

Hardware Heritage

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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'.

hardware heritage

easy to carry

briefcase-sized computer

portable computer system

lunchbox-style portable computer

transportable computer

1980s technology ideas

1. Introduction

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 ^[1], '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 ^{[2][3]}. 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.

Hardware, device, and technology heritage is often described in the context of modern IT, computerisation (from the first digital computer to the Web) ^[4], and software engineering ^[5]. The same applies even to outer space exploration, space stations, and the use of 'legacy equipment' to reduce costs of new space missions ^{[6][7]}. A

common implementation of design reuse is through flight heritage or legacy designs. Barley et al. [8] 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. [8] 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) [9].

2. Hardware Heritage—Briefcase-Sized Computers

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 [10]. 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 [10].

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) [\[11\]](#).

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’ [\[12\]](#).

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 (**Figure 3** and **Figure 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’.

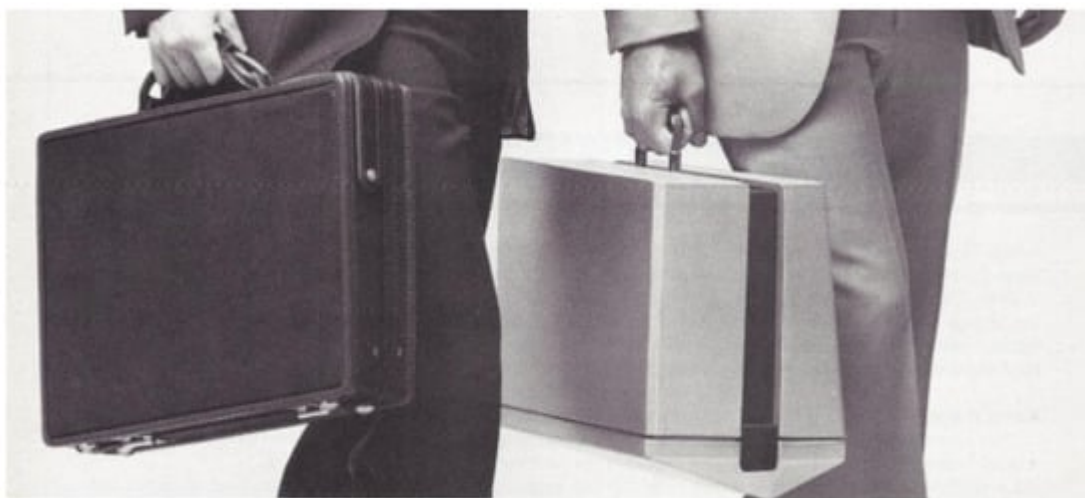


Figure 3. On the right-hand side is the Osborne 1 with its briefcase-sized body. Source: Personal Computing, December 1981 No. 12, p. 42, Internet Archive (1981) [\[13\]](#).



Figure 4. Left to right: The Osborne 1 portable computer; the Osborne Executive. Source: Internet Archive (1981, 1983) [\[14\]](#)[\[15\]](#).

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) [\[16\]](#).

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 [\[16\]](#).

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 [\[16\]](#).

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 [\[17\]](#)[\[18\]](#).

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) [\[19\]](#).

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 [\[20\]](#).



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) [\[21\]](#).

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 [\[20\]](#).

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 [\[22\]](#).

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 [\[23\]](#). The Kaypro had metal housing. According to Rimmer [\[24\]](#) 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 ^[25].

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.

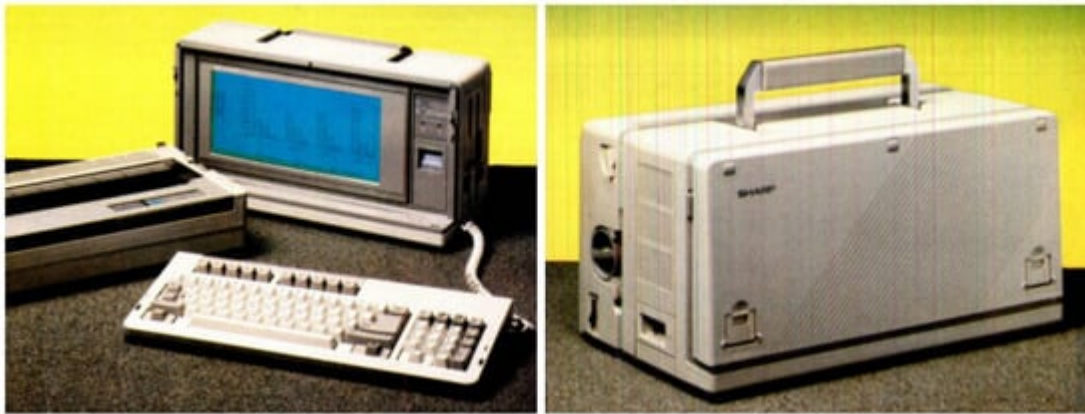


Figure 8. The Sharp PC-7000. Source: Personal Computer World (1985-12, p. 153). Source: Internet Archive (1985) ^[26].

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' ^[27].

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 ^[28]. 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) [28].

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) [27].

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 [27]. 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 dubbed '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) [\[29\]](#)[\[30\]](#).

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