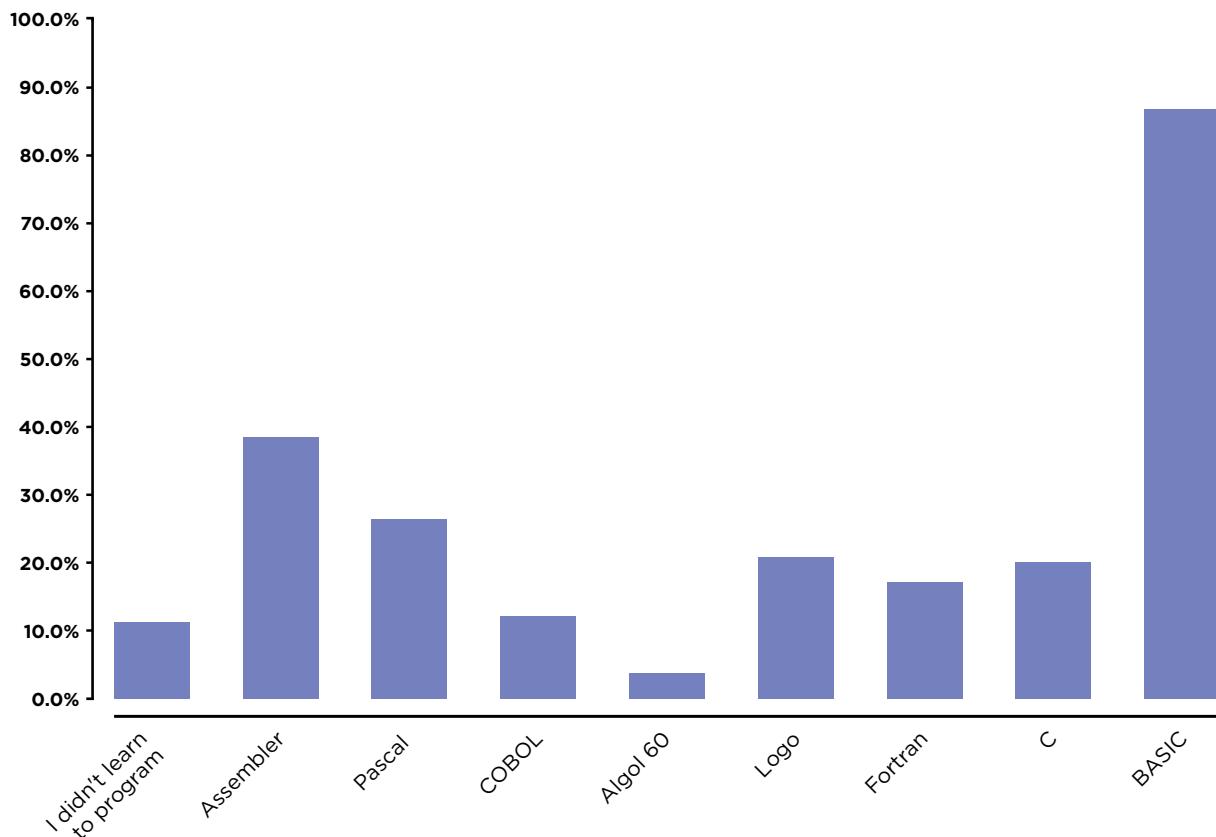
We also asked respondents about the programming experience they had gained during this period. This was an open text question which 249 respondent answered.

A significant number of respondents were self-taught, relying mainly on magazines and instruction books. These resources were used whether they were learning at home or at school. When it was with other people, these tended to be friends, a parent or other close family member.

> "I pretty much taught myself. Computer magazines at the time included programmes which you had to type in so I did some and learned a) how to type and b) some basic (sic) bits of programming. It wasn't so much that I learned how to make something up from scratch but that it impressed on me the shape of programmes: that you needed to construct little subroutines for all the alternatives and knit everything together and that the only way to do this was to have a clear sense of the structure, the overall shape if you like."
> **Mike, 1756523691**

Some respondents had learned to program in schools and particularly in universities. Despite this, a large amount of the experience they had gained had still been self-taught, for instance they had sometimes learned a different type of programming at home than at school.

"Self-taught at home and school. At home I was using the ZX Spectrum and then a Commodore 64. I read magazines, borrowed books from libraries, typed in code listings, kicked out power supplies and lost all my work, and learned about backups. I managed to persuade the town library to buy a Fortran programming book that came with a Fortran compiler for the C64 on cassette tape. I borrowed the heck out of that book. At school every available spare minute was spent on the BBCs in the Computer Room. Playing Football Manager, downloading code being transmitted via teletext, typing in programs, learning how to draw lines on the screen in different display modes, watching in silence as Elite loaded and the spinning wireframe Cobra(?) appeared on the screen."
Andrew, Respondent 1750881563

Respondents had had mixed experiences of programming at school. Some remember that there had never being enough computers, while others saw teachers as too protective of what was an expensive classroom asset. There were also cases where respondents felt they had known more about computers/programming than had teachers.

"I learnt at home and mainly from copying games out of magazines we would buy from the newsagents. I think my dad bought me the occasional programming book too. I didn't learn anything about programming computers at school - in fact I knew more than my teachers."
Stef, Respondent 1755262610

Awareness of the BBC's Computer Literacy Project

Of all respondents, nearly a third were unaware of the CLP (31.2 per cent) in the early 1980s. Nearly half of respondents had a BBC Micro at school (49.8 per cent), a large proportion recall watching the associated TV programmes (47 per cent), a similar number bought computer magazines (45.9 per cent), and a smaller number were involved in the Domesday project (14 per cent) or had joined a computer club (13.3 per cent). Only a small number (5.4 per cent) did a computing course. (Figure 14.)

As we pointed out above, many of the respondents had their first experience of computers in the home, usually through a family member. While a third of our respondents may have felt that they were not directly influenced by the CLP as children, it is likely that their parents were, as Section 5 showed that the BBC project was targeted at adults, with its television programmes reaching 16 per cent of the adult audience.[92]

Figure 14: Were you aware of the BBC's Computer Literacy Project during the early part of the 1980s?
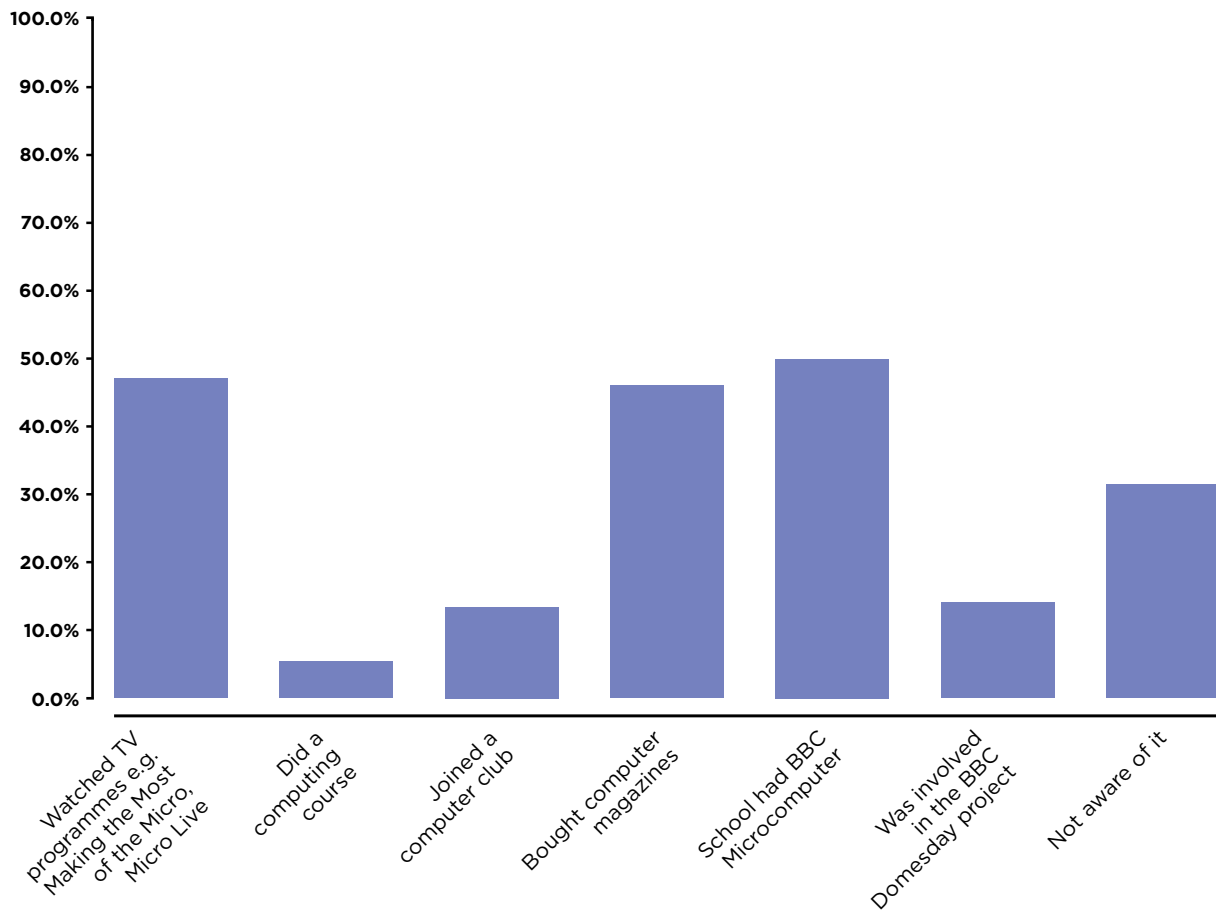
Those respondents who owned a BBC Micro were, unsurprisingly, much more likely to have been aware of the CLP; only 18.3 per cent weren't aware of it. A far higher proportion watched the TV programmes (61.1 per cent) and bought computer magazines (64.1 per cent), were involved in the Domesday project (17.6 per cent) and were a member of a computer club (18.3 per cent). (Figure 15.)

Figure 15: Owned a BBC Micro: Were you aware of the BBC's Computer Literacy Project during the early part of the 1980s?
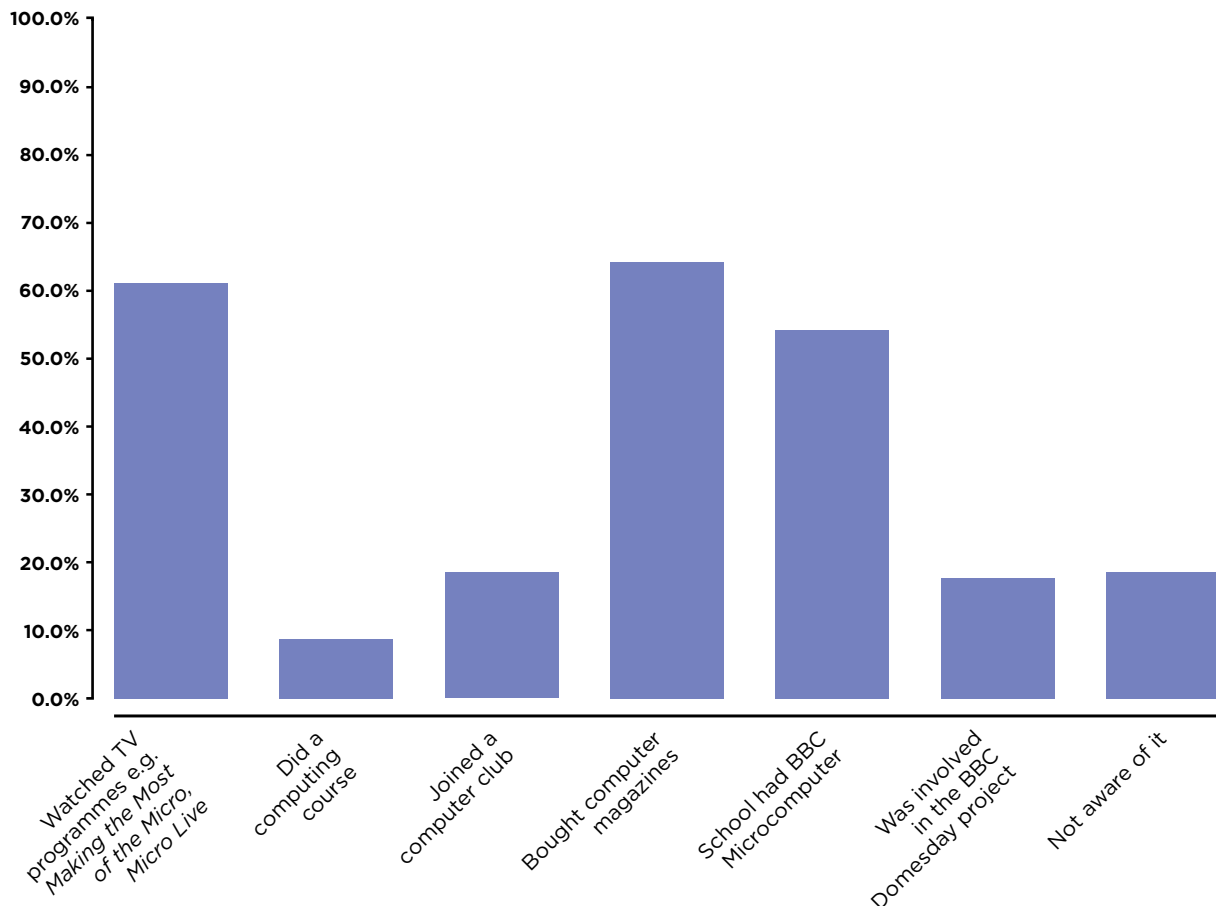
We left one very open question for respondents to answer - whether there was anything more about their memories or experience of the BBC Micro and the CLP that they would like to tell us. Amongst the 126 respondents who answered, the subject stimulated passionate comments, both positive and negative.

Positives

For some, the BBC Micro triggered happy memories of using the machine and the influence it had had subsequently on their lives:

"The BBC Micro was probably the most important machine I owned and worked with. Even though it was not my first computer, it was the one that sealed my love of programming and computing. I still remember the tactile feel of the keyboard and the pure joy of programming it. There were a number of key features of the machine. It was powerful, especially in its graphics capabilities. It felt like a real computer - instead of the small and plasticky Sinclair machines, this was a robust machine. Its BASIC environment meant that to do anything you had to execute simple programs. It was very open, encouraging exploration and tinkering. Its limitations were a challenge, forcing economical and ingenious approaches that have stood me in good stead ever since. Its community of users and programmers were welcoming and

shared their knowledge and passion freely. I owe my career to the BBC Micro. I have founded successful start-ups in Silicon Valley and worked for Apple and Google. I earned a PhD in Artificial Intelligence. I was inspired by my BBC Micro."
Dan, Respondent 1744975368

For others, it was the philosophy behind the CLP and BBC Micro that associated it with positive memories.

"The BBC's Computer Literacy Programmes brought attention to computers and IT as a possible career to lots of bright contemporaries searching for a possible career. Computing was becoming a discipline in its own right, previously companies would have employed maths or science graduates who had used computers at university."
Tim, Respondent 1750893805

The BBC Micro introduced the general population to the possibilities that computers offered. This moved computers into the mainstream and out of specialised spaces, such as research labs and universities. One respondent recalls how, despite having little to do practically with the BBC due to limited numbers at school, it meant that *"my parents (however poor at the time) were willing to get us initially a ZX81."*[93]

Michael goes on to summarise his impressions:

"IMO the BBC micro was hugely influential, but not because every kids had one or had access to one - they didn't - not even close in my experience - but because they legitimised access to micros in general amongst those who weren't from a professional background."
Michael, respondent 1754838475

Even respondents who weren't aware of the details of the CLP, still recall that it captured the atmosphere of the time:

"Oddly, I wasn't aware the BBC micro was part of a big project, or the link to the Domesday project. I just enjoyed doing something that was clearly part of a buzz, but still felt quite exclusive."
Alice, Respondent 1749337587

Negatives

However, while the majority of the respondents were enthusiastic, a few were not. One of the main complaints is that the BBC Micro was too expensive, limiting access to many. The price of the computer led it to be seen as a sign of status, adding educational and cultural capital to the home:

"It was too damned expensive for me - hence use of Sinclair machines. It was also too damned expensive for the schools: From memory we had three BBC B's between 1500 pupils. So they were used rarely and in departments: Maths and Physics."
Paul, respondent 1751127518

Experiences such as these account for the high number of people who accessed the BBC Micro at school rather than home. However, accessing the BBC Micro at school also presented problems, as Paul's account above, and the two accounts below, demonstrate:

"The BBC Micro itself was something of an irrelevance. I liked the keyboard, and it was faster than most of the computers I had access to, but the BASIC was a bit quirky and that made it hard to transfer code from the BBC to any of the computers I could actually use. The BBC

*Micros in school were locked up tight, so I only had access to a ZX81 or a friend's Spectrum…
The CLP offered a bit of inspiration for the sorts of things that were possible, but was very tied
to a computer we couldn't use. I've no doubt, however, that it contributed to a culture that
encouraged us to continue our own explorations, by legitimising an interest in computing."*
Jonathan, Respondent 1760338578

*"I can remember that it was all new to everyone. When we used BBCs in school the teachers
were as fascinated as us kids. While they struggled to teach the basics to the rest of the class, a
few of us would be given free reign to do what we wanted (writing elaborate programs to insult
each other, hacking the educational games to make them more interesting, experimenting in
audio visual coding) as long as we were relatively quiet. Afterwards the teacher would come
over to see what we had done and it was great to be able to have a conversation with an adult
where I was being asked my opinion."*
Paul, respondent 1744297664

From these respondents, it is clear that schools were at times unwilling or unable to invest money
in a large number of BBC Micros. This meant that pupils only used them for short periods of
time, and even then only playing games. Teachers, as is hinted at by Jonathan, were also very
protective of the machines, keeping them *"locked up tight"*. This meant that many of those with an
enthusiasm for computers were unable to experiment and practice creative problem-solving which
made the experience so enjoyable.

However, as Paul describes, the teachers' lack of knowledge was not always a barrier, allowing
those with an aptitude for computers *"free reign"*. While this experience was obviously a positive
experience for the respondent (he was allowed freedom to experiment, and an environment
where he was *"able to have a conversation with an adult where I was being asked my opinion"*)
it also highlights one of the fundamental problems with the CLP: teachers, unless they also had
a personal enthusiasm for the new machines, were struggling to know how, or what, to teach to
classes.

Influence on interests and subsequent career path
We included an open text question about whether the availability of microcomputers at
reasonable cost had influenced respondents' interests and career path; 286 respondents answered
the question, and the vast majority were positive. A few respondents did temper their answer by
stating that they were already interested in computers before the boom of the 1980s, but even
those felt that it made things easier.

*"My ability to use a computer has been essential to every job I've done since 1984. The fact that
I had some computer literacy at an 'early' stage was extremely advantageous to me. Not only
did potential employers like it, I wasn't afraid that everything changed every few years. That
had been happening all my computer life and gave me a good attitude."*
Jane, respondent 1752174278

Responses to this question often showed the importance of the ubiquity of computers, and having
direct access to one in the home for many respondents.

*"I saved every penny I had to buy my ZX Spectrum and spent hours making up little graphics
programmes on it - mostly little sequences inspired by the opening titles of TV programmes. It
certainly made me aware from the start of the potential for computers as something you could
use in being creative and I now write music on a computer. Prior to being able to play with a
computer, they were always mysterious machines with giant banks of flashing lights and tape
spools. They were the things which created The Six Million Dollar Man or ran the Enterprise and*

the Seaview except when they went wrong and wanted to take over the world: the idea that I could have one at home and do what I liked with it seemed magical."
Mike, respondent 1756523691

"Having a computer in the home played an important role - this was something novel and exciting (difficult to convey today when they are so taken for granted). Interestingly, it was also a very social thing - as well as learning to use it with my father, friends would come round and we would write small programs or experiment; I'd visit my friends and we would do the same with their machines (I was in a minority having a BBC). That enjoyment persisted throughout my time at school; I chose Computer Science at University and now have a PhD in the field."
Stuart, Respondent 1762806827

The responses also reflect the economic value that this early interest in computing subsequently sparked. Some respondents recounted a direct link between their confidence in computing (and occasionally the BBC Micro specifically) and their desire to found a company:

"I think I would have become a filmmaker without computers, but I doubt I would have started my own company. An interest on 'gadgets' of all sorts led to a desire to create apps."
Josh, Respondent 1753283935

"I was introduced to computers at a young age, and this very much guided what I wanted to do, and where I wanted to go. I was a little too young to properly think about a career, but a combination of using computers daily and seeing Jurassic Park when I was 12, which I followed up by getting the making-of book, and being fascinated by how they made the dinosaurs, led me very early on to have a huge interest in computer-based film-making. Now, running my own visual effects company, I'm certainly following a path that started then."
Hugh, Respondent 1753872128

"Changed my life, allowed me to do what I wanted to do, allowed me to set up a software company, allowed me to employ people, allowed me to invent things and allowed me to enjoy myself!"
Sam, Respondent 1749563209

"I started to learn programming on a BBC Micro in the 80s; I've continued to enjoy programming ever since, and am still learning; I did a computer science degree at university; founded a web-based company (Last.fm) and programmed for 12 hours a day for several years. After selling and subsequently stopping working at Last.fm, I've started another project and am doing lots of programming for that too. So yes, it directly influenced my career path."
Richard, Respondent 1744367801

"I still have, and treasure, my BBC Micro. I used it to write school administration software for my sixth-form college, which they used extensively and which they helped me to commercialise in a tiny way (we sold several dozen copies to other schools). I have been a full-time software developer for more than 20 years, and have set up three separate companies in that time, and that would never have happened without my Model B. I was more-or-less oblivious to the Computer Literacy Project, apart from the BBC Micro itself."
Nick, Respondent 1749599627

These responses were indicative of a time when there was a much bigger change in attitudes and access to computing across the country. This period shifted what were previously hobbyist activities into the mainstream, and gave a new generation confidence in computing and coding. As a result, this made it much more likely that individuals would later be comfortable using computers

at work, work in broadly related computing industries or even consider setting up their own companies.

This phenomenon was particularly apparent in cities such as Dundee. Sinclair's ZX81 and ZX Spectrum computers were built at Timex's Scottish plant in Dundee. Workers, their families and friends often gained access to the machines, or gained an interest in programming, and the city (with the support of the University of Abertay), became full of budding programmers. The wider economic influence of the factory can be seen in the high density of video games development companies in the area, such as DMA Design (creators of Grand Theft Auto - which subsequently became Rockstar North), Ruffian Games, Dynamo Games, 4J Studios, Cohort Studios, Denki, and Realtime Worlds (a well-funded attempt to break into the online gaming market, which failed in 2010).

Lessons from the Computer Literacy Project

The BBC Micro cannot be judged in purely utilitarian terms – how many programmers it created or the penetration into the home. During the early 1980s, households tried to define the use of the machine, for gaming or for educational purposes, but its existence as part of the CLP reinforced the inherent value to families of gaining familiarity with computers.

Playing games, programming and 'mucking about' with code was mainly done at home, and parents were often the main influence on getting children interested in computers. The availability of a wide range of relatively open microcomputers, some considerably more affordable than the BBC Micro, enabled a wide range of households to engage with computing.

Many respondents were keen to share with us detailed stories of their personal journey and experiences; this was a significant and influential period of their lives and shaped the future careers of many people.

The experience and quality of computing in schools and colleges differed widely and was often dependent on the enthusiasm and capabilities of individual teachers. Many teachers were unable to respond, or to capitalise on, the growing knowledge of their students gained through self-directed learning.

6.2 The technological and industrial legacy

The industrial legacy of Acorn, and indirectly, the BBC Micro, are visible in the formation of spin-out companies such as microprocessor design company, ARM. The BBC Micro touched the lives of many future entrepreneurs, including those individuals at Acorn who played a significant role in inspiring, initiating and supporting others in the growing Cambridge technology cluster.

Cambridge has long been recognised as a world leader in technology, forming a fascinating case study into the interrelationship between university scientific research and development and high-tech industrial clusters.[94] Cambridge's success stems from the university, and is visible in its longstanding technological tradition, with companies such as WG Pye (established in 1896) which developed pioneering radio, television, radar and telecommunications technology, and Cambridge Instruments (established in 1881) which became known for its precision engineering of instruments, such as the world's first seismograph and scanning electron microscope technology.

Yet more recent technological success stories in Cambridge are perhaps less widely known. In the US it is widely acknowledged that the establishment of Fairchild Semiconductors in 1957 in Silicon Valley led to the 'Fairchildren' – a group of individuals who played a seminal role in the growth of Silicon Valley through spin-off companies such as Intel. A similar effect is visible with Acorn, which generated important start-ups and spin-outs and contributed to Cambridge's sustained success as a global hub of entrepreneurship and innovation.

Section 4 of this report, on the Success of the BBC Micro, showed the important role Acorn played in bringing together a significant group of individuals who cut their teeth in a fledgling home computer industry. It also suggested that Acorn's success could, in part, be credited to the culture of the company. Hermann Hauser is keen to acknowledge that in the early days, *"We were making it up as we went along"*,[95] but in the process they created a distinctive 'can do' positive attitude in a company that felt like a family.

Although Acorn was set up in 1978, before the CLP, the company's early success can in part be credited to the state support for one of its products – the BBC Micro – and in particular, through the Micros in Schools programme. But arguably later successes could be attributed to the team's strategic foresight. In 1983, the BBC Micro was at its height, but Acorn realised it had to step up and find a successor product, so it began thinking about the future of its industry.

Steve Furber and Sophie Wilson examined the microprocessors on the market – such as the Motorola 6800 and the National Semiconductor 32016 – but they weren't impressed, especially in terms of speed. Andy Hopper, who had strong university networks, was aware of the Berkeley RISC (Reduced Instruction Set Computing) research project, where a postgraduate class had built a reasonable microprocessor in a year using a RISC design philosophy. RISC is an architectural approach to microprocessor design that cuts down the complexity of operations by executing fewer instructions more rapidly. Hopper mentioned the RISC projects to Hermann Hauser, and the Acorn team were impressed with the results, so Wilson started doodling an instruction set.

In October 1983, Furber and Wilson visited the Western Design Centre in Phoenix, Arizona, as they were interested in the development and extended capabilities of the near-ubiquitous 6502 microprocessor. Steve Furber recalled, *"We held the place in awe and respect because it was American and made microprocessors, but we discovered that they were operating out of a bungalow somewhere, they were employing school kids to do some of the silicon design on Apple IIs, and we thought, "if they can design a microprocessor, so can we!""*[96]

The Acorn team felt that designing microprocessors was a black art. They never expected to succeed, but they did hope to learn something in the process. The entire industry was very sceptical about the RISC approach, believing it was philosophically wrong to make a processor simpler. RISC did however show that if you made the compiler do more work, and the processor simpler, you would get better performance.

The entire ARM (Acorn RISC Machine) processor was designed in just 18 months, and taken to the Munich offices of VLSI (an Integrated Circuit manufacturer) in early 1985. The first silicon chips arrived on 26 April 1985, and by three o'clock in the afternoon it was running BBC BASIC.[97]

The first commercial use of the ARM chip was as the second processor for the BBC Master in 1986; the first home computer based on ARM architecture was the Acorn Archimedes in 1987. It was the most powerful home or desktop PC you could buy at the time. But although the technical merits were huge, the PC market had become obsessed with standards, as the IBM PC had taken hold. The Archimedes achieved only limited success and the chip design unit was losing too much money for Acorn to sustain.

Luckily, Apple became interested in the ARM processor, but it wasn't happy to buy it through a competitor like Acorn. The result was the formation of Advanced RISC Machines (ARM Ltd), in November 1990 as a joint venture between Acorn, Apple and VLSI Technology. The ARM processor rapidly became the preferred low-power processor in mobile devices. Its unique business model, to license rather than manufacture and sell the chips, subsequently enabled the creation of more ARM chips than human arms in the world.

Today, over 30 billion ARM based chips have been shipped around the world and ARM processors are found in 90 per cent of smartphones.[98] ARM is now a multibillion pound company and a global British technology success story that arguably everyone should know about, but probably does not, certainly not compared with US giants like Apple whose most successful products, like the iPad and iPhone, rely on ARM.

The Acorn and BBC Micro story has also had an enormous influence on the industrial vibrancy of Cambridge and beyond. A few individuals, whose formative years were touched by the work of Acorn and the development of BBC Micro, stand out.

David Braben, co-developer of the first 3D computer game *Elite* and subsequent founder of Frontier Developments and The Raspberry Pi Foundation, started out developing games for Acorn:

> *"I was at Cambridge University and didn't even have a BBC Micro, I had an Acorn Atom. I'd written 3D routines on the Acorn Atom, and I showed them to EMI in London. The game had 3D space ships, but it wasn't Elite at this stage. They said, "Would you like a job?" which wasn't the answer I wanted. I wanted them to say, "We'd like you to make a game". Part of the condition of the job was that I didn't go to university, but I'd already got a place at Cambridge and they wanted me to work full-time. So I went to university, where I met Ian Bell. Ian was developing a game for Acorn at the time, called Freefall. We went to Acorn, and showed them what we'd got and they were thrilled. Acorn they were just amazed. They offered us an advance of £2,000 between us. The great thing was, I didn't have a BBC Micro and it was becoming a real pain, so I asked if I could take my £1,000 as hardware, and I think they did it at trade price."[99]*

Elite went on to sell over a million copies,[100] opened up new frontiers in gaming, was the most successful video game ever developed by Acornsoft and for many is more famous than the machine for which it was developed.

Conrad Wolfram founded the mathematics software company Wolfram Research Europe Ltd, and learnt an enormous amount from a BBC Micro:

"The timing of the BBC Micro was absolutely crucial. A lot of people were playing with computers, but the computers didn't do much until you programmed them. At my school we had an Apple II, but I remember going out to buy the BBC Micro with my mother. She wanted it for writing a book, I wanted it because I thought it was cool to have a computer. It seemed like the right thing to get, although it had a tape drive which was an absolute disaster. My mother ended up playing games on it a lot, which I didn't do. And I ended up trying to kick her off to write programs on it a lot. Although I didn't do a huge amount of programming, I did a lot of getting it to work for my mother, which wasn't always very easy. So the BBC Micro taught me a lot."[101]

John Biggs, co-founder of ARM recalled:

"My father bought me a BBC Micro to connect with me. My interests were different to my Dad and my brother, as they were both vets, so my Dad thought it might be a good way in. Later, a friend of my brother got a job at Acorn to write the manual for the Acorn Electron. He asked me to help him, so I spent the summer of 1982 at Acorn, and then went back there during university holidays. During the slump in the home computer market Acorn had difficulties. I had been offered a 'proper job' but this was withdrawn right in the middle of my finals in 1985! Acorn felt bad about this, so they wrote a glowing reference saying how they would love to employ me if they could. I ended up in job at Cray Research, but found that the culture at Acorn suited me better. So I re-joined Acorn as soon as possible and was fortunate enough to become one of the 12 engineers who founded ARM when it spun out."[102]

These accounts might just seem like the anecdotes of individuals, but the networks of influence of the BBC Micro and Acorn go well beyond stories to illustrate real economic legacy. Research started by Segal Quince Wicksteed on 'The Cambridge Phenomenon'[103] and developed by Vyakarnam, Myint and New[104] illustrates the influence of Acorn in developing a cluster of entrepreneurial high-tech companies. They show how significant just a few entrepreneurs associated with Acorn became.

In Figure 16, we have added to this analysis with additional interviews to show how the social networks developed at Acorn have led to the creation of companies across publishing, semiconductor and software development, high-speed networks, smart-card technology and much more. Acorn's economic legacy, as defined through the people that created the culture of Acorn, goes far further than any standalone legacy that Acorn – and indeed the CLP which supported the company in its earliest days – had.

Figure 16: Acorn's networks of influence
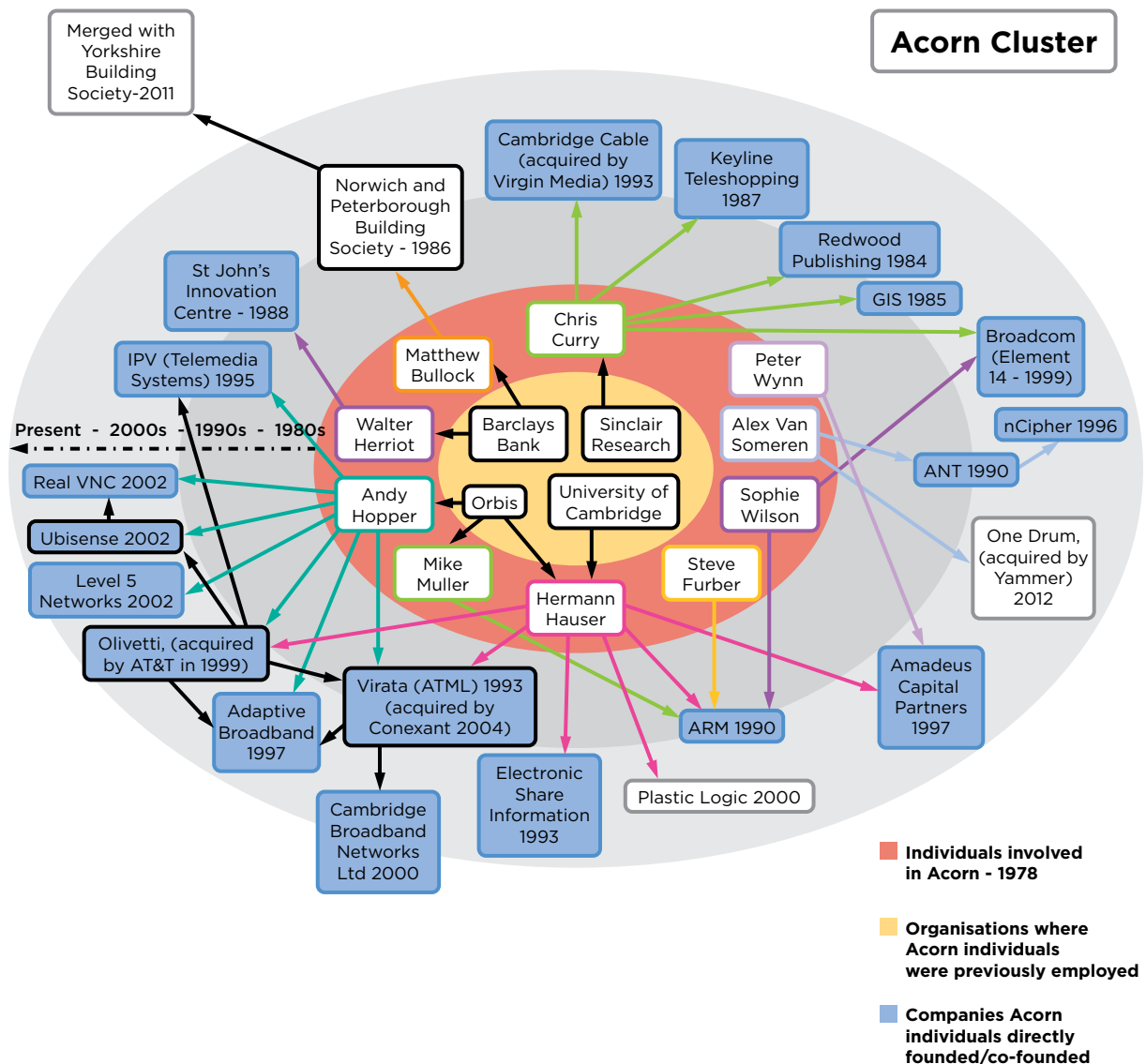
Figure 16 shows how key individuals had a profound effect on the success of the Cambridge high-tech cluster. Local venture capital firms played a major role in supporting fledgling start-ups. But the motivations, trust and cooperation of entrepreneurs are built around the social networks developed over decades. The figure shows how, in the creation of new ideas, innovation and entrepreneurship, networks and connections between individuals really mattered. In Acorn's case, the revolving door between Cambridge University and industry had been vital in seeding further innovation.[105]

Lessons from the Computer Literacy Project

The 'can-do' attitude and the bringing together of a unique network of people at Acorn may have been its most valuable and longest lasting legacy.

The research and development of the Acorn RISC Machine led to the spin-out from Acorn of a company that would become one of Britain's leading high-tech businesses, ARM Holdings. ARM's success can be traced directly back to the success of the BBC Micro.

The BBC's choice of a company within the Cambridge cluster led to a legacy well beyond that of Acorn and the BBC Micro itself. Many of the individuals involved with Acorn and subsequently ARM have gone on to play a significant role in setting up new companies.

The learning and the networks of relationships developed through Acorn stimulated new ideas, innovation and entrepreneurship in Cambridge and beyond.

6.3 The legacy at the BBC

The Computer Literacy Project (CLP) began a 15-year period during which the BBC explored a range of new opportunities for learning opened up by the combination of broadcasting and computing. From the Domesday Project to the Networking Club, BBC Education led these initiatives with opportunities for new users of technology to explore, create and contribute always at their heart. But the creation of BBC Online and the mainstreaming of personal Internet access at the turn of the millennium hastened a structural change in the BBC and its engagement with Information and Communication Technologies. Editorial and distribution - rather than educational - opportunities became the key business drivers. Does the BBC any longer have the right architecture to deliver a contemporary equivalent of the CLP?

The BBC Domesday project was an ambitious attempt to use the microcomputers that were newly available in British schools, and to ask the schoolchildren themselves to create a contemporary equivalent of William The Conqueror's great land survey of his new kingdom, one of the most famous historical documents in English history.

Peter Armstrong, then a BBC Television producer, conceived the project in 1983 with the aim of creating a public resource to be published to coincide with the 900th anniversary of the original Domesday Book in 1986. Armstrong drove the project forward as chair of a partnership that brought BBC Education and R&D together with Acorn, Logica and Philips and also received funding form the European Commission's ESPRIT Programme.

The Domesday project sliced the UK landmass into 24,000 blocks, each of four by three kilometres, based on Ordnance Survey grid references. During 1984 and 1985, schools and community groups generated three photographs and 20 items of text for each of these blocks to be compiled onto a Community Disc along with complete mapping data. This was accompanied by a National Disc produced by the BBC with professionally produced images, video content and official statistical data from the time. The public response to the project was impressive, with over one million people and 9,000 schools participating[106] and the completed system of discs, dedicated LaserVision player (from Phillips), customised BBC Micro (from Acorn) and software (by Logica) was released in 1986 alongside prime time and schools television programming presented by charismatic TV historian, Michael Wood.

Domesday was a creative and editorial success, but not a commercial one. The ambitions of the project, to create a massive multimedia resource providing access to users to explore new ways to interact with geographic data and editorial content, could only be achieved by pushing the limits of the available technology. The LaserVision players that were developed were too expensive for most schools, and eventually made obsolete by CD-Roms. This effectively locked the Domesday content away for 20 years. It was not until the CAMiLEON[107] project accessed and preserved the discs, that the original project team were recently able to make the material available online.

But the project had a more positive creative and economic legacy. Domesday stimulated an interest within the BBC in the potential of multimedia content. Peter Armstrong's team became the core of a new Interactive Television unit within the BBC and in 1990 he led, with Max Whitby, a unique management buy-out from the BBC to create The Multimedia Corporation (MMC), which subsequently floated on AIM and became a hothouse for a new generation of digital creatives and programmers. MMC alumni have subsequently founded many other enterprises from Armstrong's own OneWorld.net, to leading iPad developer Touch Press, as well as reaching senior management positions in multinational technology companies such as Microsoft and Nokia.

Whilst Domesday created a legacy of multimedia innovation, BBC Education continued to retain Computing and Information Technology as part of its portfolio, and therefore was well placed to use the insights gained in the CLP to react to the fundamental shift that followed the personal computing revolution – the emergence of the Internet and the World Wide Web. Again, this response was developed through a combination of supplying technology and making television and radio programming to educate and support the audience in how to use it.

The BBC had been aware of the importance of the Web from a very early stage, with the R&D Department registering the domain **www.bbc.co.uk** as early as 1991 (though nothing was to appear there until 1994). But in the early 1990s, BBC Education realised that the initial challenge for the general user was to gain access to the network. Well-connected universities aside, the emergent Internet Service Providers were focussed on the corporate market with online services such as AOL not yet providing full Internet access. The BBC response was to create the BBC Networking Club, providing users with software and guidance to access email and the Internet and dedicated television programming to explore the potential of online technologies.

The first of these programmes, *The Net,* was commissioned from an independent producer (Illuminations Television) with an innovation remit and ran for four series on BBC2 from 1994-98. Though produced externally, *The Net* continued the BBC Education tradition of offering additional activities for the audience beyond the show. In the first series, this included material broadcast in 'data bursts' at the end of the programme that could be recorded and viewed in slow motion on a VCR as well as an email address to interact with the production team. Series Editor John Wyver remembers this as a revelatory moment:

> *"We all went down to the pub as the first show was transmitted and after a couple of drinks we thought we'd drop back to the office to see if anyone had sent us an email. We'd had 300 responses in the first couple of hours, despite the fact that it was a Compuserve (CIS) email address and that we omitted to include the @ sign. Even though most were just saying "hello" we knew this was something new. In those days for a standard TV broadcast to a couple of million viewers you might expect a couple of letters, and one of those would be written in green ink. This showed us the audience really wanted to become involved."*

Later series created the BBC's first programme website and even a virtual world for its audience. *The Net* was a popular magazine show covering everything from video games to politics; from 1995 it was accompanied by more targeted series: *This Multimedia Business* which used virtual

studio techniques to introduce SMEs to the online world; *Computers Don't Bite*, aimed at the home-user, and in 1998 *Webwise*, an integrated campaign of television programming and an online and real-world course developed in partnership with the further education sector offering an introductory course on the Internet through thousands of UK colleges.

But by the late 1990s, the BBC's engagement with this new digital world was changing. In 1996, BBC Director General John Birt had delivered a MacTaggart lecture at the Edinburgh TV Festival that set out a vision for a BBC needing greater resources to compete in a new multichannel, on-demand world. A digital world in which the BBC's presence on the Internet would be a vital component. BBC Online was established as a new division of the BBC in November 1997, combining both the growing BBC news website and the bbc.co.uk website for content that accompanied television programming. BBC Education, though initially an important provider for BBC Online, could no longer maintain leadership of what had become another channel through which the BBC could distribute its content to audiences. Birt's digital world was one in which the Internet was mainstream and the dominant editorial values of the BBC could be expressed through new technologies.

The legacy of BBC Education's pioneering work with the CLP, Domesday, the BBC Networking Club and Webwise was to ensure that the BBC was both more strategically aware and further advanced in its capabilities than other broadcasters, both public and private, at the turn of the millennium.

In the subsequent decade, it becomes harder to trace direct legacies from the CLP. The BBC has had its great successes in the online space, such as the iPlayer. But there have also been failures and some of the greatest, perhaps surprisingly, have been in the area of education and learning. The Digital Curriculum project to create an interactive online learning service for schools, launched as BBC Jam, collapsed amidst legal challenges from publishers in 2007 with little to show for its £100 million investment.[108] BBC Jam's failure raises legitimate concerns about whether the BBC can build the kind of consensus and multi-sector partnerships that were vital in the success of the CLP. Does it still have the educational expertise, insights or networks required?

It is important to remember that the current charter (2006)[109] enshrines as two of its six Public Purposes 'promoting education and learning' and 'helping to deliver to the public the benefit of emerging communications technologies and services', so the BBC clearly has the constitutional framework to deliver such initiatives if it is capable of conceiving them. It is therefore interesting that amidst all the current debate over computing in schools there is now talk of a possible BBC CLP 2012 and a BBC Micro 2.0.[110]

Throughout the rising call for a new era of computer literacy, many have been looking to the BBC to take action and fill the void. The BBC was approached by the Raspberry Pi Foundation and was impressed with their plans. However, there are complications for the BBC around state aid and commercial impact making it unlikely that a single technology can be developed and/or backed.

BBC Learning has been seriously investigating what it can do in this space, and has been looking at a software solution for learning coding and of course looking at how it can use its ability to broadcast and its brands and celebrities. For the BBC, the root to coding is no longer, 'here's a microcomputer, it won't do anything until you code it', but 'here's a project that's significant that won't work unless you code it'. The BBC is currently developing ideas around what those projects could be; it is obvious they need to inspire people to get involved and take up the challenge to code, and they need to take account of the connected and online world we now live in. It would also be good if there were projects of scale and impact, appealing to boys and girls of all ages and for schools, informing and involving other parts of the school curriculum, for example the STEM (Science, Technology, Engineering and Maths) subjects.

David Braben is aware of the important role a BBC project like this could play in expanding interest in coding beyond a core audience and linking to a variety of resources already developed outside the BBC:

> *"What I'd like to see is a series of television programmes to reinforce and provide a basis for the teaching and to show it is not just about the technology, as this is really important for engaging girls, even more so than boys. If you imagine a series of programmes, where you use publicly available data, and you interview a celebrity on a topic they really care about … We could have a programme that has a celebrity talk about the deforestation of the Amazon, then offers all the resources and the ability to analyse all the data, such as all the satellite photos in visible light and infrared over time … Then something like Raspberry Pi (as a hardware or software platform) could be used to process the data with explanation of how it is being done - even in a very simple programming language. This way of using the technology as a tool for good rather than an end in itself is, in my opinion, a great way of engaging girls as well as boys."[111]*

Lessons from the Computer Literacy Project

The CLP increased the confidence of the BBC's Education department and unlocked new opportunities for learning through broadcasting and computing. This department went on to make a major contribution to the BBC's early engagement with the Internet.

BBC Domesday was the historical equivalent to a crowdsourcing project for schools, where children were invited to contribute to a greater whole, learning about their local environment and about new technology through their participation. Domesday established both the potential for public service interactive multimedia and spun out a series of innovative companies.

Today, the BBC's approach to learning is to leverage BBC content and BBC brands rather than pursue independent educational campaigns; it aims for BBC TV, radio and online to act as the spark for people who want to engage with learning. A BBC Micro 2.0 project that inspires people to get involved and take up the challenge to code, and informs other parts of the STEM curriculum, is an intriguing, but as yet unproven, proposition.

7. CURRENT CREATIVE COMPUTING INITIATIVES FOR CHILDREN

Advocacy, technology and software development, and a range of coding and mentoring initiatives have sought to get children interested in programming. But there is, as yet, no central body that will play the essential role in assembling, co-ordinating and supporting a learning network for computer literacy.

In the final question of our survey, we asked respondents to think about the future, and in particular how best to support and encourage young people to build their creative computing skills. This open question received responses from 258 individuals.

Like '*Next Gen.*' and the Royal Society's report,[112] the general feeling expressed by respondents was that current ICT education in schools was failing students by concentrating too heavily on using office applications, and not enough on how computers actually work. The lack of programming was also cited as a problem with the content of courses.

> *"Computer education in the UK is pitiful, we tend to teach people word processing which is a skill that really doesn't need to be taught in classes in my opinion. I believe we should teach computer history as well as teaching kids the basics of computer programming (no specific language, but the logic involved). There are very few kids coming out of school or university that appear to have taken 'creative computing' unless they have pursued it in their own time outside of a classroom."*
> **Tom, 1753570087**

According to other respondents, the complexity of today's digital technology creates barriers to using it in education: it is difficult to make the connection between modern devices, such as mobile phones, and the code that runs on them. Expectations about what technology can achieve are also higher: programming a 3D shape on a computer no longer generates the excitement and sense of achievement that it once did. Schools lack the expertise or the guidance to overcome these barriers.

> *"Whilst modern games consoles, smartphones and tablets put incredible computing power into the hands of today's youngsters, they are sadly highly locked-down consumer devices that encourage the purchasing of pre-made content, rather than creating one's own. Added to this, we have an ICT curriculum that is obsessed with teaching children how to create a PowerPoint presentation, rather than how to program the computer. So sadly, today's young people have less encouragement to explore the wonders of computers than we did in the 80s."*
> **David, 1755335719**

Three types of solution for addressing the dearth of programming in schools have been suggested: advocacy for programming that addresses how and what children are taught; technology and software; and events and courses.

7.1 Advocacy for programming and lobbying for change

Next Gen. Skills and Computing At School are two important initiatives addressing the shortcomings of computing teaching in UK classrooms, and are actively lobbying for changes in policy (see Appendix C for a list of other significant organisations active in this area).

Next Gen. Skills
The Next Gen. Skills campaign arose from Nesta's report of the findings from the Livingstone-Hope review into the skills needs of the video games and visual effects industries.[113] The campaign is led by UKIE (United Kingdom Interactive Entertainment) and supported by major high-tech companies such as Facebook, Google, Sony Computer Entertainment and Nintendo, as well as start-ups, business associations and education sector bodies.

The campaign calls for:

- The introduction of an industry-relevant computer science course within the framework of the National Curriculum.

- A review of ICT in its current form and the embedding of essential ICT skills across the wider curriculum.

- The promotion of the vital role that teaching maths, physics, art and computer science will play in ensuring the growth of UK's digital, creative and high-tech industries.

Recently, Next Gen. Skills has proposed a 'route map' through which government and industry can provide clarity to schools about how Information and Communication Technology (ICT) and Computer Science should be provided before the introduction of the new National Curriculum in September 2014.[114]

Computing At School (CAS)
The CAS Working Group is a grassroots organisation of teachers supported by industry partners, such as Microsoft and Google, and developed in collaboration with BCS, the Chartered Institute for IT.

CAS aims to directly support teachers to promote the teaching of computing in schools. It was born out of "our excitement with our discipline, combined with a serious concern that many students are being 'turned off' computing by a combination of factors that have conspired to make the subject seem dull and pedestrian." The programme aims to:

- Directly support ICT and Computing teachers who are excited by computing, by providing them with teaching material, training, local hubs, newsletters and the opportunity to meet with like-minded colleagues.

- Act as a Subject Association for computing teachers.

- Work at an institutional level, for example by encouraging the development of GCSEs in Computing.

- Act as an advocate at national policy level.

CAS has over 1,000 members and has designed a new curriculum for Computer Science at school.[115] One reason for this is that CAS is concerned that the withdrawal of the ICT Statutory Programme of Study in the school curriculum announced by Michael Gove, the Secretary of

State for Education in January 2011, may result in a vacuum at schools, with schools lacking clear guidance about what to replace it with.

7.2 Technology and software initiatives

As well as advocacy groups, many respondents to our survey suggested that the programming deficit in schools could be solved through new hardware and software. Hardware solutions tended to be aimed at older children and adults, whereas software solutions were aimed at children by providing simplified coding environments through simple games or apps.

Raspberry Pi

Of all the initiatives seeking to encourage creative computing in the classroom, Raspberry Pi, is arguably the one that has gathered most enthusiasm, in the media as well as among the respondents to our survey.

The Raspberry Pi is a single-board computer developed in the UK by the Raspberry Pi Foundation. It is a low cost credit-card sized computer that plugs into a TV and keyboard. The Foundation is proud to be following the tradition of the BBC Micro, and like the BBC Micro, it offers two versions of the Raspberry Pi: the Model A priced at $25 and the Model B at $35 plus local taxes. Model B has an additional USB and Ethernet port. The Foundation started accepting orders for the higher priced model on 29 February 2012 and started shipping in April 2012.

The Raspberry Pi is intended to stimulate the teaching of basic computer science in schools. Eben Upton, Executive Director of the Raspberry Pi Foundation, says, *"We hope that Raspberry Pi will give children today the same opportunities that machines like the BBC Micro gave us. A working understanding of what computers do, and how they do it, is more important than ever; we hope to make small contributions to fostering this understanding in the next generation of budding computer scientists."* **http://www.raspberrypi.org/**

There was an enormous amount of enthusiasm for the product in our survey, with many respondents seeing the machine as the great hope for the future:

> *"I really hope the Raspberry Pi makes good on its promises. I think a small, cheap, hackable computer in the hands of kids is the best shot we have for repeating the boom from the early 80s. Longer answer: hackability is key. I basically learned everything I know by poking at things with processors in until they broke, or I got them to do things they shouldn't have been able to do. The open nature of the web helped immensely too. Being able to click 'View Source' on any web page to see how other people had done it was the main way I learned to code HTML."*
> **Anon, Respondent 1761457964**

> *"Raspberry Pi seems like a great idea - let children see what happens under the surface and experiment with programming without fear of 'breaking' it!"*
> **Fiona, Respondent 1745990089**

Other respondents were keen on the Raspberry Pi, but concerned that the technology on its own was not a 'quick fix'. The Raspberry Pi alone might not offer the diversity of experiences that were created around the CLP in the 1980s:

> *"Things like the Raspberry Pi are ABSOLUTELY what we need - but that is going to require a lot more hardware, software and classroom resources to maximise what we can get out of it. The problem is going to be breaking through the entrenched attitudes of education policymakers*

- including Senior Management Teams in schools - after all, they are judged on stupid 'targets' and ICT is an 'easy' subject - computing requires thinking!"
Sam, Respondent 1749563209

A few respondents were concerned that the Raspberry Pi was really only for enthusiasts, not for children, and that its 'geeky' reputation would create barriers to getting it into the mainstream.

"The Raspberry Pi is what everyone's talking about right now. However, I doubt it will be appropriate for what I regard as young people. It's a Linux box. It's only really going to be usable by those who are already pretty tech savvy."
Jos, Respondent 1746241420

This concern that the machine is currently for enthusiasts may be currently valid, though it is not the final intention of the Raspberry Pi Foundation. Ultimately, they want to develop the device for three market segments:

- Adult hobbyists.

- Developing world.

- Children.

At the moment Raspberry Pi is targeting the first group, with the intention of growing its market from there. As Eben Upton has pointed out, *"These people are absolutely critical; these are the people who are going to toughen the thing up, get it running faster and smoother, and better in every way. So targeting these people at the start is important."*[116]

The next stage is to look at how to transform the Raspberry Pi from a developer's edition and a device for enthusiasts, into a consumer product. This will include putting it in a box, doing more consumer testing, making the software more robust and delivering a package of support for learning.

The package of support, currently referred to as Raspberry Filling, will include:

1. System Level software, which is used by a lot of educational software but isn't currently implemented on the Pi.

2. Tutorials on particular aspects of various programming languages.

3. Course materials to go alongside those tutorials.

Some of these learning resources, such as the tutorials, will be delivered as video on the SD card of the device. Other resources and support will be provided through online forums.

Eben Upton is well aware of the great hopes surrounding the Raspberry Pi in schools, but he also desires that the Pi will enthuse a new generation rather than being obligatory:

"Given a choice, I'd rather kids were buying these themselves, rather than having them imposed on them. I'd rather people were buying these personally because they have got interesting capabilities and interesting content. If centralised purchasing through bulk contracts come along, we will certainly service them. But we expect to see a lot of these being bought by individual parents for their children, or by children buying them for themselves."[117]

If that is the case, there will be an increasing need for a co-ordinating body, to link home users and individuals with supporting material, courses, and advice, just as the BSS did with the CLP. The Raspberry Pi Foundation hopes that the machine and the educational materials are well integrated, and is collaborating with CAS to develop Raspberry Filling.[118]

As well as Raspberry Pi, other respondents identified Arduino as a way into controlling simple computers in the physical world.

Arduino
"Arduino is an open-source electronics platform used for prototyping simple ideas using flexible, easy-to-use hardware and software. It's the ultimate tinkering device, intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be standalone or they can communicate with software running on a computer (e.g. Flash, Processing, MaxMSP)" **http://www. arduino.cc/**

Other respondents identified an increased awareness in programming environments for the very young in schools as key to inspiring creative computing. Scratch and Mindcraft were the most common programmes mentioned.

Scratch
"Scratch is a programming language that makes it easy to create your own interactive stories, animations, games, music, and art - and share your creations on the web. As young people create and share Scratch projects, they learn important mathematical and computational ideas, while also learning to think creatively, reason systematically, and work collaboratively. Scratch is developed by the Lifelong Kindergarten Group at the MIT Media Lab, with financial support from the National Science Foundation, Microsoft, Intel Foundation, MacArthur Foundation, Google, Iomega and MIT Media Lab research consortia." (**http://scratch.mit.edu/**)

> *"I am already using MIT's excellent Scratch programme to teach my son (now eight years old) - an excellent resource and the perfect introduction to coding for primary school children."*
> **Neil, Respondent 1746769637**

Lego Mindstorms
As well as working with software, a number of respondents thought that children should be encouraged to go back to basics, looking at how to control machines in the physical world. Whilst Arduino can do some of this, others suggested that robots and tools such as Lego Mindstorms, could generate real excitement about programming, and show how it could be practically applied. Finding solutions to real world problems takes programming away from the conceptual to the practical.

> *"Mindstorms is software and specially designed hardware that allows children to build and program robots out of Lego. Includes motors, light, colour and sound sensors."*
> (**http://mindstorms.lego.com/en-us/default.aspx**)

Regular events and competitions are also run around this technology, specifically targeted at nine to 16 years olds. **http://www.firstlegoleague.org/**

"Lego's 'intelligent' bricks are pretty amazing things and should be mandatory in schools."
Tim, Respondent 1746629097

Further technology and software initiatives are listed in Appendix D at the end of this report.

7.3 Events and courses for young people

There are a number of initiatives aimed at introducing children to programming by giving them access to the technology in a supportive environment, often involving industry experts. These schemes attempt to overcome conventional perceptions of programming as 'antisocial', by promoting and maintaining a community of young programmers.

Apps for Good and Young Rewired State were mentioned most often by respondents to our survey. Further activities and events are listed in Appendix E.

Apps for Good
Apps for Good (AfG) is an award-winning course where young people learn to create imaginative mobile apps that change their world. According to AfG, "students create apps that make a difference and solve real life issues that matter to them and their community, giving them a launch pad in social enterprise and the exciting world of technology, design and innovation." (**http://appsforgood.org/**)

Young Rewired State
Young Rewired State (YRS) is the philanthropic arm of Rewired State and is a network of developers aged 18 and under. Its primary focus is to find and foster the young children and teenagers who want to learn code, and teach them 'how to program the world around them'. The site offers free tutorials online, but YRS acknowledges that programming is often a lonely and isolating activity. It addresses this through mentoring during week-long hack events over the summer. **http://youngrewiredstate.org/**

Lessons from the Computer Literacy Project

There is near universal concern around the unimaginative way that ICT has been taught in schools over the last few decades.

Next Gen. Skills and CAS have both played a significant advocacy role, most recently through proposing a 'route map' and a suggested curriculum to replace the way ICT is currently taught in schools. CAS also acts as a grassroots organisation, supporting teachers with training and materials.

There are a variety of technological solutions, from hardware to software, and many of these are already being adopted in some schools. What is missing is a full package of broadcasting to raise awareness, software and data to build interesting educational tasks, and supporting courses for teachers and tutorials for learners.

There is a vast array of initiatives, courses and clubs to inspire a new generation of programmers in schools, but no single organisation centralises knowledge about these opportunities and presents this information to the public.

8. A NEW COMPUTER LITERACY PROJECT? LESSONS AND RECOMMENDATIONS

Britain is once again in a unique position, with an enormous amount of public enthusiasm for the opportunities presented by computer programming. Developments such as the Raspberry Pi are extremely exciting, offering a fully-fledged computer at a low price point, and opening up a vast new world for hobbyists, tinkerers and beyond. Many people who have previously never thought about programming are becoming increasingly aware of opportunities available to them through the manipulation and control of these amazing tools.

But to build on this new enthusiasm and make it a success, there is a need for leadership – to develop this idea, harness the clear support present across government and industry, and build the passion of the public. The technical resources have been developed, what is lacking is the leadership to inspire and develop an ambitious plan, to persuade the range of actors to fund it, and to devolve control enough to heavily involve smaller local networks to take ownership and make it 'their project'.

We don't want, and couldn't have, in 2012 a straight repeat of the CLP from the 1980s. The world has moved on, and the introduction of home computers was a particular moment in history which presented an exceptional opportunity for users to define the meaning of the machine in the home. Today, the Internet and the ubiquity of hardware present new opportunities for access, and opens up discussion and dialogue. We need to learn from the original CLP and deliver an equally ambitious project, one that is capable of delivering systemic change, but that is relevant to today's hardware, software and learning styles.

There are many things the CLP got right: multichannel delivery, supporting materials, a grand vision including both the home and educational environments, an open machine and programming language, but above all clear leadership and co-ordination that empowered local networks to deliver learning directly to many different audiences.

The current sense of both opportunity and anxiety over the place of computing within our educational system is very reminiscent of the 1980s. If we are to replicate the CLP's social, economic and educational response in a new campaign, there are a number of things we can learn.

Recommendations for a new Computer Literacy Project

1. **The vision for computer literacy matters.**
    John Radcliffe's inspiration, resolve and managerial expertise at the BBC made sure that the CLP worked. Many people, across the BBC, Acorn, national and local government, teachers and broader networks, contributed to making the project a success, but John Radcliffe's leadership was a major factor in initiating such a complex project, overseeing all the various parts and bringing it through to success.

    Today, there is no single vision holder creating the partnership between industry, education and the range of actors who want to change things. The history of 'troubleshooting czars' parachuted in to effect change through collaboration between different stakeholders is, to say the least, mixed. But personal leadership and vision, based on a level of knowledge and understanding of the industry that inspires respect, and backed up by significant skills in diplomacy, is vital at this point in time.

2. **We need a systemic approach to computer literacy and leadership.**
    The CLP was encouraged at all levels, from the ground level delivering learning to adults and children, right up to government. Whilst the project was supported by the Department of Trade and Industry, Department of Education and Science and the BBC, its success required micro-networks, co-ordinated in part through the Broadcasting Support Services, for individuals to take ownership, get involved and feel enthusiasm for the project goals.

    To deliver a similar integrated approach requires an unified action plan that leverages the coalition of the willing. Absent this, there is a real risk that the well-intentioned efforts of different partners remain fragmented and ineffective. A key part of this plan will be empowering local and regional bodies to take part and own this new movement for computer literacy. Organisations leading this effort need the commitment, the capability, the skills and the scale to deliver. At present there are many candidates, but no one organisation that meets all these criteria. Someone needs to step up to the plate.

    The BBC may be able to replicate their previous role, by providing supporting television and online programming, but to deliver at the scale of the original CLP would require not only significant buy-in at a senior level but significant institutional re-engineering and resources. The Department for Education may be another organisation that could take this role, but would tend to work through formal schools learning rather than empowering the delivery of independent learning across multiple initiatives. Industry and education bodies such as e-Skills UK and BCS have an important role to play.

3. **Delivering change means addressing the home not just schools.**
    Despite the BBC Micro now being considered 'the schools machine', the computer was actually more important in its impact of changing the culture of computing in the home, particularly through the legitimising effect of the television programmes. Parents watched them, enthused children about computers, learnt to use the machines for themselves, and bought the computer in the first place. Without the desire to reach into the home, the uptake and legacy of the CLP would have been far smaller.

    The majority of current programmes are focussed on schools (PICAXE, Scratch, .NET Gadgeteer etc.), with a few building on the enthusiasm of adult groups (e.g. Arduino). But there is no broader attempt to influence the home and create resources for independent learners. The Raspberry Pi Foundation is aware that enthusiasts are buying their machine, but their longer-term ambition is to break into schools and the developing world.

A contemporary media campaign is arguably one effective way to bridge this gap. Television remains a fantastic way to inspire (but not deliver) learning; creating calls to action across all social groups. Social media, unknown in the 80s but so central to the lives of young people today, can build awareness and connect learners to computer literacy projects, and to their peers who are taking advantage of the tools, materials, social interaction and practical tasks they provide.

We need a contemporary media campaign: television programmes that legitimise an interest in coding, co-ordinated with social media that can connect learners with opportunities and resources. This is a vital but supporting role, arguably still best played by the BBC.

4. **There is a need for two-way networks into and out of education.**
At the core of the original CLP were the BBC's educational liaison officers, who not only encouraged teachers to use the BBC's programmes in their teaching, but who brought market needs, intelligence and support from adult education, colleges and schools back into the BBC and the CLP. These two-way networks provided an invaluable way of both listening and delivering appropriate tools and training for adult, continuing and schools education.

These days, the BBC has neither the equivalent staff nor the resources to play such a role. Organisations such as CAS, that have existing micro-networks in schools and the corresponding grassroots knowledge and intelligence, can make essential contributions in creating this feedback loop, ensuring that the needs across primary, secondary, further and higher education are understood by those developing technology, learning programmes and software as well as informing educators about these new opportunities.

5. **There are lots of potential platforms; they need to be open and interoperable.**
The BBC Micro had an ambitious specification, which viewers and consumers could feel confident in, operated through the powerful and accessible language, BBC BASIC. It enabled users to get the machine to do something quickly, and build on this to extend their skills.

Today, there is no need for a single platform; we have a multitude of exciting offers. The Raspberry Pi is providing a cheap and accessible way of getting involved in programming, but many other products are already used extensively in schools. MIT's Scratch for younger children, Lego's Mindstorms for those who want to build and influence the physical world and Microsoft's .NET Gadgeteer (and many more) are all products enabling schools to explore how to build and control machines.

A new CLP needs to embrace all of these platforms, provided that they are open to users and can support users in advancing their skills and understanding. Whilst in an ideal world these platforms would be interoperable at a technical level, it's important that at least the materials, support and challenges developed by the new CLP can be applied to each platform and that this translates to the home environment which, Lego aside, they currently barely address.

6. **Kit, clubs and formal learning need to be augmented by support for individual learners; they may be the entrepreneurs of the future.**
The lesson from the 1980s is that the availability of hardware and the use of television to stimulate demand for computer literacy was not in itself enough. The project relied on the creation of a large amount of training, informal learning and curricular material; the broadcasts were part of a complete instructional package further widened by the growth of home computing magazines. Informal, rather than formal, learning seems to have been particularly influential on those who subsequently founded companies.

Current initiatives focus on either technology products or face-to-face formal learning programmes, primarily in and around schools. A new CLP needs to develop, or even better create, a market for others to develop, supporting resources that can develop learning outside the school walls or after-school clubs. These may be delivered through online services or social networks, but without tapping into the engagement of independent users, any new CLP runs the risk of being defined by formal education imperatives and following the path of ICT in schools.

7. **We should actively aim to generate economic benefits.**
Throughout the development of the BBC Micro, state entrepreneurship sat comfortably alongside corporate entrepreneurship; the creation of the machine built on pre-existing skills, knowledge, networks and products across a broadcaster, university, schools and Acorn in the commercial sector. Public procurement of the BBC Micro directly supported the development of the UK high-tech company, Acorn, which in turn led to a cluster of companies and entrepreneurs around Cambridge.

More broadly, the CLP impacted directly and indirectly on the development of the UK's high-tech economy by creating a generation intrigued by, and familiar with, computers, thus stimulating the emergence of new digital sectors such as software and video games.

A new CLP should deliver similar economic benefits. On the one hand, increasing the engagement, understanding and skills of the creative technologists and workforce of the future; on the other, creating business opportunities and growth for companies more directly involved. If the former is an obvious objective, it is important we recognise the latter. The challenges of computer literacy, future skill levels and the programmes and technologies to achieve them are global ones. Any solution that works in the UK context is likely to have international applicability with corresponding commercial opportunities.

Afterword

When thinking of actions for the future, the thoughts of John Radcliffe in 1982 still seem as prescient today as they did then:

"The effective exploitation of microprocessor technology in Britain will ultimately depend on the creativity and imagination that is brought to bear on the problems and possibilities of computer applications, and hence the capacity of the subject to attract the best minds and the liveliest talents. Our failures over the past years to compete in world markets for industrial goods have probably been at least partly due to the shortage of good scientists and engineers, through a failure to attract more young people to science based subjects."[119]

How very contemporary that sounds!

APPENDIX

Appendix A: Research interviews conducted

David Allen, Project Editor for Computer Literacy Project, BBC, interviewed 31 July.

George Auckland, Head of BBC Education Digital Media and Head of BBC Learning Innovation – retired 2011, interviewed 7 February 2007 with follow-up email 16 April 2012.

Howard Baker, Editor Innovations at BBC Learning, interviewed 24 February 2012.

John Biggs, co-founder of ARM Holdings and an employee at Acorn, interviewed 19 January 2012.

David Braben, founder of Frontier Developments and co-founder of the Raspberry Pi Foundation, interviewed 31 January 2012.

John Coll, Advisor, Acorn, wrote The User Guide, interviewed 4 July 2007.

Christopher Curry, founded General Information Systems Ltd and founding member of original Acorn team, interviewed 6 May 2008 and 21 February 2012.

David Darling, founded Codemasters, interviewed 23 February 2012.

Steve Furber, Professor of Computer Engineering at University of Manchester and member of original Acorn team, interviewed 28 January 2008.

Ed Goldwyn, BBC Director, *Now the Chips Are Down, Horizon*, 1978, interviewed in 2006.

Jon Hare, founded Sensible Software (acquired by Codemasters), 22 February 2012.

John Harrison, Deputy Sales Director for BBC Micro, BBC Enterprises, 27 January 2012.

Hermann Hauser, Partner, Amadeus Capital and member of original Acorn team, interviewed 5 July 2007.

Walter Herriot, MD St John's Innovation Centre, Cambridge, interviewed 30 April 2012.

Andrew Hewson, formed Hewson Consultants and 21st Century Entertainment, interviewed 24 February 2012.

Andy Hopper, Professor of Computer Technology at University of Cambridge and member of original Acorn team, interviewed 1 November 2007 and 5 March 2012.

Sheila Innes, Head of the BBC's Continuing Education Television Department during the Computer Literacy Project, interviewed 6 August 2008.

Paul Kriwaczek, consultant, Computer Literacy Project, BBC, interviewed 26 April 2007.

Kristen Mason, BBC Producer *Micro LIVE*, interviewed 20 March 2008.

Mike Montgomery, founded Bitmap Brothers and co-founded Lightning Fish Games, 16 February 2012.

John Radcliffe, BBC Executive Producer, Computer Literacy Project, interviewed 18 June 2007.

Richard Russell, creator of BBC BASIC at BBC Engineering, interviewed 5 November 2007.

Eben Upton, Executive Director of Raspberry Pi Foundation, interviewed 23 April 2012.

Sophie Wilson, computer scientist at Broadcom and member of original Acorn team, interviewed 16 October 2007.

Conrad Wolfram, founded Wolfram Research Europe Ltd, interviewed 27 March 2012.

Max Whitby, MD of Touchpress, previously BBC Multimedia Corporation, interviewed 6 March 2012.

Appendix B: Television programmes associated with computer literacy

Now the Chips are Down, Horizon, BBC, tx. 31 March 1978

The Mighty Micro, ITV, 1979
Six part series, tx. Monday 29 October, 1979

The Silicon Factor, BBC, 1980
Part 1: So what's it all about? (tx. 19 March 1980)
Part 2: Sink or swim (tx. 26 March 1980)
Part 3: And what of the future (tx. 1 April 1980)

Managing the Micro, BBC1, 1981
The application of computers in manufacturing
Five part series of 25 min programmes, tx. 17 May 1981 – 14 June 1981
Thinking Small (17/05/1981)
Getting in on the Act (24/05/1981)
Towards the Last Frontier (31/05/1981)
On-line (07/06/1981)
The Human Factor (14/06/1981)

Mind Stretchers, BBC Schools TV, 1981
Series 1 tx. BBC1 6 May 1981 – 12 June 1981:
Weather the Problem (06/05/1981)
Weather the Solution (08/05/1981)
Archaeology the Solution (15/05/1981)
Bridges the Problem (08/06/1981)
Bridges the Solution (12/06/1981)
Series continued until 21 June 1985 and then repeated

The Computer Programme, BBC, 1982
Ten part Series 1 of Computer Literacy Project
First transmissions:
BBC2, 15:05, Monday 11 January to 15 March 1982
BBC1, 10:10, Sunday 14 to 18 April 1982
BBC1, 23:20, Monday 22 March to 14 June 1982

Making the Most of the Micro, BBC, 1983
Ten part Series 2 of Computer Literacy Project
First transmissions:
BBC1, 23:30, Monday 10 January to 14 March 1983
BBC2, 15:05, Monday 10 January to 14 March 1983
BBC1, 12:35, Sunday 16 January to 20 March 1983

Making the Most of the Micro: Micro Live, BBC, 1983
tx. 2 October 1983
120 minutes Sunday morning special programme introducing the ability to download Telesoftware,
a demonstration of electronic mail and making microcomputer music

Computers in Control, 1984
Five part series about robotics and the monitoring and controlling of devices.
tx. 30 March 1984
Recognising the Obvious (30/03/1984)
Getting in Control (23/03/1984)
Making Things Move (16/03/1984)
Making Sense of the Real World (09/03/1984)
Introducing the Robot (02/03/1984)

The Electronic Office, 1984
Six part series on computer applications in the office
tx.12 April 1984

Micro Live, BBC, 1984
Ten part series for the Computer Literacy Project
tx. 24 June 1984
60 minutes Sunday morning special programme, part of a series that ran from October 1984.

Micro Live, 1985 – 1987
A second and third series of weekly half hour programmes ran from 1985 and 1986.

Appendix C: Further organisations acting as advocates for computer literacy

CDI Europe
The European Hub for CDI (Centre for Digital Inclusion) is a global network of community-based
centres working on digital inclusion, entrepreneurship and community action. In the UK, they run
the Apps for Good programme. Internationally, they are part of a global network made up of 803
self-managing and self-sustaining centres.

Computer-Based Math

This is a related initiative, supported by Wolfram Research, to build a completely new maths curriculum with computer-based computation at its heart. The idea is that teaching maths has got stuck on historical hand-calculating techniques, rather than getting children to think creatively about real world problems. Maths should be taught with computers so that they can do the calculating, and people can work on harder questions, try more concepts, and play with a multitude of new ideas.

http://computerbasedmath.org/

Co-founder Conrad Wolfram believes it's the understanding of how you use maths, what you do with it and how you analyse results that is important, not the ability to do the calculations yourself, as computers can do that part: *"Maths and computing are integrally related, because computing is the main tool for doing maths in the modern world. So the question becomes how do to you express yourself with a computer? In the end you need to program it. Learning composition in English is equivalent to learning programming in maths."*

Educating Programmers Summit

In August 2011, an Educating Programmers Summit was held at Bletchley Park. Attended by a mix of software developers, teachers and representatives of industry such as Microsoft, Google and the BBC, they addressed how, while 10,000 teachers qualify annually, in 2008 only three were computing graduates with the requisite skills to enthuse, support and develop the next generation of programmers.

Appendix D: Further technology and software initiatives

Microsoft .NET Gadgeteer

Gadgeteer is a rapid prototyping platform for small electronic gadgets and embedded hardware devices. It combines the advantages of object-oriented programming, solderless assembly of electronics using a kit of hardware modules, and quick physical enclosure fabrication using computer-aided design.

Individual .NET Gadgeteer modules can be connected together to construct both simple and sophisticated devices. Each module adds some extra capabilities, such as the ability to display images, playback sounds, take pictures, sense the environment, communicate with other devices or enable user interaction.

http://research.microsoft.com/en-us/projects/gadgeteer/

PICAXE

PICAXE is a microcontroller currently used in many schools to teach programming. Originally designed as an educational system for schools, the PICAXE system has now also been widely adopted by hundreds of thousands of 'hobbyists' due to its ease of use. Each year, thousands of high school students are also introduced to electronics and microcontrollers via building a PICAXE project. PICAXE chips are popular because they are very low cost, and simple to program using free, easy-to-learn software. The PICAXE chip can react to input sensors and switch outputs on and off accordingly.

http://www.picaxe.com/

"The PICAXE microcontroller programme … provides a very similar style of access to that provided by the BBC computer in the 80s (but, clearly, hugely cheaper and smaller). We now have KS3 classes not only designing and making their own embedded systems but also taking them home because the cost is so low."
Torben, Education Consultant, 1749524891

Minecraft
Minecraft is a software platform to enabling creativity in a virtual world. Although it's not coding in the pure sense, Minecraft allows people to build rather than simply play games. Based around an adventure/building game, players can design and create in the game, with children as young as three are able to play Minecraft.
http://www.minecraft.net/game

Alice
Alice is a tool for teaching introductory computing and programming through a user-friendly interface. It is a 3D programming environment that makes it easy to create an animation for telling a story, playing an interactive game, or a video to share on the web. The site include textbooks, lessons, sample syllabuses, test banks, and more.
http://www.alice.org/

YouSRC
YouSRC is a site that enables people to share apps written in a very simple programming language called ELC. All source code for the apps is freely available so users can see how people did things and learn from their skills. It acts as a starting point from where people can learn more complex and powerful languages and environments.
http://yousrc.com/

Greenfoot
Greenfoot is a visual interactive environment that teaches object orientation with Java. Users create characters which live in worlds to build games, simulations, and other graphical programs. The interface combines traditional text-based programming language with a visual environment.
http://www.greenfoot.org

Appendix E: Further events and courses for young people

Code Club
Code Club is a new project to teach children aged 10-11 how to program computers. The after-school clubs will be run by volunteers, rather than teachers, and built around MIT's Scratch programming tools. They aim to give children practical hands-on tasks that will include making games and controlling robots.
http://www.codeclub.org.uk/

Hack to the Future
This event was the idea of Alan O'Donohoe, an ICT Teacher from Preston. Hack to the Future invited 230 children to a school for a day of computer programming in February 2012. One-hundred and thirty-five mentors also came along from different roles in the IT community to lead workshops and talks on their specialist subjects. There were games designers, artists, programmers and lots more. The mentors donated their time free of charge, providing first hand knowledge on their specialist subjects. This was a chance for children to learn key skills, and use this information to make informed choices for their future academic studies, and their career paths.

CoderDojo
CoderDojo is a movement running free not-for-profit coding clubs and regular sessions for young people. At a CoderDojo, young people learn how to code, develop websites, apps, programs, games and more. Dojos are set up, run by and taught by volunteers. Dojos organise tours of technology companies, bring in guest speakers to talk about their career and what they do, and organise events. In addition to learning to code, members meet like-minded people, share what they have been working on. CoderDojo makes development and learning to code a fun and sociable, experience. CoderDojo also puts a strong emphasis on open source and free software, and has a strong network of members and volunteers globally.
http://coderdojo.com/

Codeacademy
Codeacademy encourages people to begin coding from the moment they enter the website. In encourages some basic coding, even before they register on the website to move to a more advanced platform. As the user moves through the stages they are given hints and awards. Codeacademy was created when its founders were tired with less effective text and video resources, so they teamed up to create a better, more interactive way to learn programming by actually coding.
http://www.codecademy.com

Manchester Girl Geeks (MGG)
Manchester Girl Geeks addresses the gender divide on a small scale. It is a not-for-profit group which organises networking events, talks and hands-on workshops for women and girls with an interest in Science, Technology, Engineering and Mathematics (STEM). They host Girl Geek Tea Party sessions in Manchester as an activity oriented, family friendly addition to the previously established dinners. The workshops are held monthly and include both hands-on activities such as an introduction to web development and 'Build your own PC' sessions, as well as talks on exciting science topics. All workshops are run by volunteers and are free to attend.
http://www.manchestergirlgeeks.com/

Coding for Kids
Coding for Kids was created by a community of young people, teachers, ex-teachers, developers, parents and industry with the purpose of finding ways to support education of programming and computational thinking for the current and next generations in the UK. This project is still in the early stages and based around an online wiki page. It is mainly aimed at collecting resources and approaches to programming education, and includes advice on how to start a computer club.
http://codingforkids.org

Hackasaurus
Mozilla have created Hackasaurus, an easy way to mash up and change any web page, and Nesta ran a two-day hack event with Mozilla in London to create some online missions to get more children coding. The hack day brought together about 40 people to create a series of Hackasaurus missions for young people to complete and was then followed by a day of testing with young people.
http://hackasaurus.org/en-US

Animation 12
The University of Manchester School of Computer Science launched the UK Schools Computer Animation Competition in 2008 to introduce UK schoolchildren to the fun side of basic programming whilst animating. The Competition happens annually to show schoolchildren that computers can be used creatively and to stimulate them to learn about programming.
http://animation12.cs.manchester.ac.uk/about

Codebreaker

As part of the Alan Turing exhibition 'Codebreaker', the Science Museum together with Hirsch & Mann, are creating interactive exhibits celebrating the culture of computer programming. Visitors of all ages will be able to experiment with the fundamental processes of programming and can extend this to do their own programming in a series of accompanying workshops.
http://www.sciencemuseum.org.uk/

TechnoCamps

TechnoCamps are a Welsh-based initiative the aim of offering young people aged 11-19 the chance to attend workshops on a range of computing-based topics such as robotics, video game development, animation, and digital forensics. They also offer teachers educational resources and inspire them to set up TechnoClubs.
http://www.technocamps.com/

Udacity

Aimed at university level, Udacity offers free courses in Computer Science through the Internet. Ranging across cryptography, web applications and robotics, the site was founded by three roboticists who believed that the educational value of their university classes should be offered to students all over the world.
http://www.udacity.com/

ENDNOTES

1. David Allen at the Beeb 30th Anniversary panel debate held by the Centre for Computing History, at ARM, Cambridge, 25 March 2012.

2. **http://www.guardian.co.uk/media/interactive/2011/aug/26/eric-schmidt-mactaggart-lecture-full-text**

3. Telephone interview with Sheila Innes, 6 August 2008.

4. David Allen, BCS@50 conference, British Computer Society, 14 July 2007.

5. Complete list of associated programmes in Appendix B.

6. Allen, D. and Albury, R. (1980) 'Microelectronics.' BBC Education, pp.1-64.

7. Email from David Allen, 3 May 2012.

8. Interview with Paul Kriwaczek, 26 April 2007.

9. Interview with John Radcliffe, Islington, 18 June 2007.

10. From 'Outline Specification for the BBC Micro, John Coll'.

11. David Allen at the Beeb 30th Anniversary panel debate held by the Centre for Computing History, at ARM, Cambridge, 25 March 2012.

12. Email from David Allen, 3 May 2012.

13. Interview with Richard Russell, 5 November 2007.

14. Later Tangerine renamed itself Oric Products International and the machine formed the basis for the Oric 1 computer.

15. Interview with Christopher Curry, 6 May 2008.

16. Interview with Sophie Wilson, 16 Oct 2007.

17. Interview with Steve Furber, 28 January 2008.

18. Interview with Hermann Hauser, 5 July 2007.

19. Email from John Radcliffe Wednesday 24 September 2008.

20. David Allen at the Beeb 30th Anniversary panel debate held by the Centre for Computing History, at ARM, Cambridge, 25 March 2012.

21. Email from John Radcliffe Wednesday 24 September 2008.

22. 'Acorn Computers BBC Master Series Micro Exhibition and Launch' in File R103/101/1

23. 'First Byte' in File WW4/1, 442/1.

24. Radcliffe,J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Project 1979-1983.' London: BBC Education. p.40.

25. Speech summarising the key elements of the BBC Computer Literacy Project, R103/101/1 Acorn Computers BBC Master Series Micro Exhibition and Launch.

26. Local Radio - Micro Live Liaison Plan, October 1984, R103/77/1 Micro Live.

27. Email from David Allen, 3 May 2012.

28. Paper tabled by Bob Salkeld at EO's Meeting April 20-22 1982, R99/172/1 Microcomputer Software Policy.

29. Interview with Steve Furber, 28 January 2008.

30. Radcliffe, J. 'BBC Micro ingites memories of revolution.' BBC website, 21 March 2008, **http://news.bbc.co.uk/1/hi/technology/7307636.stm**

31. Interview with David Braben, 31 January 2012.

32. Interview with Steve Furber, 28 January 2008.

33. Now known as a System On Chip (SOC).

34. Interview with Andy Hopper, 1 November 2007.

35. Ibid.

36. Radcliffe, J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Project 1979-1983.' London: BBC Education, p.30 - 31.

37. Ibid, p.35.

38. Radcliffe, J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Project 1979-1983.' London: BBC Education. p.36.

39. Interview with Steve Furber, 28 January 2008.

40. Interview with John Biggs, 19 January 2012.

41. Interview with Andy Hopper, 5 March 2012.

42. Programme for the celebration of 30 years of Acorn, 1978-2008, Cherry Hinton Hall, 13 September 2008, p. 13.

43. BBC Computer Literacy Project, Relations with Acorn Computers, David Kitson, Roy Williams, and John Radcliffe, 20 May 1982, File R103/1/131.

44. Report of the BBC Technical Study Group, 3 October 1983, File T62/233/1.

45. Memo from John Radcliffe, 28 November 1983, File R103/1/131.

46. Interview with John Radcliffe, 18 June 2007.

47. Future Policy for Microcomputer Hardware and Software Developments, 1983, File T62/233/1.

48. Interview with John Harrison, 27 January 2012.

49. Computer Literacy Project: Evaluation January 1983, File R9/96/1.

50. Linn, P. (1991) Microcomputers in Education. In: Mackay, H. 'Understanding technology in education.' Falmer Press. pp.208-209.

51. Report of the BBC Technical Study Group, 3 October 1983, File T62/233/1.

52. Confidential paper,'"Micro Futures, Softwares and Delivery Systems.'" 25/07/1985, File R103/121/1.

53. Letter from John Harrison, Deputy Sales Director, Enterprises to Robert Coates, Acorn Computers, 26 Sept 1985. File R103/101/1.

54. Interview with Christopher Curry, 21 February 2012.

55. A Preview of The Computer Programme. A complete computer literacy telecourse based on the television series from the BBC, Distributed by Films Incorporated, 1983.

56. Interview with Steve Furber, 28 January 2008.

57. Letter from EE to DGMP, 29 February 1984, File WW4/1, 422/1.

58. Memo from EE to DGMP, 4 May 1984, File WW4/1, 4/221.

59. Interview with Sophie Wilson, 16 October 2007.

60. Interview with Steve Furber, 28 January 2008.

61. Radcliffe, J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Project 1979-1983.' London: BBC Education. p.42.

62. This finding is confirmed by research which shows that the BBC Model B was often recommended as a computer system in each Australian State and Territory. Tatnall, A. (2012) The Australian Educational Computer That Never Was. 'IEEE Annals of the History of Computing.' 21 March 2012.

63. Letter from R. A. Bayham Managing Director, Acorn to Byron Parkin, BBC Enterprise Ltd, 22July 1982, File WW4/1, 422/1.

64. BBC Export meeting with Acorn, 1 February 1984, File WW4/1, 422/1

65. Letter from John Radcliffe Executive Producer, Continuing Education, Television to DPA, 01 March 1984, File WW4/1, 422/1.

66. Letter from David Allen to John Radcliffe, 12 March 1984, File R103/105/1.

67. Letter from Donald Grattan, Controller, Educational Broadcasting to Kenneth Baker MP, 19 March 1984, File R103/105/1.

68. Letter from Donald Grattan, Controller, Educational Broadcasting to Kenneth Baker MP, 19 March 1984, File R103/105/1.

69. Letter from David Allen to John Radcliffe, 12 March 1984, File R103/105/1.

70. The Future of the BBC Micro May 1984 written by John Radcliffe, DJM Kitson and RT Russell, File R103/105/2.

71. Interview with Richard Millwood, formerly the Computers in the Curriculum project at Chelsea College, University of London, which was sponsored by the Microelectronics Education Programme MEP, 27/03/2012.

72. Floodlight was founded in 1936, with the aim of promoting learning options to adults. It has now been taken over by Hotcourses.

73. Thorne, M. (1987) The Legacy of the Microelectronics Education Programme. 'British Journal of Educational Technology.' p165.

74. Email Roger Broadie, formerly MEP, 28 March 2012.

75. Radcliffe, J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Project 1979-1983.' London: BBC Education. p.23-24.

76. The Computer Referral Service, file R103/140/2.

77. Ibid.

78. The NEC still exists today, and is one of the UK's leading providers of both tutor-supported home study courses and open learning materials for colleges, companies, tutors and trainers.

79. In an email on the 5 March 2012, Richard Freeman, the former Director of the NEC, recalled the NEC's surprise at selling 3000 copies of 'The Silicon Factor' in 1979, when previously the NEC's Algol from 1972-1981 had never had more than ten students a year; their Introduction to Computing from 1968-1981 had a maximum enrolment 112 in 1969-1970; and the Introduction to Programming course from 1972-1981had a maximum enrolment of seven.

80. Richard Freeman, email 5 March 2012.

81. Richard Freeman, email 5 March 2012.

82. Ibid.

83. Radcliffe, J. and Salkeld, R. (eds.) (1983) 'Towards Computer Literacy: The BBC Computer Literacy Project 1979-1983. London: BBC Publications. p 33.

84. Ibid, p. 39.

85. Universities Statistical Record (USR) has collected data since 1968, whereas Universities and Colleges Admissions Service (UCAS) started collecting data about university courses and admissions in 1996. USR recorded A Levels that were taken by all university entrants, including computer studies as a separate subject. Post-1983 these diversified into the following four subjects: Computer Science; Computer Studies; Computer Science Endowment and Computing. For ease of comparison with pre-1983 data these have been grouped together.

86. On 1 March 2012, John Pugh MP asked Business and Innovation Secretary David Willets MP to give the percentage change in the number of students studying computer science or another technical subject at degree level between 2002 and 2012 (answer 6 March).

87. CET (1978) 'Microelectronics: their implications for education and training: a statement.' London: The Council for Educational Technology. p.16.

88. Linn, P. Microcomputers in Education. In: Mackay, H. (1991) 'Understanding technology in education.' pp.193-233.

89. Weaver, B. (1982) 'Document C: the DoI offer – advice by ILEA.' from ILEA Inspector for Computer Education, 14 October 1982.

90. Letter from Bob Salkeld, to Don Steel, EO CE North, 1 July 1981, R99/123/1 BBC Microcomputer Acorn Computers Ltd.

91. Email from Roger Broadie, former MEP, 28 March 2012.

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