# Hardware Heritage—Briefcase-Sized Computers

**Karol Król** (ID)

Digital Cultural Heritage Laboratory, Department of Land Management and Landscape Architecture, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, Balicka 253c, 30-198 Krakow, Poland; k.krol@onet.com.pl

**Abstract:** The computer industry was a vivid place in the 1980s. IT systems and technologies thrived, and the market offered ever better, smaller, and more useful machines. Innovative technical solutions or intelligent designs that satisfied customers' needs are often listed as computer hardware milestones. Consequently, they became a permanent part of the computerisation history and can be considered hardware heritage artefacts. The purpose of the paper is to analyse the usability of selected portable computer systems. The foundation of the work is a literature review that includes technical specifications, industry reviews, and research papers. Archival materials were obtained from the Internet Archive. Studies have revealed that the main problems design engineers of portable computers had to tackle in the 1980s were the reduction of mass and size of the computer system, portable power (self-power), and the quality of the displayed image.

**Keywords:** hardware heritage; easy to carry; briefcase-sized computer; portable computer system; lunchbox-style portable computer; transportable computer; 1980s technology ideas

## 1. Introduction

History is not a soulless record of past events, places, and people. The past explains what we call the present. It exhibits the origin of the world around us. Even though one could argue this view to be arbitrary, historic events show us what is important and why. It is possible thanks to the preservation and transfer of 'historical memory' perpetuated in tangible and intangible cultural heritage components [1].

The possibilities of recording and preserving social knowledge resources related to cultural assets are as diversified as cultural heritage itself: from cave paintings to virtual worlds or pieces of binary code. Computer tools can create (digital) cultural heritage components and turn into heritage objects themselves. At the same time, they render the past accessible, or more accessible, and more tangible [2].

Heritage is a constantly evolving collection of material objects and symbols, the complexity of images, cultural artefacts, statues, and ethnic customs relevant to specific groups or communities. The past is the spirit of a reality gone by that survived in pieces and can be experienced only from a temporal perspective. It cannot be restored in whole and exactly as it used to be. Nevertheless, attempts are made to represent it to today's generations as accurately as possible [3]. Cultural heritage assets can be tangible, intangible, natural, and digital. The Convention Concerning the Protection of the World Cultural and Natural Heritage [4] found these assets are at risk of destruction not only by the 'traditional causes of decay' (such as water erosion, light, or humidity), but also by socioeconomic and cultural changes that drive consecutive generations towards ignorance and abandonment of some heritage assets, or even intentional damaging or destruction. Moreover, the discussion concerning what digital cultural heritage actually is continues. Which objects, both hardware and software, are worth preserving (archiving), which are not, and who is to decide that [5]? It is a certain research gap that justifies relevant studies.

The computer industry was a vivid place in the 1980s. IT systems and technologies thrived, and the market offered ever better, smaller, and more useful machines. Manufac-

turers came and went just as swiftly, and users had plenty to choose from. The market slowly grew full of household PC machines with MS-DOS software that were relatively heavy and expensive. That is why designers strove to build a portable, self-sufficient (versatile) computer with a quality colour display (and a reasonable price). Many devices were advertised as 'truly portable'. The purpose of the paper is to analyse the usability of selected portable computer systems. For the purposes of this paper, a portable computer is one that one person can carry–but not one that is necessarily easily carried.

Many computers from the 1980s grew to be considered 'milestones', crucial steps', or even 'cult'. Innovative technical solutions or intelligent designs that satisfied customers' needs and were available at reasonable prices are often listed as computer hardware turning points. One can identify various causes of this tendency. The 'immortality' and exceptionality of some models were usually conditioned by socioeconomic or technological factors or both. Some attributes that determined the selling success in the 1980s include performance, weight, size, and usability in a broad sense. Some designs that managed to overcome barriers hindering the comfort of use won the market and found their place in the annals of the history of computerisation.

This paper is organised as follows. Section 2 concerns the notion of hardware heritage, emphasising its relevance to the history of computer hardware and software and its relations to everything that built the user experience and socioeconomic context. Section 3 describes the methodology, focusing on sources of information, whilst Section 4 provides an overview of the study results. The paper is concluded with a discussion and summary.

## 2. What Is Hardware Heritage?

Heritage is something that is, or should be, handed down between generations as an object of value because it conveys a specific value for someone. According to UNESCO's concept of digital heritage [6], 'digital heritage is made up of computer-based materials of enduring value that should be kept for future generations. Digital heritage emanates from different communities, industries, sectors and regions. Not all digital materials are of enduring value, but those that are require active preservation approaches if continuity of digital heritage is to be maintained'.

Heritage should be considered in relation to a point of reference in a specific context. Some (outstanding) objects/assets are considered world heritage. At the same time, individual countries or regions determine their components of national, state, or local heritage valid in specific circumstances. Still, the value of heritage can also be derived from what is important to a group or community (such as software or hardware users). Digital heritage is often tended by aficionados or hobbyists brought together by grassroots initiatives [7,8]. This way, many digital heritage assets were saved from oblivion, including software (such as archaic video games) and hardware.

Digital heritage's focal point is digital data and software (software heritage). Still, it requires computer equipment or electronics for operation, including peripheral devices, accessories, and gadgets, both digital and analogue. The investigation into the technological progress of computerisation, which has influenced the usability and functionality of digital equipment, facilitates a reflection on the intellectual foundations of the development of software, databases, and (data) files as digital heritage assets. Digital software heritage or digital folklore could not exist and do not exist without hardware heritage. They could also not be effectively protected and shared. Therefore, computer hardware is part of digital cultural heritage.

Today, the world seems to be fixated on breaking up with the technology of old. Not so long ago, the computer was associated mainly with a desktop device. Nowadays, computers are increasingly associated with remote access and cloud computation. Data availability and computer work are no longer restricted by the physical location of the machine or the user. What is more, the software of the previous period (installed on a medium, internal hard drive, reinstalled, etc.) controlled the spatiotemporal usability of hardware. It offered user interfaces with access to data and data processing capabilities [9].

Today, software is available through browsers and does not need to be installed on the device on which it is used. However, it is a different, much broader discussion [10,11].

Hardware, device, and technology heritage is often described in the context of modern IT, computerisation (from the first digital computer to the Web) [12], and software engineering [13]. The same applies even to outer space exploration, space stations, and the use of 'legacy equipment' to reduce costs of new space missions [14,15]. A common implementation of design reuse is through flight heritage or legacy designs. Barley et al. [16] defined heritage systems as 'hardware, software, and procedures with previous flight history that are reused for a new mission in order to enable a mission capability or reduce overall mission cost, schedule, or risk'. Moreover, Barley et al. [16] defined inheritance as the process through which the compatibility and benefits of heritage systems to the new mission are evaluated. One must appreciate that most computers and pieces of 'modern equipment' would be of limited use or even useless without software (software heritage) [17].

Hardware heritage is the history of both hardware and software. Human knowledge, experience, and skills are translated into computation models (binary code) in software and computer environment ('digital ecosystem'). The history of software is a history of how different communities of practitioners 'put their world into a computer' [17]. It was the beginning of a new perspective on the mechanisms that ran the world and helped develop new tools to express oneself and pursue goals: computer programs. From this viewpoint, models and tools that constitute software reflect the stories of communities that created them and cannot be properly comprehended without insight into these stories; stories that are much more than computer hardware and software and include the socioeconomic, political, and cultural context [17].

Therefore, hardware heritage is equipment, software, and all user experience components within a socioeconomic, political, and cultural context. Computer systems changed how we work with data and perceive data as such. They were the beginning of 'data processing'. As a result, the history of computers, software, and its socioeconomic environment are of key importance for the development of the IT and modern technologies in general [18]. Archaic hardware attracts not only historians or fans of retrocomputing [7]. Technological artefacts are still employed, for example, in teaching. The use of 8-bit machines (from around 1980) in programmer training is an example of this. The archaic technology turned out to pose challenges in completely different programming circumstances [19].

## 3. Materials and Methods

Digital heritage research focuses mostly on: (1) digitalisation of tangible (analogue) heritage assets; (2) preservation of digital heritage; (3) use of digital heritage; (4) presentation, sharing, and promotion of digital heritage; and (5) legal matters relevant to the protection of the heritage [5]. Hence, the issue is rather broad, and applies to equipment (modern and archaic), software, and digital data.

Historical research on digital cultural heritage in the context of the hardware heritage focuses mostly on archaic devices and the early days of computer systems [2]. Many texts on the matter were written by hobbyists and enthusiasts who depicted their experience, thoughts, memories, and reminiscences. Many publications are based on archival materials such as computer magazines, manuals for old equipment, etc. or are compilations of various older articles [2,18]. A special place among them is reserved for publications of corporations that had a particular impact on the technological transformation and take good care to ensure their contribution to the history of computers and software is recognized [20].

The study was desk research. The potential of desk research is yet to be fully exploited. It is a shame because it takes little financial or organisational effort to explore many (digital) data sources. Desk research can solve intricate research problems. It can also be the first step towards 'research proper' or complement it [21].

The foundation of this work is a literature review that included research papers and 1980s industry literature. Archival materials were obtained from the Internet Archive (IA). The Internet Archive's Wayback Machine is the largest and oldest public Web archive and has become a significant repository of our recent history and cultural heritage [22]. Internet archive resources are provided free of charge to historians, researchers, and for education purposes.

The analysis involved selected IA resources in 'eBooks and Texts'. First, the search was narrowed down to the section 'The Computer Magazine Archives' (a metadata search with the keyword 'computer'). Next, a text search engine was used with the following keywords: portable computer, easy to carry, briefcase-sized computer, portable computer system, lunchbox-style portable computer, transportable computer and their various combinations. The result was specific articles from computer magazines.

Usability is a property of software or hardware that determines its use quality. Usability is a measure of the comfort of use of a specific piece of software or hardware and translates into their potential efficiency when used for specific purposes. The usability indicators for portable computers (regarding technical, design aspects) can be CPU performance, display size, image quality, weight and size of the system unit, and RAM. They all affect use comfort when working with software but also transport convenience. A usability analysis can trace the evolution of hardware and better identify breakthrough solutions worth preserving for future generations.

The work assumes that usability is the measure of the comfort of use of a portable computer. The study on portable computer usability focuses on the size (dimensions) and weight (mass), factors that affect mostly portability. The display technology and image quality were assessed as well. These attributes contributed to the weight of the computer system to a significant degree in the 1980s, which made it harder to move it around.

## 4. Results

One of the distinguishing features of the businessman of the 1980s was slightly inconvenient briefcases. They contained no papers or writing implements but were cases of portable computers (Figure 1). It was the philosophy of computer manufacturers tens of years ago that a complete kit with a display in a case should be taken from the office to home and back, and also used for business travel.



**Figure 1.** Briefcase-sized computers (the 1980s). In the figures, left to right: the Otrona Attache, Findex microcomputer, TRS-80 Model 4P, Osborne Vixen. Source: original work based on materials from Internet Archive.

The 1980s saw many machines whose designers claimed them to be portable. Technical specifications of selected models have been included in the Appendix A (Table A1). Some models had handles integrated with the case, such as the 1979 8-bit Findex, which weighed 31 pounds, or 14 kg [23]. The Findex was advertised as a standalone and portable computer

system that could be taken on a plane or to a car. 'Wherever you go, FINDEX goes with you'. Its optional battery and built-in printer improved the system's functionality [23].

Computers were not cheap in the 1980s. It was not a good idea to carry them far without a carrying case. It did not take long before manufacturers offered dedicated 'briefcases' and covers for transporting the computers. The carrying cases for the first portable computers looked nothing like today's briefcases. They looked more like trunks for wheeling equipment because it would be hard to carry a dozen or several dozen kilograms of equipment in a large box through the city (Figure 2).



**Figure 2.** Carrying cases from Radio Shack. Microcomputer Newsletter–Edition No. 2 (1978-11). Source: Internet Archive (1978) [24].

This is how Radio Shack described a set of carrying cases for the TRS-80 system: 'One attache-like case houses the keyboard, recorder, power supply and cassette tapes. Black leatherette vinyl. Only for hand carriage. Not for transportation purposes' [25].

Not all portable computers came with a separate dedicated carrying case. Many systems had cases that doubled as carrying devices. A good example is the Osborne 1 with its small monitor in a plastic case (Figures 3 and 4). The user would open and close it just like luggage that it resembled thanks to a leather handle. It weighed 24.5 pounds or 11 kg. Consecutive Osborne machines, the Osborne Vixen, for example, were also 'enclosed in carrying cases'.



**Figure 3.** On the right-hand side is the Osborne 1 with its briefcase-sized body. Source: Personal Computing, December 1981 No. 12, p. 42, Internet Archive (1981) [26].
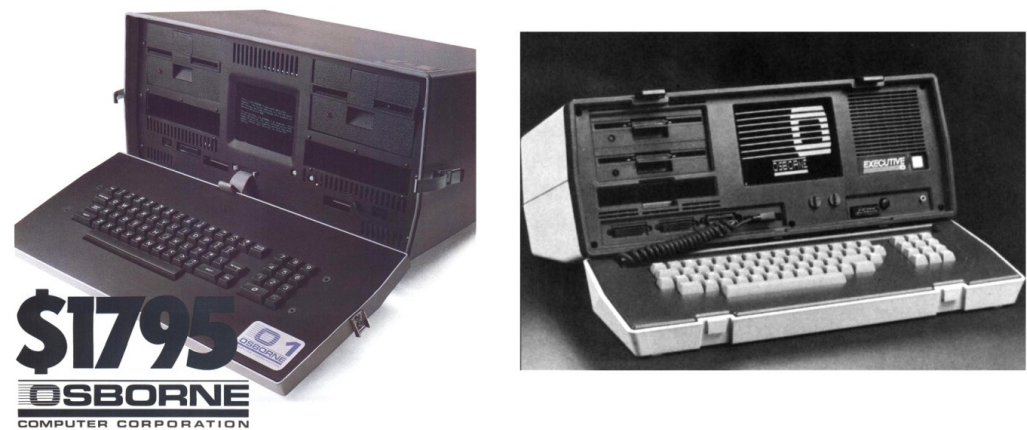
**Figure 4.** Left to right: The Osborne 1 portable computer; the Osborne Executive. Source: Internet Archive (1981, 1983) [27,28].

Following a reorganisation, Osborne Computer Corporation (OCC) was ready to conquer the market with two new computers, the Osborne Vixen and the Osborne 3 in late 1984. Determined to regain his market position, the founder Adam Osborne abandoned the CP/M operating system and manufactured his first and last IBM-compatible machine, the Osborne 3 (Figure 5). The Osborne 3, advertised as midsize, no-frills, portable, was the last portable system by OCC.



**Figure 5.** The Osborne 3 with an 80-character by 16-line liquid-crystal display (LCD) and two 5.25″ floppy-disk drives. Source: Internet Archive (1985) [29].

OCC decided to install a smaller, 16-line monitor instead of a standard 25-line one to reduce the price. Similarly to all early LCD screens, the one in Osborne 3 was not backlit. Therefore, the monitor had poor contrast, which made it difficult to read without good lighting. Some users mentioned additional light sources they carried to operate their Osborne 3s [29].

The Osborne 3 was 'truly portable' and could run for about five hours on a rechargeable standard NiCad video-camera battery. But it came with no battery or software. With one drive, the machine weighed 9.5 pounds (a little over 4 kg) without the battery, which was approximately the weight of the typical luggage. An external dial-up modem facilitated a connection with other computers over phone lines.

The Osborne 3 had an Intel 80C86, 16-bit 3.5 MHz CPU, 256 KB RAM (expandable to 512 KB using 256 KB DRAMs) and was compatible with MS-DOS 2.11. In 1985, it was discounted to 1895 USD from 2995 USD (for a set with two floppy drives and 256 KB RAM). The reduction did not save the company from going bankrupt in early 1986 [29].

The Morrow Pivot was a virtual twin of the Osborne 3, but in reality, it was the Osborne 3 that was based on the Morrow Pivot. The Morrow Pivot weighed 9.5 pounds (4 kg with no battery and a single floppy drive) and featured a Harris 80C86, 3.33 MHz CPU. The 16-bit machine from 1984 was the first product of Morrow Design compatible with Microsoft's MS-DOS (previous systems usually run on S-100 or CP/M). The Morrow Pivot was classified as a lunchbox-style portable computer with a vertical design and a fold-in keyboard. May 1985 saw the Morrow Pivot II, which was a slightly cheaper and improved version of its predecessor. It had a 25-line, backlit LCD EL screen (640 × 200). It offered a slightly better performance and was fully IBM-PC compatible. Despite the improvements, Morrow Designs could not withstand competition and filed for bankruptcy on 11 March 1986 [30,31].

The TRS-80 Model 4P portable system (1983) was advertised as 'the perfect computer for our mobile society' that can be taken along literally everywhere (Figure 6). The Model 4P was easy to carry and small enough to stow in luggage racks on a plane, train, or bus.



**Figure 6.** The Radio Shack TRS-80 line (the Model 4P in the centre of the bottom row, 1983). Source: Internet Archive (1984) [32].

It was not easy to offer colour, 'advanced' graphics in the 1980s. In most cases, additional components, generators, or controllers were used. A good example is the TRS-80 with a peripheral colour graphics generator/controller the Percom Electric Crayon (Figure 7), which offered a semigraphics mode as well [33].



**Figure 7.** The Electric Crayon was $249.95 (April 1980). It was delivered complete with the EGOS system, 1 KB of video memory, and a thick user manual. Source: Internet Archive (1980) [34].

The Percom Electric Crayon was a small box (12 inches wide and 9 inches deep, 30 by 23 cm), which output a video signal to a monitor or TV. It connected directly to the TRS-80's printer port and did not support sprites [33].

Another example of a computer system transformer that could turn into a carrying case and back was the Otrona Attache (1982, Zilog Z-80A, 4 MHz, 5.5″ amber CRT). The Otrona Attache was referred to as the 'BMW of portable computers' in the early 1980s. The Attache was launched a little after the Osborne and the Kaypro II and, with 18 pounds (8 kg), was by far the smallest and most portable of them all. Still, it was a little more expensive [35].

The Telcon Zorba (22 pounds, about 10 kg) and the Kaypro II (about 26 pounds or 12 kg) were built similarly. The Zorba had a sturdy, brown, plastic carrying case with a leather handle [36]. The Kaypro had metal housing. According to Rimmer [37] of Computing Now! It took less than a minute to transform the Zorba from a suitcase into a computer even if 'you are partially asleep'. 'You unhitch the front of its box ... the keyboard ... heave it on a table or other horizontal phenomenon, plug in the cable that connects it to the rest of the computer, plug in the power cord and boot the system'.

While the machines discussed above were advertised as handy carrying cases, the Zenith Z-171 PC (1985, 14.4 pounds or 6.5 kg) was a lunchbox that could fit on your shoulder. It was, perhaps, because the Zenith was slightly lighter than other similar designs due to the use of an LCD display. The Zenith Z-171 was presented as a briefcase-sized computer hanging on a woman's shoulder not without reason. The subliminal message was clear: the Zenith was lightweight and easy to handle, even for ladies. Indeed, six and a half kilograms was a very good result for a complete computer system in 1985 [38].

The Sharp PC-7000 (1984) consisted of three main components: a system unit with a display, keyboard, and printer. All of them had cream, light grey plastic housings. The keyboard and the printer could be clipped to the main unit to form a suitcase (Figure 8). Its handle made the system easy to carry, particularly without the printer (weight without the printer was 18 pounds or about 8 kg). With the printer clipped, the case grew significantly heavier by 11.5 pounds or over 5 kg. The complete set weighed about 13 kg.



**Figure 8.** The Sharp PC-7000. Source: Personal Computer World (1985-12, p. 153). Source: Internet Archive (1985) [39].

The adjustable handle was an interesting design feature, particularly useful after attaching the printer. The user could compensate for a shifted centre of gravity to improve carrying comfort.

Data General was among the first manufacturers of minicomputers in the 1960s. The Data General One (CPU: Intel 80C88, 4 MHz) was advertised as the first fully functional business system for working at the office, home, or anywhere else: 'truly portable, IBM-compatible personal computer with a full-size LCD display' [40].

The Data General One (DG/One) was a typical PC with built-in floppy drives and a full-size display. It was compatible with a portable printer and a battery for eight hours

of operation, an external modem, and a 5.25″ floppy drive [41]. The $2895 machine was launched in 1984 (Figure 9) and weighed 10 pounds or 4.5 kg.
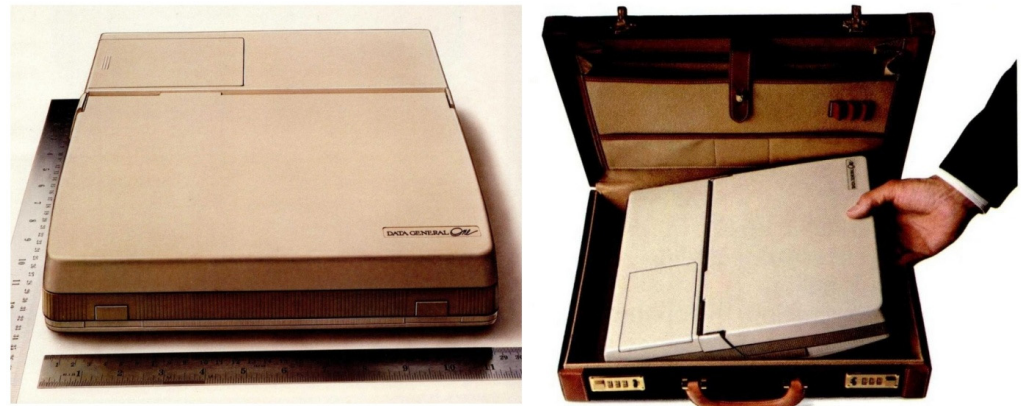


**Figure 9.** The Data General One–lightweight and portable. Source: Internet Archive (1984) [41].

The Data General One was advertised as a battery-powered mobile workstation with such advanced features as one or two 3.5″ floppy drives by Sony. It had the largest, 11″ display of all portables at that time, which could display 25 lines of 80 characters. The Data General One was only 4.5 kg, which was much less than the competition, for example, the IBM Portable PC (30 pounds, 13.6 kg) [40].

The Data General One was not flawless. The gigantic, 11″ LCD screen was 'new and amazing' but offered poor contrast, making work harder. The monitor had only two positions: opened and closed. Batteries were charged with a large external 5.8 VDC power supply. The system had no transport handle [40]. These problems were regularly taken care of in successive versions. Nineteen eighty-six saw the DG/One Model 2 with an electroluminescent display (ELD), and Model 2T was launched in 1987. Even though the new ELD offered an unparalleled image quality, its power consumption was too high for battery power.

Model 2T was designed to work only with an external power supply, which improved the image quality at the expense of portability. In January 1988, the system consisted of a new, blue supertwist (STN) LCD and a 20 MB hard drive. All this for 3195 USD.

The Data General One was a breakthrough design in 1984 but rather obsolete in the late 1980s. Portable Macintosh systems became available and slowly displaced the last 'heavy and cumbersome' portable computers, the DG/One. Nineteen ninety saw pocket computers, such as the Poqet PC and Zeos PPC with 80 × 25 displays weighing a pound or less.

Another machine with a handle that was part of its case was the Apple Macintosh (Figure 10). The Macintosh was first released in 1984 with 128 KB RAM. It quickly turned out to be insufficient. The manufacturer managed to release an upgraded version the same year; it was dabbed 'Fat Mac' due to its 512 KB of RAM. Interestingly, the computer had an innovative Macintosh GUI (graphical user interface) operating system, which was well-received. The computer could be transported over significant distances in a dedicated case by Macintosh. The Macintosh Portable was the first portable Apple computer powered by lead-acid batteries. The Macintosh Portable was released in 1989 with the Motorola 68HC000 @ 16 MHz and 1 MB RAM (9 MB max). The video was displayed on a 10-inch black and white active matrix LCD screen. The computer had a new, advanced display, which affected the price: USD 7300 in 1989. Despite the breakthrough solutions, the computer was not successful. It was relatively heavy (16 pounds or 7.2 kg). Its high price did not help. Two years later, a lighter and cheaper successor was released, the PowerBook 100.
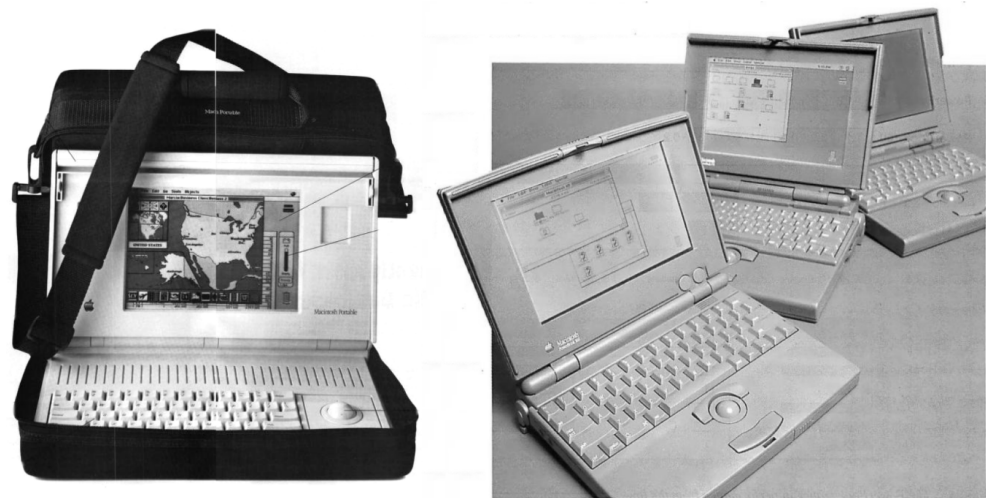
**Figure 10.** Left to right: The Macintosh Portable; Apple's PowerBook 170, 140, and 100 set the standards for portability and ease of use. Source: Internet Archive (1989, 1992) [42,43].

## 5. Discussion

The selected models of computers can be considered hardware heritage in light of the analysis of their technical and usability attributes as they are turned out to be breakthroughs. Users and experts often refer to them as 'exceptionally important', noteworthy, or 'indispensable'. The selected designs were in demand, selling in millions of copies, which paved their ways into the history of computerisation. Others were such failures that users struggling with their shortcomings have been immortalised in numerous anecdotes. Others yet were breakthrough designs that led the way of future development. In the 1980s, such attributes as weight, image quality, performance, or operation (including the operating system) determined to a large extent the uniqueness of consecutive models and drove the (technological) development of computers. They also affected machine usability. It played a particular role in the 1980s. Computers were not popular at the time. Many people had had no computer experience and were unfamiliar with their functionalities and operation. What is more, many buyers were disappointed that their machine was harder to use than they expected. This led to the potential of many computers, mostly for business use, lying idle. Therefore, manufacturers' priorities were education and hardware performance (operating speed), functionality (number of applications), and usability (weight and size or image quality) improvement.

Institutions and communities involved in archiving and promoting digital resources have underestimated the value of the proposition that the best way to preserve digital artefacts 'as they really were' is to maintain the original hardware they were created and used with. Data migration and emulation were perceived as the primary methods for ensuring the availability of archaic software and files. However, the use of archaic software produced in the mid-1980s may be difficult. It was the time of many incompatible operating systems and file formats that were discontinued for various reasons (mostly financial ones), while their creators did not care for archiving their work. Original hardware and software combined with the socioeconomic context they existed in may be necessary to fully comprehend the nature of these artefacts [44]. Moreover, a computer without software is useless. Hence, it has to be stored together with the operating system to fully show its potential regarding the current state of technology [45]. It justifies the effort to preserve archaic hardware with software and provides a rationale for historiographic analyses.

According to Bill Machrone [46], no discussion on portable devices is complete without mentioning the Golembo effect. Eri Golembo was vice-president for sales and marketing at Prodigy Computer Centers and a founding father and board member at the Association of Better Computer Dealers–now CompTIA. In the 1980s, Eri Golembo noticed that consumers would buy any new product that is made smaller, retains the functionality of its larger

counterpart, and has a handle (is easier to transport) [47]. The effect was used as an argument for miniaturisation and advancement of portable computers that would drive demand for household computers through increasing miniaturisation.

The Golembo effect was first evoked in literature by Bill Machrone [46,47], who used it in his piece on the Compaq Portable. In his paper, Machrone [46] argued that the Compaq Portable II would be a marketing success thanks to the Golembo effect. Machrone [46] emphasised that portable computers were not as functional as their desktop counterparts, indicating that Compaq Portable II's performance was better.

The Golembo effect was first proposed on pages of PC Magazine by Bill Machrone. There, one can find reference to the effect and its description, which remains underappreciated in scientific and popular science literature. Still, it is an interesting aspect worth mentioning in the context of hardware miniaturisation.

A portable computer should be easy to carry from one place to another (using human muscles and over significant distances, not only from the desk to a car). One should not mistake the word 'portable' for 'transportable' here. Otherwise, every computer would be portable if a sufficiently large vehicle is available. Wszola [48] proposed the following typology of portable computers in 1983:

- pocket computers: they fit into a pocket, are battery-powered, lightweight, offer 1-line displays, small memory, and most commonly, BASIC preinstalled in ROM (Read-Only Memory). Data were stored on cassette tapes. Touch typing was impossible on keyboards of pocket computers. The single line could be used for elemental programming only. The Sharp PC-1500 is an example of such a computer (Figure 11). Moreover, there was a custom-manufactured version of the PC-1500 built by Sharp for Tandy Radio Shack, called the TRS-80 PC-2. Apart from a different keyboard layout, it was identical. The Sharp PC-1500 was very popular among computer hobbyists, and it was used by many companies who equipped their field staff with the machine.
- briefcase computers (briefcase styling): these computers were small enough to fit into a briefcase. They usually offered a 4 to 8-line display, full-size keyboard for touch typing, and serial and/or parallel ports. They were AC or battery-powered. Most briefcase computers used BASIC, while some included applications, such as word processors, telecommunication programs, or diaries. Data could be recorded to various media. Additionally, the relatively low weight (five to ten pounds) and size of the machines made them portable. Examples of briefcase computers are the Radio Shack Model 100 or the Data General One.
- transportable computers: were relatively heavy. They could be moved but not easily. Transportable computers were simply desktop computers that could be carried using a special handle in transport configuration. These computers weighed 15 to 40 pounds (7 to 18 kg), had a CRT display, and one or multiple floppy drives. Their use was limited by the access to AC power supply or a heavy battery. An example of a transportable computer is the Osborne Executive.

### 5.1. Display

Portable computers of the early 1980s most often had the reliable CRT (cathode-ray tube) monitor. Its main issues were relatively large size, shape, and energy consumption. In addition, CRT displays were rather fragile, which affected the housing and transport conditions. They had some advantages as well. One of them was that they emitted light, which made them suitable for poor lighting conditions. They could also display any type of image, including colour (for example, the Commodore Executive 64). Plenty of software could use these capabilities.
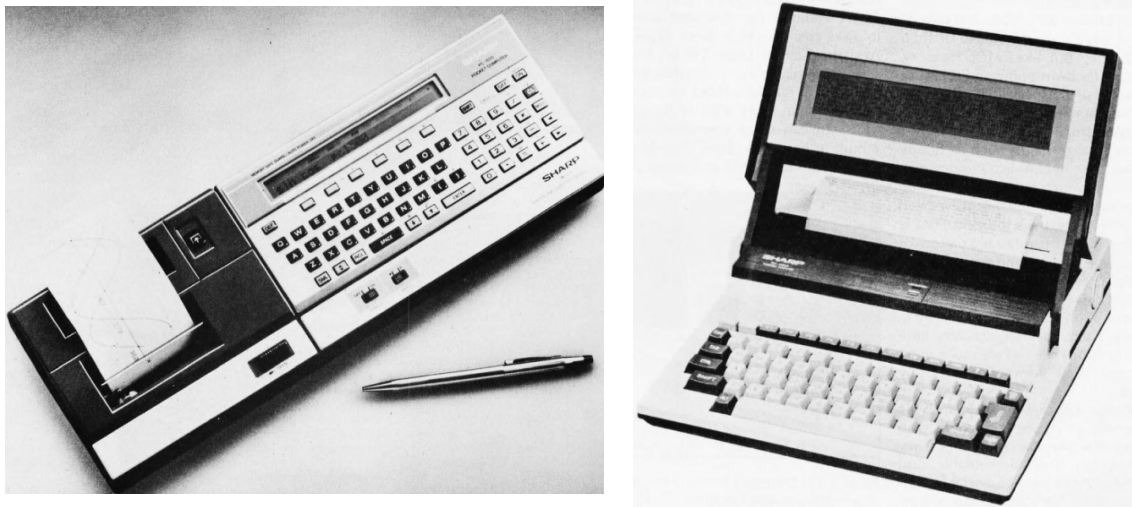
**Figure 11.** Left to right: The Sharp PC-1500 is a typical pocket computer. The flip-up 80-character by 8-line LCD screen on the Sharp PC-5000 is only one-third the size of a standard CRT screen. Source: Internet Archive (1983) [48].

The Commodore SX-64, also known as the Executive 64, or VIP-64 in Europe, was a portable, briefcase/suitcase-size 'luggable' version of the popular Commodore 64 home computer and held the distinction of being the first full-colour portable computer. The machine was carried by its sturdy handle, which doubled as an adjustable stand.

Portable computers had small and lightweight LCDs (liquid-crystal display) that usually required little power and were relatively sturdy. Still, their response time was worse than that of CRTs; they were not as good at displaying bitmaps and did not work below 0 °C. In the 1980s, designers worked on applying new display technologies in portable computers, such as ELD (electroluminescent displays) and gas-plasma display.

The Sharp PC-5000 portable computer had one of the largest LCDs available in 1983 (Figure 11) [48]. It was one of the first clamshell-style portable computers after the Grid Compass and the Gavilan. When the PC-5000 is open, the LCD screen (8 × 80) is lifted to reach its operational position, and when it is being closed, the screen tilts until it covers the keyboard.

The Sharp PC-5000 had a suite of utility software, including Easy-Writer II (a word processor), Easy-Comm (communications) and Easy-Planner (spreadsheet). There were sold together as the EasyPac (also known as Easy-Report).

*5.2. Software*

Computers are useless without software. It makes them complete and usable. Thanks to the bundled software, the machine could be used out of the box. In the 1980s, manufacturers usually delivered computers with word processors, spreadsheet applications, and database programs. Some portable systems would come with as much as 2500 USD worth of software [48]. The Osborne 1 was sold with a word processor WordStar, a spreadsheet editor SuperCalc, and was compatible with CBASIC and MBASIC. The extra software was estimated at the time at 1500 USD. It is a significant value considering that the Osborne 1 set (transportable computer), including hardware and software, cost 'merely' 1795 USD. All the user had to do was switch it on and insert the right floppy disc. This approach drove significant demand [49–51].

Consumer choices were affected by the comfortable portability and use conditions (weight, size, display, power source, etc.). Still, when choosing a computer, an answer to a question just as relevant back then as today is important: what will be the conditions of use? Is it office (transport from work to home), fieldwork (frequent transport and use in the field), or at home in different rooms? The place of work and conditions of transport relevant to it may be of key importance when selecting a portable computer.

## 6. Conclusions

There were two general types of portable computers in the 1980s. The first group included 'truly portable' computers that were battery-powered and relatively small and lightweight (they often looked like a large calculator and could be put into a briefcase, suitcase, backpack, or hung on a shoulder). Their performance was not much worse than that of their larger cousins, but small size and weight reduced work comfort, mostly due to poorer display capabilities. The 'mobility' of these systems came at the expense of image quality. The other group of portable computers were computer systems that resembled a suitcase or were stored in trunks. The luggage held complete sets and was rather heavy.

What is more, they most often required an external power source. All this made the computer portable but also cumbersome. It was a real challenge to transport it over significant distances. They were, therefore, often referred to as 'transportable computers'.

Miniaturisation and mobility of today's equipment were not always given. Rather, they were historically pursued in different ways, not always successfully. However, it is a response to the expectations of users and software manufacturers. Users of the first portable systems had to face issues posed by their weights and sizes, lack of internal power sources (batteries), and poor image quality. Therefore, designers strove to build a complete, self-sufficient computer system with a quality colour display. Such half measures as peripherals did not resolve the problem. Eventually, all the design issues discussed here have been successfully addressed. Portable computers went from 'trunks' to miniaturised systems that can fit in hand.

Portable computers were promoted as the attribute of a modernity in the 1980s. This approach was supported by a relevant presentation, usually in the hands of a smart businessman, a man of success or on the shoulder of a businesswoman, a chic woman of success. Flagship devices survived till today, just as their dedicated transport backpacks, cases and bags, perhaps except monitor trunks. Today, users have access to traditional desktop computers, and some of them have transport handles just like in the 1980s. These are most commonly used to move computers over short distances, though. Small, lightweight, and super-performance laptops, notebooks, and ultrabooks are widely used. Modern lunchbox computers are popular as well. Still, pocket computers have been replaced by smart devices. Portable computers and mobile devices keep abreast with desktop computers in terms of performance. Some of them are even dedicated to gamers or offer heavy duty performance for design, business, and professional use. They have high-quality displays and do not exceed several pounds in weight. Therefore, they can be effortlessly transported over any distance. Yet, the road that construction engineers and designers had to take to achieve what we have today was hard; and the journey is not over. The number of applications and functionalities of personal portable devices (computers) will grow even more just as their usability, despite miniaturisation. Selected functionalities can soon surpass the physical limitations if fibre backbones and conductors, cases and displays, and the latest ground-breaking machines will turn into museum exhibits. Exhibits listed as hardware heritage artefacts.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The source of the figures: Internet Archive (https://archive.org/, accessed on 25 August 2021). Access to the Internet Archive's Collections is provided at no cost and is granted for scholarship and research purposes only.

## Appendix A

**Table A1.** Technical specifications of selected portable computers from the 1980s.

| Attribute | Release Date | CPU | RAM (KB) | Display | Mass (lbs) | Price (US $) | Type |
|---|---|---|---|---|---|---|---|
| Apple Macintosh | 1984 | Motorola 68000 @ 7.83 MHz | 512 | 9-inch monochrome screen, 512 × 342 pixels | 16.5 | 2495 | transportable computer |
| Commodore SX-64 Executive | 1984 | MOS 6510 @ 1 MHz | 64 | 5-inch composite color monitor (CRT), 40 × 25 text 320 × 200 | 23 | 995 | transportable computer |
| Data General One (DG/One) | 1984 | Intel 80C88 @ 4 MHz | 128 (up to 512) | 11-inch LCD, 80 × 25 characters, 640 × 256 graphics | 9 | 2895 | briefcase computer |
| Findex | 1979 | Zilog Z80 @ 2.5 MHz | 48 | 40 × 6 text plasma display built-in thermal printer | 20 | 4980 | transportable computer |
| Kaypro II | 1982 | Zilog Z80 @ 2.5 MHz | 64 | 9-inch CRT green monochrome display, 24 × 80 text | 26 | 1595 | transportable computer |
| Morrow Pivot | 1984 | Harris 80C86 @ 3.33 MHz | 128 (up to 512) | monochrome LCD, white-on-black, 480 × 128 graphics, 80 × 16 lines text | 9.5 | 1995 | lunchbox style portable computer |
| Osborne 1 | 1981 | Zilog Z80 @ 4.0 MHz | 64 | built-in 5-inch CRT monitor, 52 × 24 text | 24.5 | 1795 | transportable computer |
| Osborne 3 | 1984 | Intel 80C86 @ 3.5 MHz | 128 (up to 512) | monochrome LCD, black-on-white, 480 × 128 graphics, 80 × 16 lines text | 9.5 | 2995 | lunchbox style portable computer |
| Osborne Executive | 1982 | Zilog Z80A @ 4.0 MHz | 128 | built-in 7-inch, 80 character × 24 line amber monochrome CRT display | 28 | 2495 | transportable computer |
| Osborne Vixen | 1985 | Zilog Z80 @ 4.0 MHz | 64 | 7-inch diagonal amber display, 80 × 24 text | 18 | 1298 | transportable computer |
| Otrona Attache | 1982 | Zilog Z-80A @ 4 MHz | 64 | 5.5-inch amber CRT, 320 × 240 graphics, 80 × 24 text | 18 | 3995 | transportable computer |
| Poqet PC | 1989 | Intel 80C88 @ 7.0 MHz | 640 | monochrome LCD, 80 × 25 text, 640 × 200 graphics | 1.2 | 1995 | pocket computer |
| Radio Shack Model 100 | 1983 | Intel 80C85 @ 2.4 MHz | 8 (up to 32) | monochrome LCD, 40 × 8 text, 240 × 64 graphics | 3.9 | 1099 | briefcase computers |
| Sharp PC-1500 | 1981 | LH 5801 @ 1.3 MHz | 3.5 | LCD, 26 × 1 text, 156 × 7 pixel | less than 1 | 200 | pocket computer |

**Table A1.** *Cont.*

| Attribute | Release Date | CPU | RAM (KB) | Display | Mass (lbs) | Price (US $) | Type |
|---|---|---|---|---|---|---|---|
| Sharp PC-5000 | 1983 | Intel 8088 @ 4.77 | 128 | LCD, 640 × 80 pixel, 80 × 8 text | 11 | 1995 | lunchbox style portable computer |
| Sharp PC-7000 | 1985 | Intel 8086 @ 4.77/7.37 MHz | 320 (up to 704) | EL backlit (blue) LCD, 640 × 200 graphics, 80 × 24 text | 19 | 1795 | lunchbox style portable computer |
| Radio Shack TRS-80 (Model I) | 1977 | Zilog Z-80A @ 1.77 MHz | 4 (up to 48) | 12-inch monochrome monitor, 64 × 16 text | No data | 599.95 | transportable computer |
| TRS-80 Model 4P | 1983 | Z-80A @ 4 MHz | 64 (up to 128) | 9-inch, monochrome CRT, 80 × 24 text | 26 | 1790 | transportable computer |
| Zenith Z-171 | 1985 | Intel 80C88 @ 4.77 MHz | 256 (up to 640) | 10-inch backlit LCD, 80 × 25 text, 640 × 200 graphics | 14.4 | 2699 | lunchbox style portable computer |
| Zeos PPC | 1992 | NEC V30 (80C86) @ 4.77 MHz/7.15 MHz | 640 | 7.0 × 2.75-inch LCD, 80 × 25 text, 640 × 200 graphics | 1.2 | 595 | pocket computer |
| Zorba | 1982 | Zilog Z-80 @ 4 MHz | 64 | 7-inch green/amber CRT, 80 × 24 text | 22 | 1595 | transportable computer |

Source: own study based on technical specifications published by digital computer museums.

## References

1. Ruggles, D.F.; Silverman, H. From Tangible to Intangible Heritage. In *Intangible Heritage Embodied*; Silverman, H., Ruggles, D.F., Eds.; Springer: New York, NY, USA, 2009; pp. 1–14, ISBN 9781441900722.
2. Król, K.; Hernik, J. *Digital Heritage. Reflection of Our Activities*; Publishing House of the University of Agriculture in Krakow: Krakov, Poland, 2020. [CrossRef]
3. Loulanski, T. Revising the Concept for Cultural Heritage: The Argument for a Functional Approach. *Int. J. Cult. Prop.* **2006**, *13*, 207–233. [CrossRef]
4. UNESCO. Convention Concerning the Protection of the World Cultural and Natural Heritage. 1972. Available online: https://whc.unesco.org/en/conventiontext/ (accessed on 25 August 2021).
5. Wang, X.; Lasaponara, R.; Luo, L.; Chen, F.; Wan, H.; Yang, R.; Zhen, J. Digital Heritage. In *Manual of Digital Earth*; Guo, H., Goodchild, M.F., Annoni, A., Eds.; Springer: Singapore, 2020; pp. 565–591. ISBN 9789813299153.
6. UNESCO. Concept of Digital Heritage. Available online: https://en.unesco.org/themes/information-preservation/digital-heritage/concept-digital-heritage (accessed on 25 August 2021).
7. Takhteyev, Y.; DuPont, Q. Retrocomputing as preservation and remix. *Libr. Hi Tech* **2013**, *31*, 355–370. [CrossRef]
8. Tait, E.; MacLeod, M.; Beel, D.; Wallace, C.; Mellish, C.; Taylor, S. Linking to the past: An analysis of community digital heritage initiatives. *Aslib Proc. New Inf. Perspect.* **2013**, *65*, 564–580. [CrossRef]
9. Kaldrack, I.; Leeker, M. (Eds.) *There Is No Software, There Are Just Services*; Meson Press, Hybrid Publishing Lab, Centre for Digital Cultures, Leuphana University of Lüneburg: Luneburg, Germany, 2015. [CrossRef]
10. Kittler, F. There is no Software. *Stanf. Lit. Rev.* **1992**, *9*, 81–90.
11. Manovich, L. *Software Takes Command*; Bloomsbury: London, UK, 2013.
12. Ceruzzi, P.E. *A History of Modern Computing*; MIT Press: Cambridge, MA, USA, 2012. Available online: https://mitpress.mit.edu/books/history-modern-computing (accessed on 25 August 2021).
13. Wirth, N. A Brief History of Software Engineering. *IEEE Ann. Hist. Comput.* **2008**, *30*, 32–39. [CrossRef]
14. Portree, D.S.F. *Mir Hardware Heritage*; National Aeronautics and Space Administration; Lyndon B. Johnson Space Center: Houston, TX, USA, 1995.
15. Explore the NASA STI Repository (NTRS). Available online: https://sti.nasa.gov/ (accessed on 25 August 2021).
16. Barley, B.; Bacskay, A.; Newhouse, M. Heritage and Advanced Technology Systems Engineering Lessons Learned from NASA Deep Space Missions. In *Proceedings of the AIAA SPACE 2010 Conference & Exposition, Anaheim, CA, USA, 30 August–2 September 2010*; AIAA SPACE Forum; American Institute of Aeronautics and Astronautics: Orlando, FL, USA, 2010.
17. Mahoney, M.S. What Makes the History of Software Hard. *IEEE Ann. Hist. Comput.* **2008**, *30*, 8–18. [CrossRef]
18. Mahoney, M.S. The History of Computing in the History of Technology. *Ann. Hist. Comput.* **1988**, *10*, 113–125. [CrossRef]
19. Schielke, P.J. Old hardware new students: Using old computing machinery in the modern classroom. *J. Comput. Sci. Coll.* **2014**, *29*, 74–79.
20. Bashe, C.J.; Johnson, L.R.; Palmer, J.H.; Pugh, E.W. *IBM's Early Computers*; MIT Press: Cambridge, MA, USA, 1986.

21. *11 Lessons: Managing Design in Eleven Global Companies*; Desk Research Report; Design Council: London, UK, 2007. Available online: https://www.designcouncil.org.uk/resources/report/11-lessons-managing-design-global-brands (accessed on 25 August 2021).

22. AlNoamany, Y.; AlSum, A.; Weigle, M.C.; Nelson, M.L. Who and what links to the Internet Archive. *Int. J. Digit. Libr.* **2014**, *14*, 101–115. [CrossRef]

23. 23. FINDEX Microcomputer with Bubble Memory 1980. Internet Archive. Available online: https://bit.ly/findex-portable (accessed on 25 August 2021).

24. Carrying Cases from Radio Shack. Microcomputer Newsletter—Edition No. 2 (1978-11). Available online: https://bit.ly/Radio-Shack-case (accessed on 25 August 2021).

25. A Tandy Company, 1980 Catalog No. 315. p. 170. Available online: http://pdf.textfiles.com/catalogs/RADIOSHACK/ (accessed on 25 August 2021).

26. The Guy on the Left Doesn't Stand a Chance. Personal Computing 1981 12. Internet Archive. Available online: https://archive.org/details/PersonalComputing198112/page/n43/ (accessed on 25 August 2021).

27. It was inevitable. *Microcomputing Magazine*, June 1981; 25. Available online: https://archive.org/details/kilobaudmagazine-1981-06/page/n23/(accessed on 25 August 2021).

28. Executive Sweet. *Creat. Comput.* **1983**, *11*, 48. Available online: https://archive.org/details/Creative_Computing_1983-11/page/n51/ (accessed on 25 August 2021).

29. Osgood, D. The Osborne 3. *Byte Mag.* **1985**, *10*, 284–289. Available online: https://archive.org/details/BYTE_Vol_10-09_1985-09_10th_Anniversary_Issue/page/n287/ (accessed on 25 August 2021).

30. MS-DOS Portable, Pivot Has Modem, Drive Built in. *Byte Mag.* **1984**, *9*, 46. Available online: https://archive.org/details/byte-magazine-1984-08/page/n51/ (accessed on 25 August 2021).

31. McCarthy, M. Pivot II Update: Warning Signal Gives Portable a Higher Score. *Infoworld* **1985**, *7*, 46. Available online: https://books.google.com/books?id=My8EAAAAMBAJ&pg=PA46 (accessed on 25 August 2021).

32. Radio Shack Catalog RSC-10 Computer Catalog. Internet Archive. Available online: https://bit.ly/Model4P (accessed on 25 August 2021).

33. Kalinowski, F.S. Color by Percom. *80 Microcomputing* **1981**, 68–87. Available online: http://bit.ly/80-Microcomputing (accessed on 25 August 2021).

34. 80 Microcomputing Magazine (April 1980). Percom Electric Crayon. Available online: http://bit.ly/Electric_Crayon (accessed on 25 August 2021).

35. Otrona Attache. OldComputers.net. Available online: http://oldcomputers.net/attache.html (accessed on 25 August 2021).

36. The Zorba Portable Computer. *Byte Mag.* **1983**, *8*, 441. Available online: https://archive.org/details/byte-magazine-1983-01/page/n450/ (accessed on 25 August 2021).

37. Rimmer, S. The Zorba. *Comput. Now* **1984**, *2*, 30–33. Available online: https://archive.org/details/ComputingNow1984-02/page/n29/ (accessed on 25 August 2021).

38. Z-170 PC Portable Computer, Owner's Manual. Zenith Data System. Available online: http://oldcomputers.net/Zenith-Z-170-operators-manual.pdf (accessed on 25 August 2021).

39. The Sharp PC-7000. Personal Computer World, December 1985; p. 153. Internet Archive. Available online: https://bit.ly/sharp7000 (accessed on 25 August 2021).

40. Data General One. Old Computers. Available online: http://oldcomputers.net/data-general-one.html (accessed on 25 August 2021).

41. Introducing the Data General / One Portable. *Byte Mag.* **1984**, *9*, 33–36. Available online: https://archive.org/details/byte-magazine-1984-11/page/n33/ (accessed on 25 August 2021).

42. The power to be your best. Even when there's no power. *MacWorld* **1989**, 42–43. Available online: https://archive.org/details/MacWorld_8911_November_1989/page/n57/ (accessed on 25 August 2021).

43. Apple Reinvents the Notebook. *Byte Mag.* **1992**, *17*, 253. Available online: https://archive.org/details/byte-magazine-1992-03/page/n277/ (accessed on 25 August 2021).

44. Galloway, P. Retrocomputing, Archival Research, and Digital Heritage Preservation: A Computer Museum and iSchool Collaboration. *Libr. Trends* **2011**, *59*, 623–636. [CrossRef]

45. Burnet, M.; Supnik, R. Preserving computing's past: Restoration and simulation. *Digit. Tech. J.* **1996**, *8*, 23–38.

46. Machrone, B. Here it comes—The Compaq Portable II. *PC Mag.* **1986**, *5*, 147–149. Available online: https://archive.org/details/PC-Mag-1986-03-25/page/n145/ (accessed on 25 August 2021).

47. Machrone, B. DOS to Travel. *PC Mag.* **1986**, *5*, 108–140. Available online: https://archive.org/details/PC-Mag-1986-07-01/page/n111/ (accessed on 25 August 2021).

48. Wszola, S.J. How to choose a Portable. *Byte Mag.* **1983**, *8*, 34–47. Available online: https://archive.org/details/byte-magazine-1983-09/page/n35/ (accessed on 25 August 2021).

49. Osborne computer. *Byte Mag.* **1982**, *7*, 31. Available online: https://archive.org/details/byte-magazine-1982-04/page/n31/ (accessed on 25 August 2021).

50. Pournelle, J. The Osborne 1, Zeke's New Friends, and Spelling Revisited. *Byte Mag.* **1982**, *7*, 212–213.

51. Collins, R.H. Portable computers: Applications to increase salesforce productivity. *J. Pers. Sell. Sales Manag.* **1984**, *4*, 75–79.