MARCIN WICHARY SHIFT HAPPENS PREVIEW

This is a preview of the upcoming book *Shift Happens*.

If you are reading this, I wanted to say thank you for supporting my efforts by signing up for the newsletter. I hope you enjoy this sneak preview of one of the 42 chapters in an almost-final form.

Please do not share this PDF with other people or link to it. You can always find more information about the book at *shifthappens.site*.

Thank you so much for your support and interest throughout the years.

22

LIKE FONDLING A ZOMBIE

Olivetti is the obvious response to people who ask about beautifully designed typewriters. When it comes to computer keyboards, however, the answer is never very clear. Some people will point to a few exuberant terminal keyboards from the 1970s. Others will choose younger home computer keyboards, perhaps praising the Apple IIc, the Atari XE line, or the industrial starkness of IBM's keyboards.

But I bet no one will think of the particular keyboard we'll talk about in this chapter. Its reviewers did not mince words. One of them said, "Only the fact that you have spent all your money on the machine persuades you to stick at it," while another casually brought up "the experience of defeat when faced with the keyboard."

The opinions of owners were even more colorful. The keyboard was "too small and light to make a decent doorstop," said one. "It mostly felt like trying to type on eyes," explained another. "Like fondling a zombie," surrendered another owner. Even a book about this computer let out a big sigh and tried to set expectations on one of its first pages. It started, "The first look at the ZX Spectrum keyboard might be petrifying."

You can't talk about the ZX Spectrum, a British home computer from 1982, without starting with Clive Sinclair, a man who became nearly mythological in the United Kingdom during his life.

Sinclair was born during World War II, designed a submarine at the age of 14, and abandoned his formal education at 18 to learn electronics and engineering on the job. He designed his first radio kit at 18, and sold his first book on building it the next year – followed by more than a dozen electronics engineering kit manuals. In the late 1960s, Sinclair determined he could cheaply purchase in bulk transistors that failed certain quality tests, and sell them singly at a huge markup to people who didn't need perfect components.*

He took a job at a publisher while selling transistors via mail order from his bedroom, and then shifting into designing and selling his own radio kits. He founded Sinclair Radionics, not long after turning twenty. It was the first of many companies he founded. Most bore his name. Most were based in Cambridge, a university town an hour away from London. Most ran out of money and were forced to shut down.

Yet the early days were heady. Sinclair Radionics sold amplifiers, radios, and speakers of his design. But the first runaway hit came only a decade later, and from an unexpected place. Dubbed by Sinclair the first pocket calculator, the Sinclair Executive was beautiful and came in a small, sleek case. The engineering team developed a clever design that minimized battery use while keeping the calculator's size small by the standards of the day,‡ and Sinclair set the price correctly and had pre-ordered enough components to match the high demand for it.

Other Sinclair calculators followed. Almost all had problems. The drive to make things inexpensive and small, combined with unfortunately lax production standards, resulted in quality issues. The calculators drained batteries faster than the competition. Cheap materials used for the on/off switch on Sinclair Cambridge calculators made them stop working after some time. And, in one incident, a Sinclair Executive calculator exploded in a Soviet diplomat's breast pocket, and created an international incident.⊖

However, even the explosion paled when compared with the fiasco that was the Black Watch, released in early 1976. On paper, it seemed like an attractive product. It was an electronic wristwatch with a small red display, clad in a black plastic case with modern styling. But everything fell apart in the execution. The quartz it used to keep time – the heartbeat of

* Transistors are the basic building blocks of computers. At that time, hobbyists trying to build simple circuits had a hard time getting ahold of them due to scarcity and cost.

‡ The calculator used a chip from Texas Instruments. People working at TI were astonished to see the pocket-sized Executive: their own calculator based on the same chip was wider, longer, and over three times as thick.

⊖ The person was fine. He forgot to turn the calculator off, and a design flaw caused the batteries to overheat and then explode.

Unique full-function 8-digit wrist calculator... available only as a kit.

A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes—take your jacket off, and you're lost!

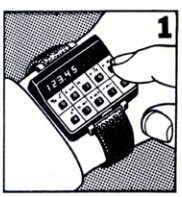
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

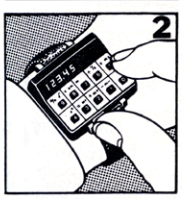
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable $19.95. And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, $1/x$, x^2; plus a full *5-function memory*.

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.





1. The switch in its normal, central position. With the switch centered, numbers—which make up the vast majority of key-strokes—are tapped in the normal way.

2. Hold the switch to the left to use the functions to the left above the keys. . .

3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free*: we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Contents

Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and accompanied by full instructions. The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10 day money-back offer.

Send the coupon today.

KIT ONLY $19.95

Sinclair Instruments Inc.
6 Commercial Street
Hicksville, N.Y. 11801

To: Sinclair Instruments Inc.
6 Commercial Street
Hicksville, NY 11801

Please send me

_____ Sinclair wrist calculator kit(s) at $19.95 $_____

Sales tax (NY residents) _____

Shipping & handling ($2.50 per unit) _____

Enclosed is check/MO (payable to Sinclair Instruments Inc.) TOTAL $_____

Name _____

Address _____

City _____

State _____ Zip _____

I understand that you will refund the purchase price of the kit in full if I return it in saleable conditiion within 10 days of receipt.

SA3

an electronic watch – was sensitive to temperature, making the watch run at different speeds in winter and summer, and needed to be tweaked as the seasons changed. And the final nail in an already very secure coffin? The chip inside could be ruined by static from your shirt or carpet, causing the display to freeze and the batteries to overload. And, yes, it could explode, right there on your wrist.

A popular joke suggested Sinclair saw more Black Watches returned than had actually been made. A follow-up product in a 1978 Sinclair Radionics catalogue, a Microvision TV that weighed 1½ pounds and had a "two-inch screen as clear as a 21-inch screen," also faltered in the marketplace. Both the watch and the television siphoned most of the money out of Sinclair Radionics' coffers, leading to its demise.

But my favorite product from that era is the February 1977 Wrist Calculator, the smallest of Sinclair machines. Meant to be worn on whichever wrist survived the Black Watch explosion, it was an odd-looking device, with none of the elegance of other Sinclair calculators. (Someone once described it as "an eyesore in black plastic.") Yet, more than 10,000 Wrist Calculators were sold to hobbyists around the world, eager to assemble something – *anything* – as long as it had to do with electronics.

The Wrist Calculator had an interesting keyboard. Along with ten keys for the digits, it also had a three-position switch. In its middle position, each key output its respective digit. But switching left or right allowed access to the alternative functions of each key. This gave the tiny keyboard twenty-eight different functions (the key for [0] was left alone).

The second version of the calculator increased the number of functions per key from three to four, its ad claiming "now 10 keys can do the work of 32." But that was just the beginning. In time, Sinclair products would take this idea and run with it further than anyone thought possible.

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At Sinclair's next company, Sinclair Research, the calculators led to computers. Three of them appeared before 1982's ZX Spectrum saw the light of day. That they all had unique and fascinating production issues will come as little surprise.

The journey started in 1977 with the Microcomputer Kit 14 (MK14), which resembled an exposed calculator. It had a printed circuit board, a small keypad,* and a tiny display. It offered very little, but was programmable and priced at just £40. People jumped at it, ordering and assembling 50,000 kits. The success took Sinclair Research by surprise. Sinclair, never previously sold on the idea of the computer, now started paying attention.

The ZX80 followed in – no surprise – 1980.†† It looked much more like a home computer. You could buy it in kit form, which required some assembly; a completed model cost only slightly more. The ZX80 had a full

alphanumeric keyboard integrated into its small white case. You plugged it into your TV for output, and used ordinary audio cassette tapes to save and load programs.

The ZX80's keyboard still had a lot in common with the keyboards of calculators, toys such as the Speak & Spell, and the Atari 400. It was called a *membrane* keyboard: effectively two plastic layers with a bit of space in between. Someone compared it to "merely a printed picture of a keyboard," and it wasn't far from the truth. Its main benefits – low price, no mechanical complexity, small height, and the "ability to withstand the ravages of Coca-Cola" – meant little for the tired and confused fingers of those typing on it.

The computer itself felt tired as well. It was so slow it could not accept input and output it to the screen at the same time. Whenever you pressed a key, the display turned off momentarily, the machine fully dedicating itself to figuring out exactly which key you pressed. The ZX80 could easily overheat – what looked like vents on the case's top were actually painted lines – it lacked graphics, and its text was only black and white. But many people decided it was good enough, willing to wait months for the machines to arrive.⊖ In the end, Sinclair shipped two ZX80 computers for each MK14.

All of this might seem similar to the way hobbyist computers took off in America. The early keyboard-less computers released in the mid-1970s, the transition from kits to fully assembled devices such as the Apple II, the willingness to endure poor quality, the long waits, and the arrival of a computer with a cryptic instruction manual – just for a shot at this fascinating new technology.

But there were differences, too. One celebration of Sinclair's machines started by painting a picture of the United Kingdom in the early 1980s:

> The Falklands War was properly kicking off, skirt-bothering Europhiles Bucks Fizz were number one with their unforgettable hit *My Camera Never Lies,* and new romantic coal miners were using yellowed ration books as makeshift lavatory paper while they waited in million-strong lines for their Giro (welfare checks) – if they weren't being beaten up by skinheads.

⁂ It was far from the best calculator keypad. Sometimes the conductive rubber was of the wrong grade, so people had to wear thimbles and press on the keys with force. Many would buy or make a separate keyboard.

⁑ "ZX" is pronounced "zed ex." The computer was originally named after its microprocessor, the Z80, with Sinclair adding an X for the "mystery ingredient." In time, however, people and the company itself started associating the name with the year 1980 rather than with the processor.

⊖ At one anniversary event, an early ZX80 owner said, with tears in his eyes, "You cannot imagine what that meant for my professional life. *I built my own computer.*"

↑ COURTESY XV. GYMNASIUM, ZAGREB

↗ COURTESY ALEXANDRA GLEDHILL, MUTANT CATERPILLAR GAMES

American computers were available for import, but at prices unaffordable to most Britons. The MK14 and ZX80, simple and limited, were also cheap, making them the first-ever computers in some U. K. households.

The ZX81, the third Sinclair Research machine, turned "some" into "many." While it appeared similar to the ZX80, it had a more elegant case, designed by young industrial designer Rick Dickinson. The machine still only output black and white, but at least it had some graphics capabilities. It sported yet another membrane keyboard, packed with more symbols than the previous model – but at least the display didn't blank out during typing.

The machine had issues. The first line of its display was uneven because of the limitations of technology. When you asked it for the square root of 0.25, it replied 1.3591409. The ZX81 would often overheat, prompting people to keep a carton of cold milk pressed against it. Some expansions needed help from blu-tack (a putty-like adhesive popular in Great Britain); some adjustments required a bent paperclip. But once again, the radical simplicity – "ZX81 had four chips when our nearest competitor [...] the Radio Shack TRS-80, had 44," said Sinclair – allowed it to be cheap. Despite inflation raging in the U. K., the machine sold for less than even the ZX80

had. Assembled, it was £70 – or just £50 if you were willing to spend some time with a soldering iron. It was also the first time a Sinclair computer could be purchased in a department store, rather than only via mail order.

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Around the same time, the BBC, the United Kingdom's national broadcaster, was preparing to launch a national computer literacy project, aiming to get its viewers up to speed with the brand-new world of microcomputers. Along with a series of educational TV programs that would teach basic and intermediate concepts, the company – funded largely by mandatory television licenses paid by all viewers – sought a computer-manufacturing partner to build a BBC-branded computer.

The dominant broadcaster would put its vaunted name on the box, pay for an enormous quantity to be made, and promote it on the air – all at no cost to the manufacturer. While there were other U.K. computer makers, Clive Sinclair felt the job was his. After all, he had made thousands of ZX80s, turning the machine into one of the most popular computers in the world – perhaps even the *most* popular one at one moment in time. His company was about to launch the ZX81, and he projected even more

sales. By the time the planned programs would premiere in early 1982, they expected to ship at least 100,000 units.

But the BBC had reservations about the ZX80 and the ZX81. It didn't matter that they were cheap, popular, and simple. One sticking point was that the cheap and unpleasant membrane keyboard felt inappropriate for a serious machine that would introduce people to computing. "The touch of the ZX80 keyboard," said a historian of that time, "must have been an eloquent speaker in the debate."

Clive Sinclair refused to budge. In the end, he lost the contract. It must've hurt that the BBC sided with Acorn, another Cambridge company, started by Chris Curry, one of the creators of the MK14. Sinclair wrote many passionate letters complaining about the unfairness of the entire deal, but it didn't change anything. Neither did a well-publicized encounter in a London pub, in which Sinclair and Curry got into a fight involving rolled-up newspapers.* Now, Sinclair had less than a year to prepare a machine that would compete with a computer officially endorsed by the BBC.

At least the ZX81 sold like hotcakes, substantially beating Sinclair's estimates. It eventually sold a million and a half units – ten times that of the MK14 and ZX80 combined – and spawned an entire cottage industry of people who wrote software and built hardware for the new machine.

Acorn's computer came out in December 1981, and the BBC started broadcasting *The Computer Programme* not long after. The machine, with the name BBC Micro, looked professional, sported a proper typewriter keyboard,‡ and was properly expandable. As promised, it was promoted on TV. As hoped, the government opted to subsidize its purchase for schools.

Sinclair lost, but still launched its new computer in early 1982. A significant improvement over the ZX81, the ZX Spectrum owed its name to its support of color, available on most household TV sets by that time. The machine had much more memory and better software. Its alphabet included lowercase letters, and its keyboard...

Well.

The keys now had five, sometimes even *six* different legends. Some were printed on the keys, others around them. These labels covered letters and punctuation, of course, but also featured a curious subset of English, like NEW and PRINT and TRUE VIDEO and DIM and... CAT?

If you hunted for keys that you would expect to find on any keyboard, you might be in for a surprise. The arrow keys were not just tucked away in the top row, but required a modifier key to invoke them. The spacebar was not a bar, but just *another key.*⊖ On the plus side, there were two Shift s – but,

* Dramatized beautifully in the U.K. movie *Micro Men*.

‡ Its home version had, as far as I know, the first Fn key similar to those found on every notebook today.

A ZX Spectrum (actual size) COURTESY ALEXANDRA GLEDHILL, MUTANT CATERPILLAR GAMES


sinclair
ZX Spectrum
BLUE EDIT
RED CAPS LOCK
MAGENTA TRUE VIDEO
GREEN INV. VIDEO
CYAN
YELLOW
WHITE
GRAPHICS
BLACK DELETE
1 ! DEF FN
2 @ FN
3 # LINE
4 $ OPEN #
5 % CLOSE #
6 & MOVE
7 ' ERASE
8 (POINT
9) CAT
0 _ FORMAT
SIN COS TAN INT RND STR $ CHR $ CODE PEEK TAB
Q <= PLOT ASN
W <> DRAW ACS
E >= REM ATN
R < RUN VERIFY
T > RAND MERGE
Y AND RETURN [
U OR IF]
I AT INPUT IN
O ; POKE OUT
P " PRINT ©
READ RESTORE DATA SGN ABS SQR VAL LEN USR
A STOP NEW ~
S NOT SAVE |
D STEP DIM \
F TO FOR {
G THEN GOTO }
H ↑ GOSUB CIRCLE
J − LOAD VAL $
K + LIST SCREEN $
L = LET ATTR
ENTER
LN EXP L PRINT L LIST BIN IN KEY $ PI
CAPS SHIFT
Z : COPY BEEP
X £ CLEAR INK
C ? CONT PAPER
V / CLS FLASH
B * BORDER BRIGHT
N , NEXT OVER
M . PAUSE INVERSE
SYMBOL SHIFT
BREAK SPACE

just like a hundred years ago during the Shift Wars, each one served a different function! [Enter] was tiny, there was no [Backspace], and the colon and the comma were shifted.

The feel of the keyboard? In theory, it was an improvement over the ZX80 and ZX81. Sinclair tried a new method, placing a layer of sculpted rubber on top of a standard membrane. This allowed the tops of the individual keys to go down slightly when pressed. But the feel wasn't great, and since all the keys were still part of a single sheet of rubber, sometimes a key became stuck under the keyboard's cut-through plate and had to be fixed by hand. This offered an almost uncanny resemblance to typewriters, where clashing typebars impeded your typing.

Mastering the new rubber keyboard had its limits. Fast touch typing was impossible, as the user had to press the keys in their exact center to make sure they registered properly. Use this keyboard for an extended period of time, and "fondling a zombie" and "typing on eyes" seemed just about right. Many more people felt the same way; one keyboard reviewer compared it to typing on "dead flesh." If you opened the Spectrum's manual, the first sentence in the keyboard section claimed, "The keyboard of the Spectrum is very similar to a standard typewriter." If you ever wanted to imagine a sentence snickering, this would be the right time.

Sinclair's approach was terrible when compared to the BBC Micro's standard, professional keyboard, or the keyboards of many American-made home computers. But, again, Sinclair's machine had one advantage: it was far cheaper. At £125 – later reduced to £99 – it cost between a half and a third of what you needed to pay for the BBC machine, and vastly less than imported models.

In time, aided by official promotion and exposure, 1½ million BBC Micros were built. But on its own and despite various challenges,# the ZX Spectrum surprised everyone by selling *five million* units and becoming one of the most popular computers in history.

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A British cottage industry of software and hardware companies – those "one-man bands pushing stuff out of sheds all the way from Penzance to Prestonpans" – blew up in response to the demand. The BBC launched its

⊖ This solution was employed in some early nineteenth-century typewriters; it was recognized as awful and was abandoned long ago.

The first Spectrums that rolled off the assembly lines failed to identify which key was pressed half the time. Sinclair had to add a tiny circuit board attached upside down to the right chip. The addition was nicknamed "the dead cockroach."


YELLOW
6
MOVE
CYAN
5
%
CLOSE
GREEN
4
OPEN
T
3
LINE
R
RUN
VERIFY
E
REM
ATN
W
DRAW
D
STEP
DIM
S
SAVE
A
NEW
X
Z

popular TV series, magazine stands started filling with personal computer publications (many devoted solely to Sinclair's computers), and computer fairs attracted so many people that the police were called in to control the crowds. The interest in computing in the U. K. at that time was unparalleled, surprising even American journalists:

> More Britons from a wider range of ages (still almost exclusively men and boys, though) are clamoring for microcomputers than Americans are on the basis of any American convention I've ever attended. [...] The past decade has not been kind, economically or socially, to Britain, and as a result most people have learned to accept long lines and high prices as part of daily life. Fearful that high technology may put him out of a job someday, the average Briton has accepted the computer as a potential influence, but one that he has some control over. This [...] may explain the strong interest in microcomputers that transcends British class and economic boundaries.*

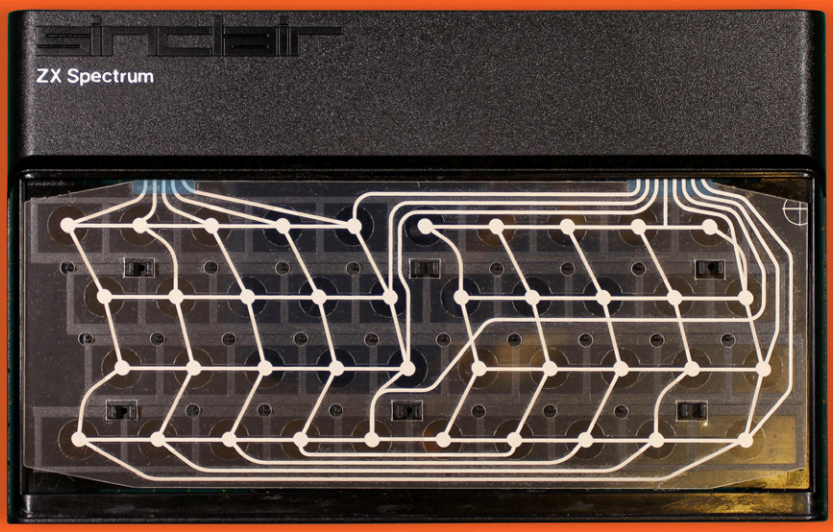
Quite a few customers became "customisers," equipping their ZX81s and Spectrums with various improvements, like memory extensions, floppy drives, and joystick ports. (Clive Sinclair was amused by those endeavors, comparing them to "overgilding the lily.") A lot of attention was directed toward the keyboard, with many replacement keyboards available. I lost count at forty for the ZX Spectrum alone. British computing magazines sometimes offered multiple ads for replacement keyboards on a single page. Some of those ads were professional, full-color productions; others looked and sounded cheap.

The keyboards themselves reflected the variety of approaches. Some wear meant to be mounted on top of a ZX Spectrum, using rods to press down on the computer's built-in keys. Others completely wrapped around the machine. Some solutions required disassembly of the computer, while others just plugged into the back. The size and heft of the cases and keyboards that wrapped over, around, or near the Spectrum robbed it of most of its diminutive charm.

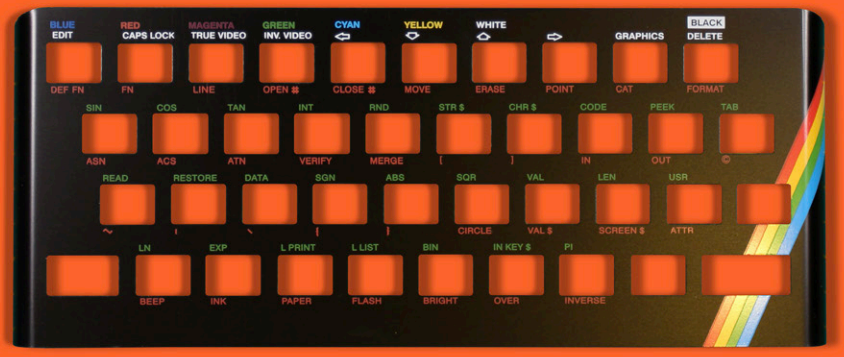
Soon, the ZX Spectrum prospered outside the U. K., but not in the lush markets of Western Europe or the United States.‡ Instead, the computers

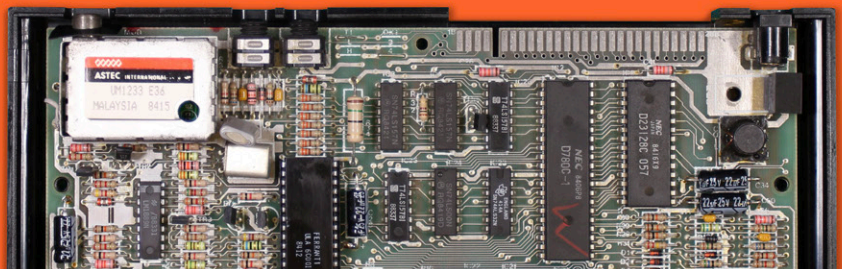
* One of my British friends called that last sentence "rubbish." "Very little transcends class and economic boundaries in Britain," she added.

‡ Although they tried. In America, Sinclair entered into a partnership with the watch company Timex, and sold computers under the brand "Timex Sinclair." They were not, however, very popular.


sinclair
ZX Spectrum


1 2 3 4 5 6 7 8 9 0
Q PLOT W DRAW E REM R RUN T RAND Y RETURN U IF I INPUT O POKE P PRINT
A NEW S SAVE D DIM F FOR G GOTO H GOSUB J LOAD K LIST L LET ENTER
CAPS SHIFT Z COPY X CLEAR C CONT V CLS B BORDER N NEXT M PAUSE SYMBOL SHIFT BREAK SPACE


BLUE EDIT
RED CAPS LOCK
MAGENTA TRUE VIDEO
GREEN INV. VIDEO
CYAN
YELLOW
WHITE
GRAPHICS
BLACK DELETE
DEF FN FN LINE OPEN # CLOSE # MOVE ERASE POINT CAT FORMAT
SIN COS TAN INT RND STR $ CHR $ CODE PEEK TAB
ASN ACS ATN VERIFY MERGE [ ] IN OUT ©
READ RESTORE DATA SGN ABS SQR VAL LEN USR
CIRCLE VAL $ SCREEN $ ATTR
LN EXP L PRINT L LIST BIN IN KEY $ PI
BEEP INK PAPER FLASH BRIGHT OVER INVERSE


ASTEC
UM1233 E36
MALAYSIA 8415

found other locales in which price trumped keyboard perfection, such as South America, the Soviet Union, and the countries of the Eastern Bloc.

If the United Kingdom fared poorly in the early 1980s, those countries had it even worse. Many were faltering under the last gasps of Communist regimes. With import restrictions, the limited purchasing power of one's money, and little intellectual property protection, other computers couldn't be purchased or were prohibitively expensive. Used ZX81 and ZX Spectrum computers were the only ones within the limits of affordability.*

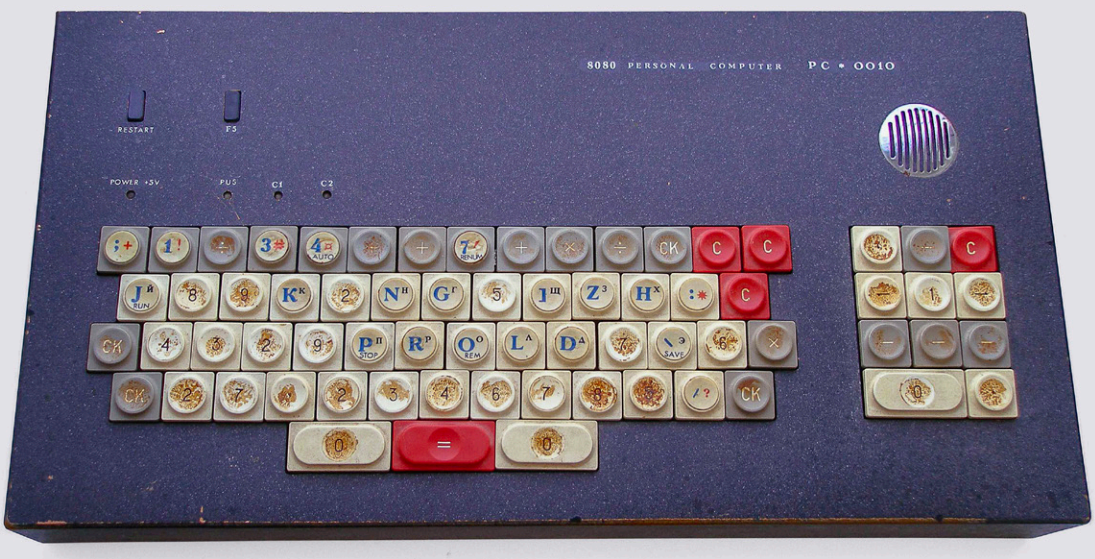
In Eastern Europe, most software traded among users had been pirated – copied without the knowledge of its creators and contributing nothing to their income. In the case of the ZX Spectrum, the same was true for its hardware. The machine was relatively simple to put together, and cheap copies of its microprocessor, the Z80, made it possible for pirates to duplicate the entire machine and sell it inexpensively.‡

"If imitation is really the sincerest form of flattery, then the Russians flattered Sir Clive Sinclair's computer to death," wrote one ZX Spectrum retrospective. The shelves and unofficial purchasing channels of Eastern

Bloc countries filled with dozens of different computers that had the soul, if not the enclosure, of the ZX Spectrum.

Some of the Spectrum "clones," as they were often politely called, closely resembled the original machine, but something was always a little off: the iconic rainbow in the corner contained just three colors, a key legend had a typo, or some of the keys weren't perfectly aligned. But other duplicators went in new directions. A running joke in the Soviet Union was that many of the engineering specs contained the line "Material to be used:

* At one point, someone calculated that the purchase price of a legitimate ZX Spectrum would equal 13 years' worth of average wages in the Soviet Union. In 2021, the historian Aaron A. Reed wrote that "By 1988 there may have been close to a hundred thousand Spectrums in Czechoslovakia, some brought in legally, but most slipped in through ⁝gaps in the Iron Curtain.⁝" Spectrum's small shape "made it easy to shove deep into a bag or under a pile of laundry."


8080 PERSONAL COMPUTER PC • 0010
RESTART
F5
POWER +5V
PUS
C1
C2


Aircomp 16
! 1
« 2
3
$ 4
% 5
& 6
' 7
(8
) 9
INS Ø DEL
* :
SQR Q DEFFN
ATN W STEP
STR$ E END
RND R RETURN
TAN T THEN
EXP Y NEW
USR U LOAD
MIDS I IF
CO$ O ON
PEEK P POKE
NOT A AND
SIN S SAVE
INPUT D DIM
LFTS F FOR
RGH$ G GOTO
CHR$ H GOSUB
INT J CONT
ASC K DATA
LEN L LIST
FRE TRC
RUN
BRK
LOG Z TO
POINT X POP
CALL C CLR
VAL V RESTR
PLOT B OR
SGN N NEXT
ABS M READ
CR
SH
SPACE
SH


PRINT 65535 - USR 7982

Previous pages:
The Byte, a Soviet ZX Spectrum clone
An Aircomp 16, a Hungarian computer similar in nature to the ZX Spectrum
COURTESY NAGY ATTILA KÁROLY, INDEX.HU, FROM THE COLLECTION OF THE NJSZT ITK
A copiously annotated ZX Spectrum case
The PC-0010, a ZX clone

WA," where WA stood for Whatever's Available. This was sometimes taken to extremes. A Polish clone, the Elwro 800jr, used a case repurposed from a toy piano – complete with a metal wire to hold the sheet music in place,[⊖] while a Romanian version with the wonderful name Electromagnetica Jet reused case tooling from a desk phone.

There were clones with keyboards resembling calculators, or employing the now-retrograde membrane technology used by the ZX80 and ZX81. Some of them used cheap stickers or paper inserts instead of properly printed legends. Those legends – confusing enough in the original – became even more elaborate with the addition of Cyrillic, Czech, or Polish alphabets alongside English, and extra keys to switch between them.

On the other hand, some keyboards incorporated full-travel plastic keys. A few touted extra Shift s and a spacebar missing from the original. A couple recognized that most Spectrum keyboards were used for gaming, and came with separate arrow keys and even keys labeled Fire.

A ZX Spectrum+ (actual size)
COURTESY ALEXANDRA GLEDHILL, MUTANT CATERPILLAR GAMES

I counted over fifty clones, but that is almost certainly an underestimation. (One source claimed "at least 20 different Spectrum clones in St. Petersburg alone.") Many replicas proudly sported names of their place of origin, so you could own a computer called Leningrad, Moskva, Baltic, or Krasnogorsk. Others used a typical Communist vocabulary: Zvezda (star), Vostok (East), or Raduga (rainbow). Many of the clones borrowed the ZX Spectrum name verbatim, or lacked any name whatsoever.

It was an entire universe of dirt-cheap, poorly made, horrible-looking computers, filling the homes of troubled countries well into the 1990s. Sinclair's company, located in the faraway land of Cambridge, never got a penny out of all the piracy.

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Looking today at dozens of replacement keyboards and pirated clones of the ZX Spectrum – all of them, without exception, grotesque – allowed me to see the original ZX Spectrum keyboard in a new light.

The more I saw it, the more there was to like. The machine's proportions were appealing, the color palette of the keyboard attractive, and the keys laid out in a simple manner designed to appeal to people new

to computers. Even the legends showed thought: the more common words were printed directly on the keys, and the less common ones added as labels around them.

The enclosure's proportions were elegant. Outside of key legends, the computer felt timelessly minimalistic. Even the ergonomically suspect decision of using almost identical dimensions for each key – spacebar included – added to the visual allure.

The Spectrum's keyboard, just like the Wrist Calculator's, relied on mode shifting. Instead of a three- or four-position switch, however, it had several modes – some invoked from the keyboard via modifier keys, and some automatically chosen by the machine. Type an *m* or *M* in the typing mode, and the lowercase or uppercase letter appeared. In other modes, the [M] key would pause a program for a certain amount of time, print a full stop, or output the mathematical constant π. And the word INVERSE, printed underneath the key – that was accessible too, in yet another mode.[#]

In the Wrist Calculator, ten keys did the work of 32. Here, 40 keys shared 191 functions – or an astonishing 217 if you included traditional letter shifting.

The keyboard's primary focus was to let people code in BASIC, the friendly, English-like programming language that came built in. The mode-based BASIC input method first appeared in the ZX80, and Sinclair extended it with the ZX81.[卐] On a membrane keyboard, pressing labels that entered entire words made programming far easier on the fingers. Instead of typing [1] [0] [P] [R] [I] [N] [T], it was enough to press [1], [0], and then [P].

By the time the ZX Spectrum was released, Sinclair had expanded its BASIC, and the number of commands and functions in the language

exploded. But instead of rethinking the whole approach, the company chose to add more modes. That meant that a key could have five, six, or even seven different functions or word replacements, putting the most adventurous typewriters from the Shift Wars to shame.

Some people argued that the Spectrum's rubber keyboard was enough of an improvement over the membrane keyboard of the ZX81 that Sinclair could have dropped the extra legends and let people type normally, a letter at a time.[≡] But that ignored one benefit: the ZX Spectrum's keyboard was its own instruction manual. It was a treasure map, a promise of all sorts of adventures that awaited your fingertips. Even as you were playing a simple game, even when the computer was off, the keyboard and its hundreds of colorful labels called out to you. What are those colors in the top row? What do PEEK and POKE mean? What's the difference between RND and RAND? What could I do with INK and PAPER?

With the Spectrum, you were always just a few seconds away from a blinking cursor and from the infinite number of things you could call into existence – if you only learned a bit of programming.[⏚] And many people did, drawn in by the Spectrum's playful appearance and seeming harmlessness. "Toys are not really as innocent as they look. Toys and games are preludes to serious ideas," the famous designer Charles Eames said. And indeed, some people started with BASIC only because they wanted to use it to cheat at their favorite game, and then got hooked.

⮑

All of this renewed appreciation for the Spectrum's keyboard made me curious enough to reach out to Rick Dickinson, the industrial designer

[⫻] The counterfeiters reverse engineered early CPUs by grinding away a chip's top layer, which covered and protected its transistors and other circuitry. Under a microscope, they analyzed it and then created fabrication designs to replicate its logic. The situation was so frustrating for some legitimate chip designers that on one DEC VAX machine chip was a secret message written in minuscule lettering, visible only under magnification. The message said "When you care enough to steal the very best"... in Russian.

[⊖] This was at least somewhat appropriate, since many owners of home computers spent a lot of time keying in BASIC programs from magazines.

[#] As a matter of fact, there was *yet another mode,* in which pressing [M] would output a character of your own design – but since the character could change, it was impossible to print it on the case.

[ᔓ] The method had been used before in a few other computers, including the Wang 2200 and Olivetti P6040 seen in the previous chapter.

An Atari 2600 Keyboard Controller with BASIC overlays, using a method of four functions per key, similar to that of Sinclair computers

behind the look of the ZX81 – which won the prestigious Design Council Award – and the ZX Spectrum. We met over a video call, but within minutes of talking, we were both transported back to Great Britain in the early 1980s, when Sinclair's computers reigned supreme.

Dickinson explained that very little of the ZX Spectrum's design was left to chance; every detail was required by manufacturing limits and carefully decided – something that became mainstream in computing only two decades later, marked by the introduction of the first iMac.

But the constraints of early 1980s were cruel. "We couldn't have nice round keys," Dickinson said. Rounded keys would make it hard to position the labels around each key in a way that made it easy to understand all the relationships. Dickinson opted for rectangular keys spaced at distances identical to the Selectric's.

As Jonny Ive, the industrial designer who led the integration of design and function at Apple, demonstrated repeatedly a few decades later, the materials mattered too. (Ive and Dickinson sound a bit alike and, I found out later, went to the same college.) "If you don't know how something works, you can't design it," said Dickinson. "Not every industrial designer holds that view. Many think of themselves as stylists, but I need 100% control over my material. When I'm trying to create things, I'm hideously restricted by the material world and the laws of nature,

Early prototypes of the ZX Spectrum COURTESY RICK DICKINSON

≡ Just a few years before in America, the creators of the powerful desktop calculator HP 9825 had a similar problem. They originally envisioned a traditional calculator keyboard, which earned the whole project the nickname *Keeper* (from "one *key per* function"). The unexpected explosion of functions during design made them turn to a full QWERTY keyboard instead, with BASIC commands typed letter by letter. Within two years the machine was upgraded to a full mechanical keyboard, and original owners could purchase an official retrofit. The HP 9825, however, cost thousands of dollars.

⏚ Or even if you didn't. One owner wrote "I literally learned to write on a Sinclair [keyboard], writing stories that incorporated the BASIC shortcuts on its keyboard. Characters would GOTO places a lot; they would RUN; THEN they would do something else."

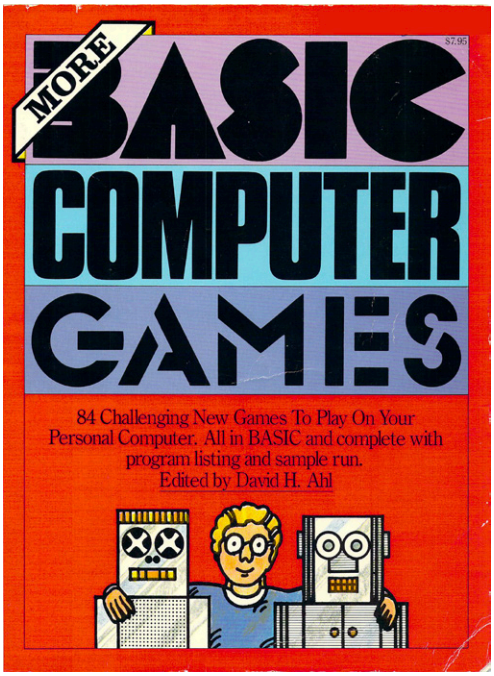
and I cannot ignore them. I can only work through it and manipulate it."

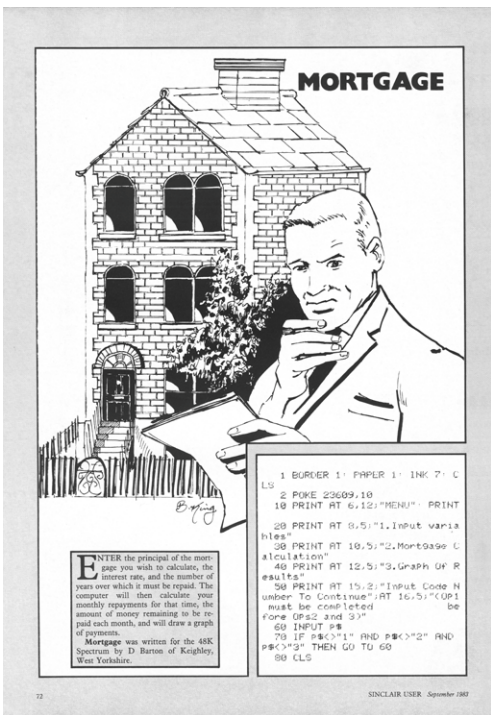
The ZX Spectrum proved his point. The Cambridge crew had to figure out a way to print the labels onto silicone rubber keys, something previously thought impossible. They collaborated with a London condom manufacturer to find a way to make it work. Color-coding some labels – so that the Symbol Shift key was the same red color as all the functions it invoked – required working with a Birmingham manufacturer of cooker dials. "They'd never done a computer before," mentioned Dickinson.

With a tiny case, dissipating heat was always a problem. Dickinson was involved with this as well. "Here I am, a designer, dealing with thermal stuff," he joked, but soon clarified that the collaboration with engineering was essential. "It's critical to speak their language," he says. He worked with software engineers on BASIC commands; early prototypes of the ZX Spectrum used FORE and BACK legends, but these were eventually changed to the more friendly INK and PAPER.

Dickinson shared photos of some pre-production models, which included an early ZX Spectrum – still called ZX82 at that point – that had a proper-length spacebar underneath the keyboard and typical Shift s on each side. Although in Dickinson's memories it felt "as long as a cricket pitch," it wasn't quite. But even a short spacebar was ultimately abandoned, as it added to the size and cost of the machine.

In between chatting about the ZX Spectrum, Dickinson offered his colorful opinions of other home computers. Of the Commodore 64, a popular U.S. home machine, he said: "No innovation, bog-standard approach. Can I swear? Just grim. You haven't got a product designer working on that. Just run of the mill." Pressed further, he elaborated. "You couldn't launch an American product in Europe. Look at the American cars at the time. They are so unrefined, so unsophisticated. Compare Audi to Chrysler: one is from Mars, the other one's from a coal mine." He spoke





Books and magazines with BASIC listings of serious programs and simple games

about his influences, from the Bauhaus school of design to European companies such as Braun, Olivetti, and Bang & Olufsen. Among computer companies, he reserved kind words only for Apple, and their "drop-dead desirability," although not without a dig at their price. "I could buy a car for that," he added.

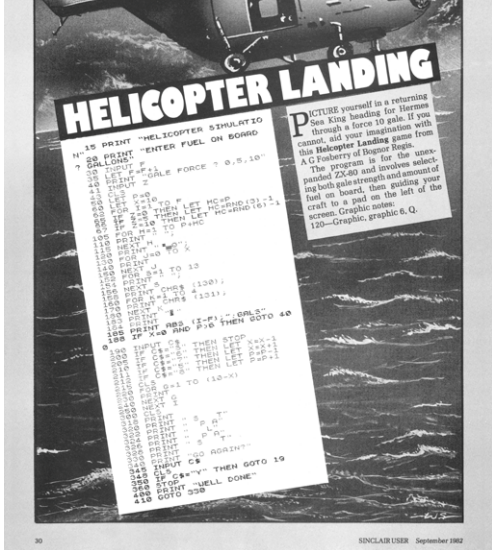
All in all, the ZX Spectrum "deviated from other manufacturers who bought keyboards and slapped them on" – not just in the U.K., but around the world, visible in most ZX Spectrum replacement keyboards, many of the clones, and most other computers. Surely, though, those keyboards were nicer and easier to use? This felt the perfect point for me to ask Dickinson the question everyone wanted to know: "What if you'd had more budget?" I felt I already knew the answer: full-size keyboard with full-travel keys, a separate spacebar, fewer Shift s, bigger Enter , no awkward modes.

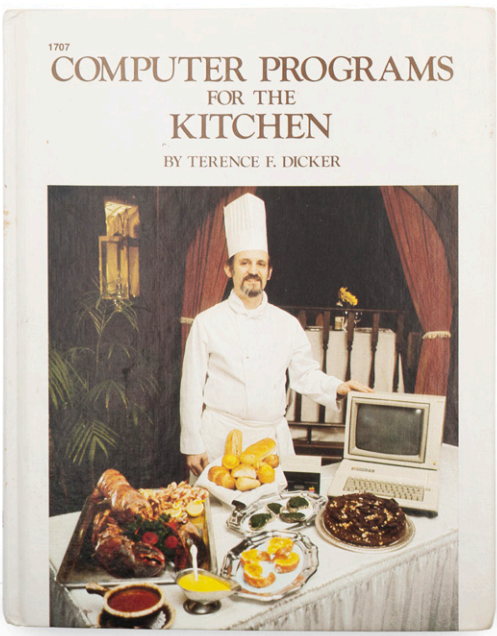
But he surprised me again, having no interest in that hypothetical. "Every design is a solution to a given question," he said.

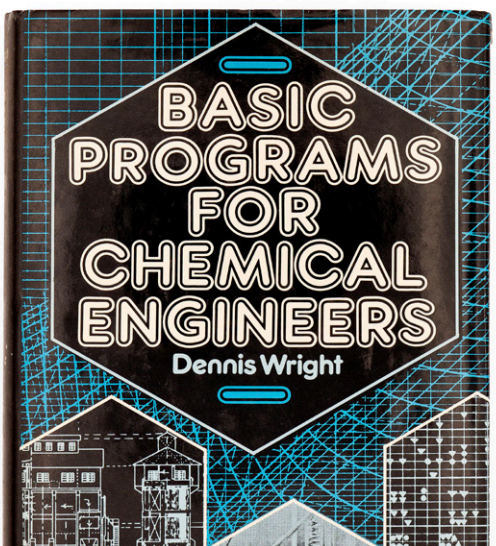
In the case of the ZX Spectrum, it was to make an affordable computer not just for hobbyists, but for many people who might not have cared about computing before. A bigger budget would have added design freedom – but it would also invalidate the very premise of the computer for the masses. Dickinson told me that "Clive saw that there were cost barriers for market entry," and then decided to abolish those barriers. The ZX Spectrum needed to be a certain cost, and everything else followed: the small keyboard, the manufacturing process, the modes. "Meeting these cost barriers created limitations that other products

didn't have, and the job was just dealing with those limitations."

Behind Dickinson's words lay the true meaning of design. It wasn't to make things attractive. It was to *solve problems*.







Sinclair and Dickinson paired up on a few more machines, but none had the impact of the ZX Spectrum, whose little rubber keyboards shaped the future of personal computing. It was the first machine produced in the millions and pirated as numerous illegal clones. ZX Spectrum machines were, in the words of reviewers, "paperbacks of computer literacy" and "passports to the future" for many countries in Europe. At the machine's twenty-fifth anniversary, one programmer asserted that "without the Spectrum, three quarters of my company's programmers wouldn't be programmers." And the website Planet Sinclair noted that the Spectrum "fostered an enormous pool of programming talent, to this day allowing Britain to punch far above its weight in the world software market."

Dickinson continued his industrial design practice until his death in 2018. He considered the ZX Spectrum his biggest accomplishment.* In the late 2000s, he recalled, "People just love the Spectrum. When I tell them [I designed it], it's as though they've just met a celebrity. Most people seem to know something about it, or have owned one. It makes me grin."

The critique? Dickinson had heard it all: the complaints, comparisons to zombies or dead flesh, nicknames like "coffin," "galoshes," and "doorstop."† He didn't care. "People want the world, don't they? But unless you're in the market of selling dog food, cat food, or light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switches, you're the bloody designer and you need to decide for everyone," he said. "You can't be blind to criticism, but often asking people for their thoughts is like asking a teetotaler about Scotch whisky."

But he did come up with one regret after initially expressing none. "The bloody rainbow in the corner," denoting Sinclair's first color computer, seemed a bit garish to him in the late 2010s. It was supposed to be a peel-off sticker, Dickinson noted, although I like the idea that where every other computer tried to wear a suit and a tie, the ZX Spectrum had a colorful sash.

Dickinson wasn't delusional. He recognized that the computer had flaws, but it was the flaws that defined it. "It was not perfect," he says, "but it was *special*." In a 2007 interview, he mused wistfully, "Maybe it's the things we find slightly not quite technically right about a product that are precisely the things we fondly remember them by..."⊖

But in our conversation, he was the quick-witted, acerbic Brit I had learned to like. To anyone who dared complain about the ZX Spectrum or its keyboard in particular, he offered this response: "How many people have actually touched dead flesh?"

✲ The 1984 Sinclair QL might have been more elegant-looking and professional, but it had limited influence and an interesting flaw: if you picked up your machine and turned it upside down, some of the keys would fall off.

⫲ The last one wasn't just a nickname. The people who a few years later worked on creating the Commodore Amiga recalled needing to find a Z80 microprocessor in a hurry – and then remembered their actual *doorstop* happened to be a Sinclair machine with one inside.

⊖ One renowned design critic said once about his beloved Fiat Mini, "This car has a lot of faults. Buy it anyway."

A 2017 photo that recreates an early 1980s ZX Spectrum+ in use in a typical Polish high-rise, complete with a Unitra tape recorder, a Unitra Vela portable TV, and a popular clone of the game Monopoly COURTESY ADAM PODSTAWCZYŃSKI

Shift Happens preview

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