Intel Fab Crunch Slows MMX Rollout

Increased Demand Delays Transition to Larger P55C and P6 Chips

In many ways, Intel is an enormous semiconductor fabrication engine with a small design house on the side. One of the biggest impacts on pricing is Intel's ability to ramp production on its newer, larger chips; the company typically won't cut prices until it can build enough chips to satisfy demand. Unexpectedly high demand for Intel processors is slowing Intel's shift to its Pentium/MMX (P55C) and Pentium II (PII), reducing our forecast for these chips.

Some of this surge in demand is due to faster-than-expected growth in the PC market during 2H96, but Intel's current fab crunch is rooted in the pratfalls of its competitors. With AMD's weak K5 unable to gain traction in the market and Cyrix's fab limitations preventing its 6x86 from picking up the slack, Intel's share of the x86 market swelled by nearly 10% last year, according to our estimates.

Due to the lead times for fab construction, Intel must plan its fab capacity two to three years in advance. That long ago, Intel's strategic planners, led by the Paranoid One himself, could not have anticipated such a rapid and significant increase in market share. This extra volume produced giddy financial results in 2H96, but pressure on the company's fabs may create a hangover that lasts throughout 1997.

To meet this increased demand, Intel must adjust its production mix to favor its smallest processors, in this case the P54C Pentium. Because of yield effects, a single wafer of 91-mm^2 P54C die produces nearly twice as many good chips as the same wafer full of 140-mm^2 P55C die and four times as many good chips as a wafer full of 196-mm^2 P6 (Pentium Pro) die. The more wafers Intel devotes to the P55C and P6, the fewer total processors it can build.

This fab crunch comes at an awkward time for Intel, which is in the middle of two key product transitions. The company is currently moving from the non-MMX P54C Pentium to the new Pentium/MMX, providing a boost in multimedia performance. Next month, the company will officially launch Pentium II, igniting a move from the Pentium generation to the P6 family. These transitions are critical for enticing PC owners to upgrade their systems and for keeping Intel ahead of its x86 competitors.

To shift to these larger chips, Intel must increase its fab capacity. Taking into account both new fabs and process shrinks, Intel's capacity doubles every year, on average. Without these rapid increases in capacity, Intel could not deliver its best new processors to large numbers of PC buyers, rendering moot the efforts of its leading-edge design teams.

Intel would like to quickly obsolete the P54C in favor of the new MMX processor, but it is trapped by simple arithmetic: given the wafer-output ratios noted above, Intel must double its fab capacity to complete such a transition. Accounting for market growth and the unanticipated share growth, capacity would have to increase by 250%. Tacking on extra capacity for a modest number, say 20%, of Pentium II chips would require more than three times current capacity, an increase that takes 18 months at Intel's normal pace.

This mathematical exercise has several implications. We believe Intel is pulling out all the stops to increase its fab capacity over the next year. Adding capacity, however, is an expensive proposition that, in most cases, must be planned years, not months, in advance. The company may be able to build out a fab more quickly than planned, and it may be able to slightly accelerate deployment of its next-generation 0.25-micron CMOS process. These schedules typically have little slack, so any gains are likely to be small.

In the meantime, some of Intel's customers will not get as many high-end chips as they want, particularly Pentium Pro and Pentium II. Capacity limits will reduce the number of P6 processors shipped in 1997 to about 12 million. Intel simply won't have the capacity to move its flagship P6 core into the high-volume segments of the PC market until 2H98. This delay will give Intel's competitors more opportunity to develop and deploy competitive products.

Intel had once hoped to completely sweep the P54C Pentium out of its lineup by year's end, but fab limits may keep the non-MMX part alive into the new year. There is, however, some hope for improvement. We believe a circuit-design team is busy compressing the original P55C layout, which was somewhat bloated in its rush to market. A 10–15% compaction would increase P55C output by 20–25%. A shrink to 0.25-micron CMOS, code-named Tillamook, will further reduce die size, but this process shrink is already taken into account in our capacity estimates.

Ironically, an increase in AMD's market share will benefit Intel. If AMD supplies more of the x86 market, Intel can shift its mix toward its higher-margin chips, accelerating the deployment of its P55C and P6 processors. But while Intel wants to give up share at the low end, AMD wants its K6 to take share where the margins are higher, setting the stage for continued conflict between the two rivals. M

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