The Evolution of Pentium

It was evolution, not revolution, that made Pentium chips what they are today. More than 20 years of development brought Intel's microprocessors from the primitive 8-bit, 6,000-transistor, 2-MHz 8080 design, which was used in the Altair (the first personal computer), to the 32-bit, 3.1-million-transistor, 66-MHz Pentium processor we see today. Measured in MIPS (millions of instructions per second), the first 66-MHz Pentium chips off the line will be rated at an impressive 112 MIPS. This is about 1,800 times more powerful than the 4004 processor that was the conceptual basis for what followed. While the Pentium's specifications and features (see "Inside Pentium") are impressive, it owes a lot to many of Intel's designs that came before it.

While the sophisticated Pentium chips owe some of their lineage to the early 4004 design, Intel's 8008 and 8080 microprocessors, and the *x*86 line, begun in 1978 with the introduction of the 8086, are its most direct predecessors. The first members of the *x*86 family had 16-bit registers, a 16-bit bus, and could address up to 1MB of physical memory. Available in 4.77-, 8-, and 10-MHz versions, the 8086 originally cost $360 in bulk quantities.

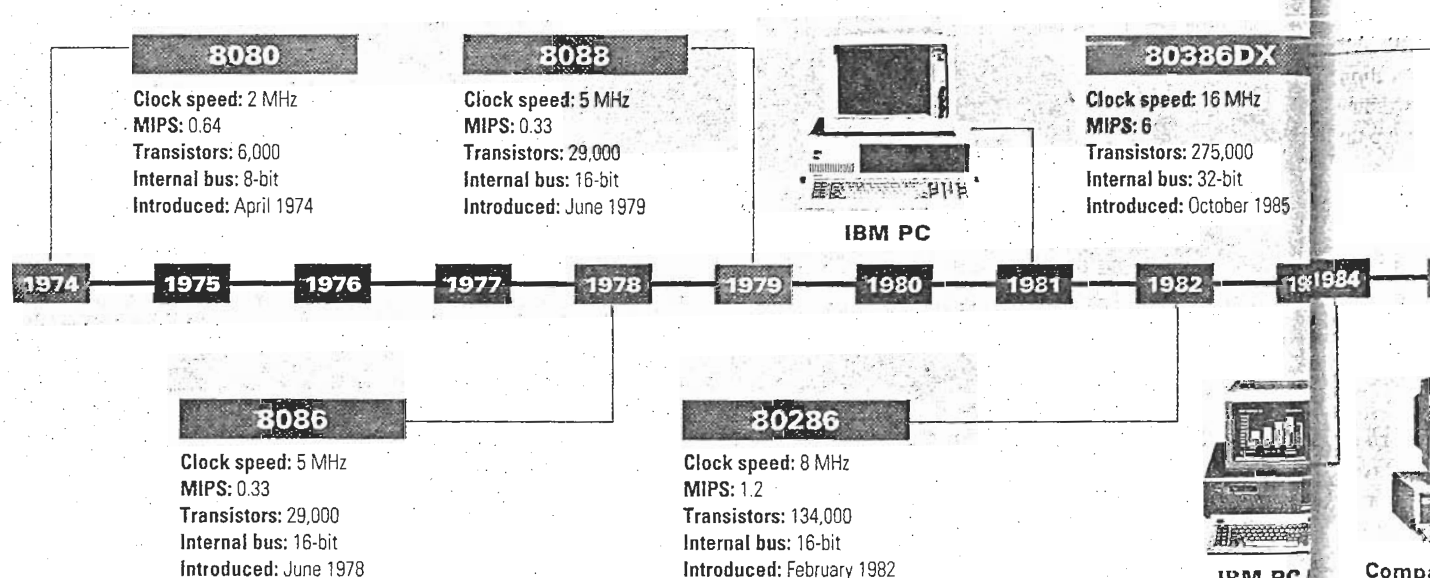
IBM chose the 8088 processor, which was basically an 8-bit–bus version of the 8086, for the first IBM PC. This chip was rated at .33 MIPS.

When the 80286 appeared in 1982 (first used by IBM in 1984's PC-AT), it had 134,000 transistors, and, at 1.2 MIPS, was faster and 4 times more powerful than the 8088. More importantly, it introduced protected mode (in addition to the 8086's real mode), which meant that the CPU could break through the 640K memory barrier. Systems with the 8086 were able to address up to 16MB of physical memory and 1GB of virtual memory. This processor quickly supplanted the 8088 as the corporate standard and was used in millions of IBM PC AT–compatibles.

It would take years before there was a protected-mode operating system because software and compilers that exploit a microprocessor's capabilities usually lag a few years behind the initial release of a processor. Still, a large part of the 80286's appeal was that it was compatible with applications written for the 8086/8088. It had the ability to run the entire library of programs, and do it faster than the earlier chips.

In 1985 Intel brought out the 80386DX microprocessor design to much hoopla. It initially ran at a clock speed of 16 MHz and contained 275,000 transistors. The 80386 was a full 32-bit processor, and was available in 16-, 20-, 25-, and 33-MHz speed variants. Initially, it was rated between 5 and 6 MIPS—roughly 15 times the power of an 8088 CPU. It had 32-bit registers, was 32-bits to the bus, and could address 4GB of physical memory and up to 64 terabytes (TB) of virtual memory. The 80386DX had more programming tools such as virtual 8086 mode (Both OS/2 and Microsoft Windows use the virtual 8086 mode to run multiple DOS sessions) and much better memory management than its 80286 predecessor. Compaq was the first major OEM to use the 80386 in 1986, eclipsing IBM's premier status for the first time.

Evolution of a Powerhouse: The Lineage of Pentium Processing



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Intel realized that the 80286 was "brain-damaged" because of its segmented memory model based on 64 286K segments. The company moved to replace it with the 80386, which had larger segments. Intel quickly brought out faster versions, and in 1988 introduced the 386SX, which was a 16-bit external bus version. This chip and its more powerful DX cousin were able to run Windows 3.0 faster than an 80286, quickly supplanting the older chip in desktop systems. But, the 286 chip lives on as an embedded processor in appliances like microwave ovens.

The latest step came in April of 1989, when Intel introduced the 486DX family of processors. With 1.2 million transistors, the 486 would become available in speed ratings of 25-, 33-, and 50-MHz. Its computing power was 20 MIPS. While seemingly not much more than a beefed-up 80386DX CPU, the 486 (Intel had dropped the 80 designation in an effort to differentiate itself from competitors offering work-alike chips) included a number of technical innovations that gave it enhanced performance over its predecessors. Intel supplemented its new design with an 8K instruction and data cache on the chip, and a floating-point coprocessor unit, which had been separate. This was a move designed to appeal to the workstation market.

The most profound change was the 486's ability to execute instructions in one clock cycle, virtually doubling its processing speed. All together, this meant that even a 486 CPU with a relatively slow clock speed could easily outperform a faster 386.

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In the meantime, Intel aggressively expanded the 386/486 line, designing many products to fill the various market niches. First came the 386SL chip for notebook computers with built-in power-management options. Then came the 486SX, which was identical to the DX chip, although its floating-point coprocessor was disabled.

The next step in CPU evolution included the clock-doubling (clock-halving, actually) DX2 series of chips that ran a 486 at twice the clock speed of the motherboard. These chips were available in 25/50-MHz and 33/66-MHz clock speeds. And along the way came the 3.3-volt 486SL, the latest power-saving CPU for notebooks. All told, there are about 40 different 386 and 486 chips available from Intel, the fastest being the 54-MIPS 66-MHz 486 DX2.

Intel is tight-lipped about the future direction of its chip design. There are immediate plans for a clock-tripled 486 that should operate at 99 MHz, and there will be a series of Pentium-based upgrade products that will plug into the 238-pin socket that many OEMs have begun installing on 486 motherboards. These designs will be followed with 3.3-volt versions that will allow cooler operation—a major problem with early Pentium chips—and power savings.

Intel currently has teams working on the Pentium's successors. The first is working on a project dubbed P6, a CPU that is due for release by the end of 1995, which will weigh in with 10 million transistors—9,994,000 more than 1974's original 8080 that started it all.

—*Christopher Barr*

386DX
ed: 16 MHz
s: 275,000
ıs: 32-bit
l: October 1985

80386SX
Clock speed: 16 MHz
MIPS: 2.5
Transistors: 275,000
Internal bus: 32-bit
Introduced: June 1988

486SX
Clock speed: 20 MHz
MIPS: 16.5
Transistors: 1.185 million
Internal bus: 32-bit
Introduced: April 1991

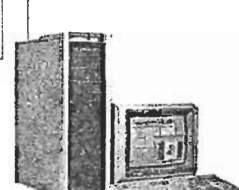
Pentium
Clock speed: 66 MHz
MIPS: 112
Transistors: 3.1 million
Internal bus: 64-bit
To be introduced: May 1993

82 — 1984 — 1985 — 1986 — 1987 — 1988 — 1989 — 1990 — 1991 — 1992 — 1993


IBM PC


Compaq Deskpro 386

486DX
Clock speed: 25 MHz
MIPS: 20
Transistors: 1.2 million
Internal bus: 32-bit
Introduced: April 1989


ALR PowerCache 4

486DX2
Clock speed: 50 MHz
MIPS: 40
Transistors: 1.2 million
Internal bus: 32-bit
Introduced: March 1992