Intel Graphics Entry Lays Groundwork

Platform Control Drives Company's Interest in 3D Graphics

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Intel's entry into the PC graphics market raises a number of questions, but the biggest is simply: Why? In particular, why would the most profitable semiconductor company in the world deign to enter a low-margin business like PC graphics?

We quickly rejected some explanations (Andy Grove was envious of S3's stock price) and only briefly considered others (it was just a mistake; Intel meant to buy WebTV instead of Real 3D). This quickly left us with three options. First, it's purely a revenue play. Second, Intel wants to accelerate the pace of 3D development to support its microprocessor business. Third, Intel needs its own graphics cores so it can merge them into its system-logic chip sets and perhaps even its microprocessors.

None of these explanations is entirely satisfactory, given the high cost to Intel of being a serious player in the graphics market. The costs of developing the Intel740 and even of acquiring Chips & Technologies (see MPR 8/25/97, p. 4) are minor for a company with $10 billion in cash, but the real costs are in manufacturing the chips.

According to our estimates, margins on the 740 (see MPR 2/16/97, p. 1) are wafer thin at best. The chip may still make a positive contribution to the bottom line, but it is certainly dragging down the company's vaunted gross margin, 58% in the most recent quarter. Wall Street likes incremental profits but may not react well to decreasing margins.

Initially, the impact of the 740 will be minimal. Market analysts at Fourth Wave *(www.fourthwave.com)* project Intel will ship about 6 million 3D chips this year; at $30 per chip, this works out to $180 million, less than 1% of Intel's revenue. In 1998, the margin effect will be imperceptible. But as Intel's market share increases, the pain will intensify.

Graphics Revenue Is Small

Even if Intel takes over the entire 3D graphics market, the revenue gain will be relatively small. The total market for graphics chips is more than $1 billion today and could rise to $2 billion soon (100 million PCs each with a $20 graphics chip). In comparison, the markets for high-end workstations and servers, where Intel is also making a major investment (see cover story), total only about two million units today, or about $2 billion, assuming an average selling price (ASP) of $1,000 per processor.

The profit margins on these high-end processors are quite attractive, leading to Intel's interest. Technology from these markets can also filter down into the mainstream PC markets, leveraging Intel's investment. The graphics market, in contrast, has much lower margins and may not provide technology for PC processors, reducing Intel's incentive to be in this market.

But with growth in the PC market slowing, Intel may be willing to go to extremes to add revenue and profit dollars. The low-margin graphics business can still make a positive financial contribution.

The challenge will increase in 1999, when Intel's graphics chips must move to the company's 0.25-micron process to remain competitive. This process is also used to build Intel's flagship Pentium II processors, and a single wafer devoted to Pentium II yields about $20,000. In contrast, the same wafer devoted to the 740 will yield about $9,000.

The key is ensuring adequate 0.25-micron capacity before 1H99. If there are enough wafers to go around, the lost opportunity cost is moot; $9,000 per wafer is more than enough to cover the manufacturing costs.

Intel has announced a major increase in 0.25-micron capacity slated to come on line late this year and into 1999. In addition to its current fabs, most of which are being converted to the 0.25-micron process, incremental wafer capacity is being added in Ireland (Fab 14), Jerusalem (Fab 18), and, if the FTC approves the Digital Semiconductor purchase, in Hudson, Mass. This incremental capacity should support a significant share of the 3D chip market without impeding Intel's ability to manufacture its cash-cow microprocessor products.

Controlling the Platform

A parable: When Intel entered the system-logic business, it explained that the existing chip-set makers weren't moving fast enough. Intel needed to make chip sets to support its new processors, and it also wanted to quickly build support for new technologies such as PCI. Within a few years, however, the company had decimated its chip-set competitors, acquiring a 90% market share.

Intel initially used the same justifications for its graphics products: progress isn't fast enough, and we need support for new technologies like AGP, it said. In fact, the graphics market is moving faster than Intel can push it. While the 740 is an impressive product, competitors have already announced even better 3D chips (see MPR 3/30/98, p. 4). There are no signs these competitive products would have been any different had Intel never announced its plans for

the 740. Other graphics vendors have also been quick to support AGP; Intel is hardly leading the way in this regard either.

The company may be concerned about geometry acceleration. Intel believes that if graphics vendors add this feature to mainstream chips, it could reduce demand for high-performance floating-point in the CPU. Intel wants to keep geometry processing on the CPU, spurring demand for its high-end chips. Preventing other graphics vendors from adding their own geometry processing will be difficult unless Intel can grab a clear majority of the market, severely weakening or even eliminating its competition.

Getting more than about 30% of the market will be challenging. The 3D graphics vendors are far more innovative than the system-logic vendors ever were, and many are ahead of Intel on price, performance, or both. Intel must deliver more products and better products than just the 740 to take the lead in this market.

Prepare for Integrated Graphics

One way for Intel to take over the graphics market would be to integrate 3D acceleration into either the CPU or the chip set, two areas that Intel already dominates. For example, Intel could be planning to follow Cyrix's lead and offer CPUs with integrated graphics. The Cyrix MediaGX and MXi processors are a good fit for low-cost multimedia PCs and subnotebooks. Without some form of integration, Intel's only way to compete in these markets is by means of substantial price cuts on its processors and core logic, requiring low-cost graphics chips from other vendors. Even so, this alternative lacks the elegance and space savings of the Cyrix solution.

Another difficulty with the CPU/graphics combination is the mismatch between the performance required from graphics memory and the price pressure on PC main memory. This year's leading graphics chips will need about 2 Gbytes/s of local memory bandwidth. The MXi's unified memory system provides this bandwidth, but it requires expensive DIMMs for main memory and reduces the number of slots supported. These are acceptable limitations for low-end PCs that lack end-user upgradability, but they would be problematic for a processor designed for mainstream PCs.

The most serious problem with combining a CPU and a graphics core on a single chip is the rapid evolution of 3D on the PC platform. Cyrix's MediaGX, for example, provides good 2D performance, but within a year of the chip's introduction, the market's focus had shifted to 3D, rendering the MediaGX less attractive to OEMs. The forthcoming MXi appears to have competitive 3D performance but will undoubtedly fall behind over time.

Any integrated graphics core Cyrix or Intel can design is likely to be outclassed within six to twelve months by newer discrete 3D chips from other vendors. CPUs are too complex to permit such frequent redesigns; it would be even more difficult to keep combined CPU+graphics chips up to date. As transistor budgets soar, however, it will be increasingly tempting to combine the two functions.

In the near term, it will be easier and perhaps more effective to combine the 3D-graphics accelerator with the north bridge of the system-logic chip set (see MPR 1/26/98, p. 3). This strategy provides a better match between the process technologies used for discrete products of each type, and the relatively simpler designs can be revised more rapidly to accommodate new 3D features required by developers and end users. Combining the two also reduces system cost by eliminating all pins associated with AGP, which becomes an on-chip bus. One downside of this strategy is that it prevents OEMs or end users from changing the type of 3D graphics acceleration from what is included in the system logic.

A north bridge with integrated graphics is well suited for a low-cost chip set aimed at the "basic PC" segment. Sources indicate Intel is already developing such a device. If Intel offers 3D acceleration as a standard feature in its low-end chip sets, all other 3D chip vendors would essentially be locked out of this market segment, since Intel holds roughly 90% of the system-logic market.

Adding Up the Benefits

Perhaps the best explanation is that there is no one explanation. With Intel searching for revenue growth outside of its core processor business, graphics chips could add a billion or two to the company's top line. While this amount is only 5–10% of Intel's total revenue, it's not chump change. Given the company's planned fab buildup, it appears that this revenue will be incremental instead of undercutting the more profitable CPU business.

Taking a significant position in the graphics market gives Intel more control over the PC platform, which may help the company rebuff a move toward widespread hardwired geometry acceleration or other trends adverse to Intel's interest. Adding 3D graphics to its technology portfolio gives Intel the flexibility to merge that function into the north bridge of the chip set and ultimately into the processor itself if necessary.

When Intel started the 740 project more than two years ago, it may have thought the other 3D vendors would not boost performance as much as they have. It now appears that Intel's efforts to spur progress were not needed.

But now that Intel is in the market, it is likely to continue its 3D efforts. The company still can't take the risk that progress at the other 3D vendors will slow down. Intel relies on advances in the PC platform, in particular 3D performance, to spur demand for its high-profit processors. If Intel takes substantial market share, however, it will reduce the ability of other 3D makers to innovate, possibly creating a self-fulfilling prophecy.

While the PC processor continues to be Intel's primary strategic focus, there are signs that that market may not be a cash cow forever (see MPR 3/30/98, p. 3). Having a few other options, such as 3D graphics and the company's recent StrongArm move (see MPR 3/9/98, p. 5), is undoubtedly appealing to the paranoid leaders at Intel. M