

## 25

MICROCHIPS  
THAT SHOOK  
THE WORLD

In microchip design, as in life, small things sometimes add up to big things. Dream up a clever microcircuit, get it sculpted in a sliver of silicon, and your little creation may unleash a technological revolution. It happened with the Intel 8088 microprocessor. And the Mostek MK4096 4-kilobit DRAM. And the Texas Instruments TMS32010 digital signal processor.

Among the many great chips that have emerged from fabs during the half-century reign of the integrated circuit, a small group stands out. Their designs proved so cutting-edge, so out of the box, so ahead of their time, that we are left

groping for more technology clichés to describe them. Suffice it to say that they gave us the technology that made our brief, otherwise tedious existence in this universe worth living.

We've compiled here a list of 25 ICs that we think deserve the best spot on the mantelpiece of the house that Jack Kilby and Robert Noyce built. Some have become enduring objects of worship among the chiperati: the Signetics 555 timer, for example. Others, such as the Fairchild 741 operational amplifier, became textbook design examples. Some, like Microchip Technology's PIC microcontrollers, have sold billions, and are still doing so. A precious few, like Toshiba's flash memory, created whole new markets. And one, at least, became a geeky reference in popular culture. Question: What processor powers Bender, the alcoholic, chain-smoking, morally repre-

hensible robot in "Futurama"? Answer: MOS Technology's 6502.

What these chips have in common is that they're part of the reason why engineers don't get out enough.

Of course, lists like this are nothing if not contentious. Some may accuse us of capricious choices and blatant omissions (and, no, it won't be the first time). Why Intel's 8088 microprocessor and not the 4004 (the first) or the 8080 (the famed)? Where's the radiation-hardened military-grade RCA 1802 processor that was the brains of numerous spacecraft?

If you take only one thing away from this introduction, let it be this: Our list is what remained after weeks of raucous debate between the author, his trusted sources, and several editors of *IEEE Spectrum*. We never intended to compile an exhaustive reckoning of every chip that was a commercial success or a major technical advance. Nor could we include chips that were great but so obscure that only the five engineers who designed them would remember them. We focused on chips that proved unique, intriguing, awe-inspiring. We wanted chips of varied types, from both big and small companies, created long ago or more recently. Above all, we sought ICs that had an impact on the lives of lots of people—chips that became part of earth-shaking gadgets, symbolized technological trends, or simply delighted people.

For each chip, we describe how it came about and why it was innovative, with comments from the engineers and executives who architected it. And because we're not the *IEEE Annals of the History of Computing*, we didn't order the 25 chips chronologically or by type or importance; we arbitrarily scattered them on these pages in a way we think makes for a good read. History is messy, after all.

As a bonus, we asked eminent technologists about their favorite chips. Ever wonder which IC has a special place in the hearts of both Gordon Moore, of Intel, and Morris Chang, founder of Taiwan Semiconductor Manufacturing Company? (Hint: It's a DRAM chip.)

We also want to know what *you* think. Is there a chip whose absence from our list sent you into paroxysms of rage? Take a few deep breaths, have a nice cup of chamomile tea, and then go to <http://www.spectrum.ieee.org/may09/25chips>. There you can drop us a line and check out the runners-up that didn't make the list and more favorite picks by other luminaries.

BY BRIAN R. SANTO

## Xilinx XC2064 FPGA (1985)

**BACK IN THE EARLY 1980S**, chip designers tried to get the most out of each and every transistor on their circuits. But then Ross Freeman had a pretty radical idea. He came up with a chip packed with transistors that formed loosely organized logic blocks that in turn could be configured and reconfigured with software. Sometimes a bunch of transistors wouldn't be used—heresy!—but Freeman was betting that Moore's

Law would eventually make transistors really cheap. It did. To market the chip, called a field-programmable gate array, or FPGA, Freeman cofounded Xilinx. (Apparently, a weird concept called for a weird company name.) When the company's first product, the XC2064, came out in 1985, employees were given an assignment: They had to draw by hand an example circuit using XC2064's logic blocks, just as Xilinx

customers would. Bill Carter, a former chief technology officer, recalls being approached by CEO Bernie Vonderschmitt, who said he was having “a little difficulty doing his homework.” Carter was only too happy to help the boss. “There we were,” he says, “with paper and colored pencils, working on Bernie's assignment!” Today FPGAs—sold by Xilinx and others—are used in just too many things to list here. Go reconfigure!

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Xilinx® XC2064 FPGA Demonstration Board (circa 1985)