

MICROPROCESSOR REPORT

THE INSIDERS' GUIDE TO MICROPROCESSOR HARDWARE

Intel Fumbles MMX Transition

Prices Dive; Revenues Sag; Competitors Hurt; PC Buyers Win

by Linley Gwennap

One of the world's most reliable money machines finally stripped a few gears. Instead of making a smooth shift to its new MMX processors, Intel first stood on the brakes, then stomped on the accelerator, ultimately damaging the transmission. While the microprocessor minter can surely afford the repairs, the bill will be steep: with revenues and profits declining for at least one quarter and probably the remainder of the year, the missteps could cost the company a billion dollars.

Intel's competitors are not cheering the giant's stumble; unfortunately, they are right in the path of its fall. With Intel forced to cut the price of its most popular MMX processors in half, as Figure 1 shows, AMD must follow suit or see its potential business evaporate. Suddenly, a K6 processor that was worth \$200 last month is worth \$100 this month, creating an unexpected dislocation in AMD's plans to improve its profitability. Cyrix is caught in the same sinkhole, and IDT must cut the price of its C6 processor before the chip even begins shipping. What was shaping up as the year for Intel's competitors to finally reach up into Intel's profitable midrange is now turning into yet another year in the gutter.

The winners in this story are PC buyers. Having wisely and wholeheartedly rejected non-MMX processors, they are being rewarded with lower prices and more MMX machines than previously expected. Consumers will go back to school with MMX and have an MMX Christmas, and even the Scrooges at big corporations will get MMX for free.

Intel Rediscovered the Osborne Effect

Ironically, Intel was stung by the success of its own marketing. When the Pentium/MMX introduction was planned last fall, the company decided to announce the part at a minimum price of \$407, well above the high-volume "sweet spot,"

and gradually (for Intel) ease the price down over the course of 1997. In the critical third quarter (August through October, on Intel's pricing calendar), when most processors for Christmas PCs are shipped, the cheapest MMX processor would still be around \$200, leaving about a third of the market for non-MMX Pentiums. Only in 1H98 would the non-MMX parts be completely eliminated.

The reason for the gradual transition was the size of the Pentium/MMX chip: at 140 mm², it yielded about half as many good die per wafer as the 90-mm² P54C Pentium. To make a complete transition to Pentium/MMX, Intel would have to more than double its production capacity, a feat that the company expected to take about 18 months. So Intel timed its price cuts to effect a lengthy changeover.

Unfortunately, Intel's marketing department got carried away. After a highly successful nine-month campaign to boost interest in MMX among the technical community (see MPR 3/5/96, p. 1), the January launch of Pentium/MMX

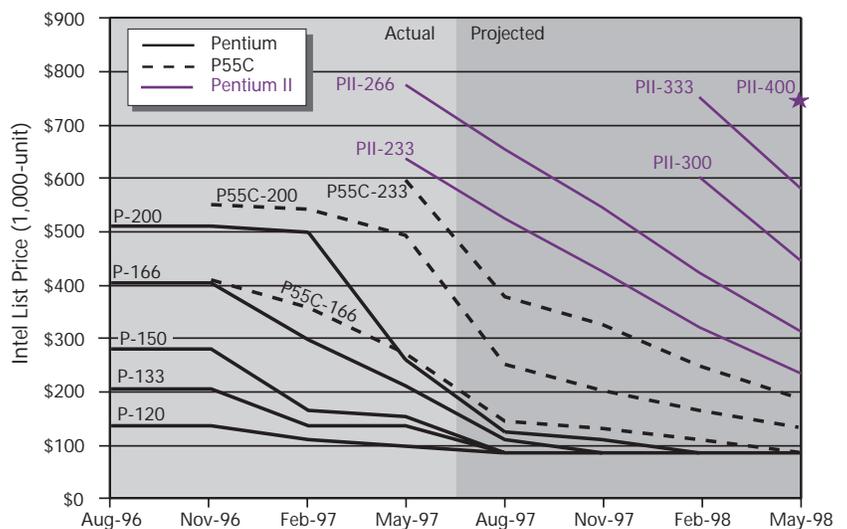


Figure 1. Intel will cut the prices of its Pentium and Pentium/MMX (P55C) more deeply than usual in August, accelerating the penetration of MMX in low-cost PCs. (Source: Intel, MDR projections)

ignited a mass-media firestorm, culminating in the first television commercial for a microprocessor ever shown during the Super Bowl.

The company hoped the advertising would increase demand for its MMX processors. It succeeded all too well: demand for non-MMX systems quickly dried up. Since the MMX boxes were too expensive, however, many PC buyers put off their purchases, knowing that MMX prices would eventually come down. Others refused to buy non-MMX PCs unless their prices were drastically reduced. Everyone wanted MMX, but only the well-to-do could afford it.

By March, sales of "classic" (non-MMX) Pentiums had already started to droop. Spot prices for the chips began to free-fall. In May, things grew bad enough that Intel issued a press release warning that the company's revenue for Q2 would be 5–10% below its Q1 revenue, rather than increasing, as many analysts had predicted. In June, the company decided to drastically cut prices on both its classic Pentium and Pentium/MMX chips.

In short, Intel was caught by the infamous "Osborne effect," named after the company that went out of business when people stopped buying its initial product before the new product was available. By heavily promoting the new MMX chips before it had the factory capacity to deliver them in enough volume, Intel fell into the same trap.

Pentium Prices Reach New Low

The company has not publicly revealed the new pricing, officially slated to take effect on July 28. Word of the price cuts quickly leaked, however, and Table 1 shows pricing we have obtained from reliable sources. Because of the dramatic changes, many of Intel's largest customers are already receiving significant discounts off the official May prices.

The changes in the classic Pentium prices reflect PC buyers' lack of interest in these parts. Each quarter, Intel usually moves one speed grade to the \$106 low-end price point; in this quarter, three new parts have met or breached that mark: the Pentium-133, -150, and -166. Of the classic Pentiums, only the Pentium-200 is above that price point; at \$123, it barely clears the bar. For the Pentium-166 and Pentium-200, this represents a price cut of roughly 50%.

The sources indicate that, for the first time, Intel will sell Pentium processors at a list price of less than \$106, as the Pentium-133 and Pentium-150 prices fall all the way down to about \$93. Intel intends this lower price to appeal to makers

	May-97	August-97	Change
Pentium/MMX-233	\$594	\$375	-37%
Pentium/MMX-200	\$492	\$250	-49%
Pentium/MMX-166	\$270	\$142	-47%
Pentium-200	\$257	\$123	-52%
Pentium-166	\$209	\$106	-49%
Pentium-150	\$150	\$93	-38%
Pentium-133	\$134	\$93	-31%

Table 1. Reliable sources indicate that Intel will cut the list price of most of its Pentium processors nearly in half in Q3.

of sub-\$1,000 PCs, which often have been using Cyrix's MediaGX chip (see MPR 3/10/97, p. 1) and other non-Intel parts. The lower price is somewhat moot; since it takes 2–3 months for a chip to be fully processed, packaged, and shipped, we believe Intel has already ceased new production of classic Pentiums and will probably stop selling these chips sometime in the fourth quarter.

Pentium/MMX Prices Also Halved

Intel's drastic price cuts on its Pentium/MMX processors are somewhat counterintuitive. After all, the company's problem is high demand for these parts, a situation that in classic microeconomics leads to a price hike. If we postulate a price of \$225 for the 166-MHz Pentium/MMX, however, it would create a huge gap between that price and the \$123 for the Pentium-200. This gap happens to cover the high-volume sweet spot of Intel's market, corresponding to PCs that sell for roughly \$1,500.

In this scenario, PC makers couldn't afford to drop the MMX chips into their best-selling systems; saddling these systems with classic Pentiums would kill their sales. Consider the thought process of PC buyers with \$1,500 in their pocket: they could buy a lame non-MMX machine today or wait a few months for the MMX system to reach their price point. Undoubtedly, many would take the latter path.

Thus, if Intel were to hold up the prices of its MMX processors, it would cause significant damage to its own unit sales and to those of the PC market in general. Instead, Intel cut its MMX prices in half. The new prices allow Intel to offer products at all popular price points, keeping its customers satisfied.

In fact, given the current lack of demand for non-MMX chips, higher Pentium/MMX prices might actually decrease Intel's revenue. The higher prices might not compensate for the lost unit sales. Furthermore, leaving a hole in the product line would also open the door for AMD and Cyrix, both of which are willing to sell MMX processors for less than \$200. Intel didn't want to leave such an opening, particularly since the revenue upside was minimal.

Manufacturing Build-Up Required

Of course, simply cutting the prices of the MMX processors isn't enough; Intel must also be able to supply enough chips to meet the volumes demanded at these price points. A key problem for Intel has been a factory overload caused by an unexpected gain in market share during 2H96 (see MPR 4/21/97, p. 3). A more rapid shift to Pentium/MMX puts even more pressure on Intel's fabs. The company has responded by increasing production in a variety of ways.

Increasing fab capacity in a short period of time is difficult, since clean rooms take years to build and new fab lines need months to get running. Fortunately, Intel recently completed construction of a 160,000-ft² clean room at its Fab 12 in Chandler, Arizona. Last fall, this fab began running the P854 (0.35-micron) process used for Pentium and

Pentium/MMX on a relatively small line, but the bulk of the clean-room space was ticketed for the 0.25-micron P856 process, due to start ramping this fall. Instead, the company has increased the P854 capacity of Fab 12, which it will later refit for P856. Intel also increased the capacity of its Santa Clara (California) Fab D2 by shifting some test and assembly work, which is not as dust-sensitive, into former office space in the company's adjacent headquarters building.

Intel took a second approach to improve the throughput of its fabs, reducing the die size of both the classic and the MMX Pentiums by using an optical shrink. The 5% linear shrink reduced the P54C die from 91 mm² to 83 mm² and the P55C die from 140 mm² to 128 mm². These changes seem minor, but because yield improves with the square of the die area, our model estimates Intel can produce 15% more die per wafer with the smaller die. That translates to increasing Pentium/MMX output more than 20%; since each wafer yields more parts, some wafers can be converted from P54C to P55C without reducing the number of P54C chips.

In total, these improvements have allowed Intel to increase Pentium/MMX production more rapidly than originally planned, resulting in a faster conversion from the classic Pentium. As Figure 2 shows, we project more than 70% of Intel's shipments in Q3 will be MMX processors, and the non-MMX chips will disappear entirely by 1Q98.

Billion-Dollar Profit Gap

Intel has already admitted that its revenue began suffering in Q2 this year. Some analysts have forecast a quick recovery, but the drastic price cuts will make such a rally difficult. Revenue will not, of course, drop at the same 50% rate as the prices; most PC makers will simply replace the old \$150 Pentium-150 with the new \$143 Pentium/MMX-166, getting much better performance but giving Intel essentially the same amount of money.

Neither, however, will the price cuts leave Intel's sales completely unaffected. The new Pentium prices range from \$93 to \$385; in the two most recent quarters, Pentium prices ranged from \$106 to well over \$500. Even as the relative mix between products changes, the reductions, particularly at the high end of the range, will cause the product line's ASP (average selling price) to fall; we forecast a drop from \$219 in 2Q97 to \$194 in 3Q97, as Figure 3 shows. Now that the Pentium hand is fully played out, further declines are inevitable; we project an ASP of \$174 for the Pentium line in 4Q97.

Traditionally, Intel has tried to compensate for declining ASPs in one product line by converting customers to a more expensive product. In this case, the higher-priced product is Pentium II, but factory constraints created by ramping Pentium/MMX as fast as possible prevent Intel from quickly increasing Pentium II production at the same time. At 203 mm², Pentium II yields fewer than half as many good die per wafer as reduced Pentium/MMX, so changing over to Pentium II represents a reduction in units sold.

In fact, due to the smaller number of chips per wafer,

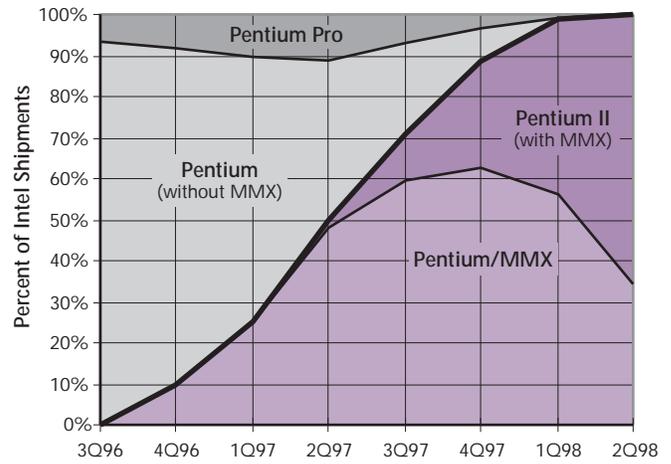


Figure 2. With the latest price changes, MMX processors will be the bulk of Intel's shipments in 3Q97; non-MMX processors will disappear by 1Q98, when the last Pentium Pro chips reach the market. (Source: MDR)

Pentium/MMX and Pentium II produce about the same revenue per wafer, so Intel would get no revenue benefit from switching production to Pentium II. We forecast Pentium II will supply about 12% of Intel's shipments in Q3 and 21% in Q4, enough to ease but not eliminate the drop in ASP.

As a result, we estimate Intel's overall ASP will decline from \$259 in Q1 to \$243 in Q4, a 6% reduction. This drop may not seem like much, but combined with stagnant unit shipments due to fab constraints, it will cause a decline of about 9% in Intel's total revenue during that period, according to our forecast. As Figure 4 shows, we expect Intel's revenue will finally start to rise in 2Q98, as 0.25-micron capacity becomes abundant and fab constraints are unlocked. By 4Q98, we project quarterly revenues will reach \$7.9 billion, a 23% increase over 4Q96.

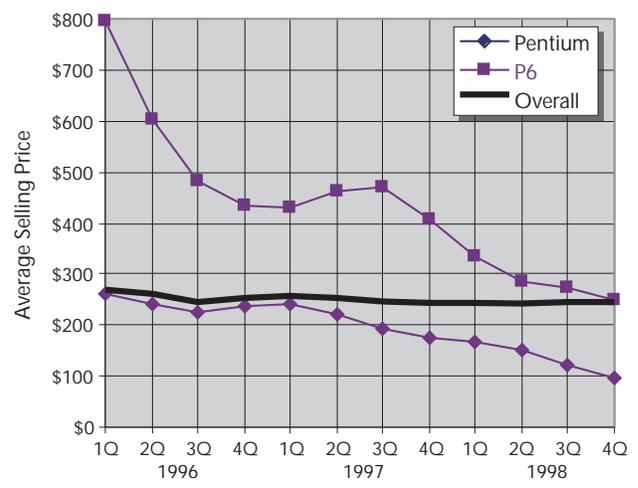


Figure 3. The average selling price (ASP) of Intel's product lines declines over time, but the overall ASP stays relatively constant as Intel shifts from one line to the next. In 1997, fab constraints will slow the transition to the P6, causing the overall ASP to decline slightly. (Source: MDR)

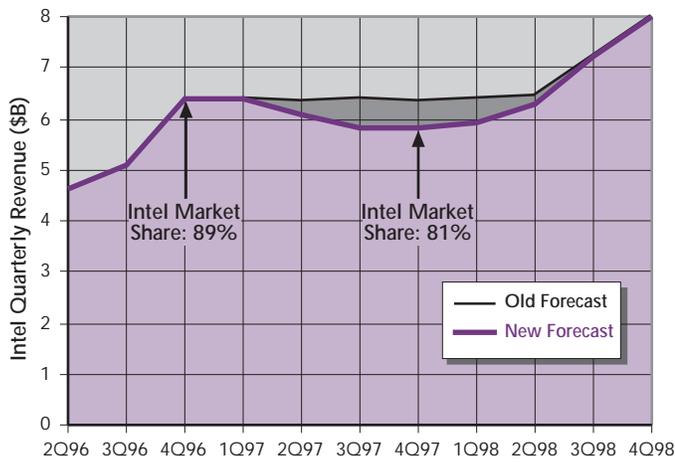


Figure 4. Rapid price deflation in the Pentium market will drag down Intel's revenue beginning in 2Q97. Revenue probably won't recover until 2Q98, when Deschutes volumes kick in. Had revenue stayed flat during 1997, as in our previous forecast, total revenues would be \$2.0 billion higher. (Source: MDR)

Our previous forecast, assuming more gradual price cuts and an MMX transition extending into 1H98, showed quarterly revenues essentially flat through 1997, as Figure 4 shows. The gap between the two forecasts represents the decrease in revenue caused by the rapid price cuts; the total difference in revenue is about \$2.0 billion. This corresponds to 8% of Intel's total revenue during this period, a modest but significant dip.

Most of this revenue, however, would have gone straight to the bottom line, since it comes from higher prices. Assuming some higher manufacturing costs and accounting for taxes, we estimate the corresponding net profit shortfall to be at least \$1 billion, 15% of Intel's projected net income during this period.

Figure 4 also shows the large runup in revenue that occurred in 2H96, as Intel's share of the x86 processor market ballooned to an estimated 89%. During 1997, we expect Intel to give back some share, reaching 81% by the end of this year. Although the 1997 revenue dip is disconcerting, it can be viewed as compensating for Intel's unsustainably rapid growth in 2H96.

What Could Intel Have Done?

Although it is impossible for an outsider to understand all the choices Intel faced, we believe Intel could have avoided this awkward transition if it had planned ahead. The 486-to-Pentium transition went more smoothly, despite the big increase in die size between the two parts, because Intel had launched an unprecedented buildup in fab capacity to support the changeover. If Intel had accurately foreseen the MMX transition, it could have built the needed capacity. The company also, however, would have needed to foresee the gain in market share caused by its competitors' pratfalls, a more difficult thing to predict.

The best strategy would have been to avoid having to predict the transition so accurately. If the die size of the MMX Pentium were close to that of the classic Pentium, the product mix could have been adjusted more easily, depending on market demand. At one point, Intel had planned an MMX Pentium with the same smaller caches as P54C, but this idea was shelved in favor of the full-blown P55C. These or other ideas could have kept the die-size impact of MMX to a minimum. The Pentium II CPU, for example, is only 7 mm² larger than the MMX-less Pentium Pro CPU.

Even after getting into this mess, Intel could have avoided slashing Pentium/MMX prices so deeply by adding a 150-MHz MMX part to the mix. The company probably thought that announcing a new product at a price point of \$150 and then obsoleting it six months later would cause needless confusion in the market. In retrospect, a cleaner solution would have been to announce such a part in January with the rest of the family.

Competitors Feel the Pain

Although the initial impetus for the price cuts was to solve Intel's own product-mix problems, the fact that the lower prices will wound its competitors undoubtedly assuages some of Intel's own pain. The potential loss of a billion dollars in net income is not pleasant, particularly for Intel's stockholders, but this money can be seen as an investment in making life difficult for AMD and Cyrix.

These vendors must price their parts against Intel's to gain any attention in the market; in particular, AMD's K6 and Cyrix's new 6x86MX sell for anywhere from 30% to 50% less than Intel's Pentium/MMX chips. As Intel slashes its prices, its competitors must follow suit or be deemed irrelevant. We expect third-quarter pricing for the 6x86MX and K6 to range from \$75 to \$250, down 50% from the recent introductory prices.

Both companies lost money in 1996 and were counting on their new chips to help them become more profitable in 1997. Now, it appears both will struggle to be profitable instead of raking in cash to fund their next-generation efforts. In particular, AMD has an aggressive plan in place to complete the build-out of its Fab 25, convert that fab to 0.25-micron processing, and begin construction in Dresden, Germany, on a second megafab. These plans may be delayed if AMD can't come up with the cash it expects from the K6.

At great cost, Intel is converting its production to MMX to meet market demand, crushing the hopes of its competitors in the process. The good news for competitors: the giant occasionally missteps. The trick is not to be underfoot when it happens. □

Linley Gwennap has recently revised his Intel Microprocessor Forecast, now available as a Technical Library report. For more details, see www.MDRonline.com/tech_lib/intel.