



SUB-MICRON DEVICES INC.

In March 2001, the ASIC Division of Sub-Micron Devices received an inquiry from Western Digital: would ASIC be willing to supply 3,000,000 chips annually for a period of three years at a price of \$40/chip? ASIC's Controller Gary Ravenport convened a meeting with Peter Parks, his assistant, to review the profitability of the Western Digital proposal.

SUB-MICRON DEVICES INC.

Sub-Micron Devices Inc. started operations in the mid-1980s. The company was located in Phoenix, Arizona, and had 4,000 employees by early 2001. The ASIC Division of Sub-Micron Devices manufactured application-specific integrated circuits.

A large part of ASIC's output was transferred internally to the Systems Division, which sold electronically controlled scanning equipment to a variety of industrial clients. Originally, ASIC started out as a captive supplier for the Systems Division. In the late 1980s, however, it became clear that ASIC would be able to take on external business in addition to satisfying the needs of the Systems Division. As a consequence, ASIC was transformed from a cost center into a separate profit center.

The opportunity for additional external business resulted from substantial yield improvements that ASIC experienced in 2000 and early 2001. Some yield losses were considered inevitable in semiconductor manufacturing, but the rate at which yields improve is generally viewed as an important strategic variable.

The production facility at ASIC was designed so that the plant could produce the 7,000,000 functional chips annually needed by the Systems Division. In the early years of production, 7,000,000 functional chips required ASIC to produce at least 16,000,000 integrated circuits, since the average yield was less than 50 percent (i.e., more than half of the output had to be

Professors Tim Baldenius (Columbia Business School) and Stefan Reichelstein, professor of accounting, prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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discarded as scrap). By 2001, however, average yields had become as high as 85 percent and, moreover, temporal fluctuations in yield had been greatly reduced. As a consequence, ASIC had considerable excess capacity by 2001.

Cost Pools

The ASIC Division's value chain consisted of two parts: Wafer Fab and Assembly. In Wafer Fab, raw silicon wafers were processed in a sequence of processing steps. These activities required sophisticated equipment, well-trained employees, and a high level of cleanliness. The final step of the fabrication process consisted of cutting up the processed wafers into individual die. The integrated circuits used by the Systems Division were relatively small, allowing ASIC to place 100 (identical) die on a single wafer (wafers processed at ASIC were 12 inches in diameter.)

In Assembly the die were then completed and turned into integrated circuits (ICs or simply chips). This required the addition of electric connections, a casing for the die, and finally an electronic testing of the functionality of the chip. Like the situation in most of the semiconductor industry, Assembly was more labor intensive than Wafer Fab at the ASIC Division.

The cost accounting system at ASIC was structured in the following way: Wafer Fab and Assembly constituted separate cost pools, each of which collected direct and overhead costs. Also, both cost pools separated variable from fixed overhead costs. As was common in the semiconductor industry, overhead costs were the biggest part of total costs. When the current cost accounting system was introduced, the company did an extensive analysis to identify the most important cost drivers for each of the two cost pools. Sub-Micron Controller Joe Tisch always stressed the importance of identifying the cause and effect relationship between products and overhead costs.

The crucial cost driver in Wafer Fab was considered to be the number of moves. A move was defined to be any significant alteration of a wafer, e.g., the application of a mask layer on the wafer. However, not all moves were of equal complexity. Hence the accounting rules differentiated between "regular" moves and photolithographic moves. Photolithographic moves tended to be of higher complexity. Specifically, it was estimated that the resources spent on a photolithographic move were three times higher than those spent on a regular move.

Production of one wafer as needed by the Systems Division included 15 regular moves and 25 photolithographic moves. So the relevant allocation base for the ICs produced for Systems was given by $15+3*25=90$ basic moves per wafer. The wafers produced for the external customer also required 15 regular moves but only 20 photolithographic moves, so the corresponding allocation base was $15+3*20=75$ basic moves per wafer. Direct materials requirements, however, were identical for both internally and externally demanded chips.

Since direct labor played a more important role in Assembly, direct labor costs were the allocation base for overhead cost in Assembly. Since the chips sold to the external customer were less complex than those needed by Systems, the former only accounted for 25 percent of the direct labor costs in both cost pools, although they constituted 30 percent of the produced quantity. Within both cost pools—Wafer Fab and Assembly—variable and fixed overhead costs

were recorded separately, but the allocation base within each pool applied to both variable and fixed overhead.

Situation at ASIC Division in March 2001

Since the company's inception, there had been extensive debates about how to account for the internal transfers between ASIC and Systems. Since early on ASIC was only serving the needs of the Systems Division, Sub-Micron's management had decided to calculate transfer prices based on full manufacturing cost plus a 10 percent profit markup. The markup was intended to create incentives for ASIC to stay responsive to Systems' quality needs, and to cover ASIC's selling and administrative expenses. In earlier years, ASIC's capacity was insufficient to serve external customers and, as a result, market prices were not considered a reasonable basis for determining transfer prices. At the same time, Sub-Micron's management had strong concerns that a policy of negotiated transfer pricing would lead to excessive haggling and to internal conflicts.

As practical capacity increased quickly due to learning-by-doing, ASIC was in a position to enter into a long-term contract with external customers while still being able to cover Systems' demand. However, even in 2001, a major fraction of ASIC's output continued to be transferred to the Systems Division (**Table 1**). The budgeted profit and loss statement for ASIC in 2001 is shown in **Table 2**.

Table 1
Supplementary budgeted data for 2001 (March 31, 2001)

Number of chips sold internally to Systems Division	7,000,000
Number of chips sold externally	3,000,000
Number of regular moves in Wafer Fab	1,500,000
Number of photolithographic moves in Wafer Fab	2,350,000

Table 2
Pro forma profit and loss statement for 2001 (March 31, 2001)

Revenues		\$ 468,495,000
Internal sales to Systems Division	\$ 333,495,000	
External sales	135,000,000	
Cost of goods sold		410,550,000
Internal sales	303,177,000	
External sales	107,373,000	
Selling & administrative expenses (allocated entirely to external sales)		23,800,000
Budgeted profit	30,318,000	34,145,000
Internal sales	3,827,000	
External sales		

The data for cost of goods sold given in Table 2 are derived from ASIC's cost budget (**Table 3**) and supplementary data for the main cost drivers (Table 1), which are used to estimate the direct and overhead costs for the two cost pools.

Table 3
Manufacturing cost budget for 2001 (March 31, 2001)

Wafer Fab:		
Direct labor costs	\$17,000,000	
Direct materials	35,700,000	
Variable overhead	37,400,000	
Depreciation	71,400,000	
Other fixed overhead	47,600,000	
Total manufacturing cost in Wafer Fab:		\$209,100,000
Assembly:		
Direct labor costs	\$25,500,000	
Direct materials	17,850,000	
Variable overhead	45,900,000	
Depreciation	68,850,000	
Other fixed overhead	43,350,000	
Total manufacturing cost in Assembly:		\$201,450,000

Western Digital's Proposal

In March 2001, Western Digital inquired whether ASIC would be willing to supply 3,000,000 chips annually, for a period of three years. Western offered a price of \$40 per chip. The ICs demanded were of even higher complexity than those needed by Systems. Specifically, Western's design required a greater number of mask layers in Wafer Fab and, in order to increase the heat tolerance of the ICs, they would have to be inserted into ceramic casings in Assembly. Both features would substantially raise direct materials requirements. The manufacture of one wafer, as requested by Western, would require 20 regular and 28 photolithographic moves. Since more moves typically also meant more labor hours in both cost pools, direct labor costs were assumed to increase more than proportionally. However, there were no further selling and administrative expenses connected with this order. Peter Parks, assistant to AISC's Controller Gary Ravenport, came up with the manufacturing cost calculations in **Table 4** in case ASIC were to accept Western's proposal, using the revised data projections in **Table 5**.

Table 4
Manufacturing cost budget for 2001 (including Western's order)

Wafer Fab:		
Direct labor costs	\$ 22,525,000	
Direct materials	50,410,000	
Variable overhead	52,394,000	
Depreciation	71,400,000	
Other fixed overhead	47,600,000	
Total manufacturing cost in Wafer Fab:		\$244,329,000
Assembly:		
Direct labor costs	33,788,000	
Direct materials	29,205,000	
Variable overhead	68,391,000	
Depreciation	68,850,000	
Other fixed overhead	43,350,000	
Total manufacturing cost in Assembly:		\$243,584,000

Table 5
Supplementary budgeted data for 2001 (including Western's order)

Number of chips sold internally to Systems Division	7,000,000
Number of chips sold externally	3,000,000
Number of chips sold to Western Digital	3,000,000
Number of regular moves in Wafer Fab	2,100,000
Number of photolithographic moves in Wafer Fab	3,190,000

Meeting at the ASIC Division

After studying Parks' calculations, Ravenport convened a meeting to discuss Western's proposal.

Parks: Do you remember Joe Tisch complaining about ASIC's idle capacity? Now we have a possibility to utilize part of it. Of course, the price offered by Western would not be worth thinking about, if we were running at full capacity. But we are not, and Western knows that. However, as long as we are not ruining our prices by accepting a low-price order, the most important thing is that variable costs are covered and this seems obvious to me. Put simply, we are adding contribution margin.

Ravenport: I am tired of this “incrementalism.” You accept one project on an incremental cost basis, then a second one and so on, and in the end your income statement shows a whopping loss due to uncovered fixed costs. Although I have not checked your calculations in detail yet, I am pretty sure that a price of \$40 is insufficient to cover the total costs of the order.

We have always calculated our prices on a full cost basis, and we would have great difficulties explaining to Systems why we give more favorable conditions to outside buyers than to buyers within the firm. My guess is that management of the Systems Division will not be happy to subsidize external customers. And this is exactly what happens when we charge the external customers only for variable costs. We should ask Joe Tisch about this. I cannot imagine that he wants us to favor external buyers.

Parks: It seems to me that a key principle for a company like ours is that divisions have autonomy in pricing their products. Joe Tisch has emphasized this principle over and over. So, I am pretty sure that he will not interfere. If we—that is, the ASIC Division—want to accept this order, Tisch and corporate headquarters won’t stand in our way.