European Semiconductor Manufacturers Seek Competitive Edge

By Pete Caldwell and Tom Snoxell

Championing diversification and efficiency

At its annual SEMICON Europa conference this autumn, the European semiconductor industry met under the motto “Building on the Strength of Europe”, with the collective aim to improve its competitiveness against the so called Asian “mega-fabs”, which have gained such a large share of the world market in recent years, at the expense of European and US manufacturers.

The worldwide semiconductor market is a large and diverse force, expected to exceed US$ 300 billion by 2013[1]. Semiconductor products are used in all areas of modern life, from automotive to telecommunications, and this looks set to continue as technology advances and expands to emerging markets.

As with many manufacturing sectors, Europe has seen many companies relocate or lose market share to more efficient competitors in the Far East. High labor costs in western economies and local subsidies have contributed to the drift of market share eastwards, with Taiwan – the traditional location for semiconductor production – being joined by India and China to almost treble the manufacturing market share taken by Asia (ex-Japan) over the last 15 years[2].

Against this backdrop, European manufacturers have had to find other ways of competing, by driving technical innovation coupled with competitive pricing, particularly in the foundry business. Heinz Kundert, President of SEMI Europe, is optimistic: “Despite some location-related problems like higher energy costs, Europe is generally competitive. Today, an engineer in China or Taiwan costs just as much as in Europe and the industry has become more capital-intensive. We can partly compensate for disadvantages by showing a high innovation rate and efficiency.”[3]

[1] Critical factors and performance measures of TQM, Jaideep Motwani | **http://www.emerald-library.com/ft**
[2] ASIAS: The Power of Data, Peggy Gilligan
[3] American Hospital Association | **http://www.aha.org/advocacy-issues/quality/index.shtml**

To capitalize on innovation and position themselves effectively in the market, European manufacturers need:

1. Powerful engineering and R&D expertise to produce leading new technology and high flexibility to tailor existing technology to their requirements
2. High resource utilization, productivity and competitive pricing, the latter being a prerequisite for market entry. European companies must strive to maintain parity, even if they are unable to match the pace of the Far East

This article examines the barriers to high productivity and resource utilization, takes a mathematical approach to resource allocation and provides a framework for driving productivity through accurate planning, lean techniques and cultural change.

Solid forecasting reduces staffing costs

To ensure staffing costs are kept in check and in line with the level of demand, accurate planning and forecasting of demand is essential. Information must be kept up to date and used effectively to set staff levels. The S&OP process is key to balancing resource levels needed to achieve delivery objectives and requirements with the need to keep labor costs low.

The semiconductor industry often experiences high variation in demand levels year on year and even month on month. The rate of innovation, and the short life cycle of semiconductor products, both within the R&D and foundry sectors, mean that manufacturers must be flexible in the following areas:

1. Labor allocation – staffing levels must be flexible enough to meet ramp demand and then adjust to stabilized or even falling demand
2. Equipment allocation – technical and engineering skills must be in place to qualify tools, run the necessary prototypes and to stabilize immature processes, to create a stable manufacturing environment
3. Risk management – European fabs must be willing to manage their customer risk and cash availability intelligently so that they can maintain stable wafer starts, even starting wafers before firm customer orders arrive, to keep pace with variable demand and an ever-changing product mix. This will prevent their susceptibility to high demand peaks and troughs while maintaining resource efficiency.

Failing to have a robust S&OP and demand forecasting process can lead to misaligned staffing allocations and higher labor costs as a result. Figure 1 shows the potential pitfalls that can result from poor demand visibility.

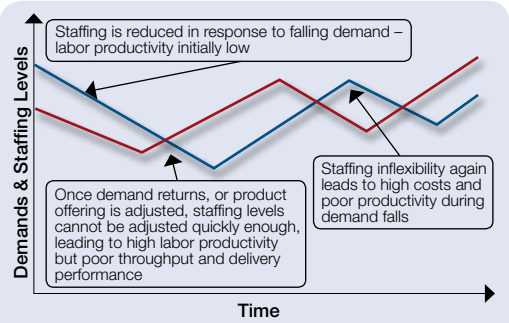

Fig 1 – poor visibility of demand and labor inflexibility lead to misaligned staffing levels

Figure 1 shows that, during times of falling demand, poor visibility of demand combined with labor inflexibility (particularly on the downside) can lead to elevated labor costs and a significant impediment to competitiveness in the semiconductor market. Once demand returns, staffing levels are quicker to respond and reach appropriate levels as temporary employees can be hired and trained relatively quickly. However, the products or options on existing products that come with newfound demand often lead to diminished throughput, as the processes associated with these products mature and suffer from inconsistency, with increased maintenance issues as a result.

Since the labor market in Europe is less flexible than in Asia, companies must prepare properly by increasing demand visibility or embracing higher risk levels (for starting unconfirmed wafers) to ensure resource efficiency and cost competitiveness is maintained.

Beyond traditional staffing models

Once the level of demand is known and translated into resource requirements, resources must be planned to maximize efficiency whilst maintaining delivery performance. Equipment costs take the largest chunk out of a semiconductor manufacturer's capital investment budget and ensuring optimum utilization of this equipment is one of a company's prime concerns. However, this again requires that appropriate levels of operators and maintenance technicians are maintained. Despite being a complex challenge, labor allocation plays a major role in equipment efficiency and manufacturing throughput.

Studies of labor productivity in semiconductor fabs show a distinct relationship between headcount and throughput (Fig. 2). Three parameters determine equipment throughput – availability (uptime), utilization and the process speed of machines. Since process speeds are relatively stable, it is the first two factors which have the greatest impact. Improving availability and utilization directly increases throughput.

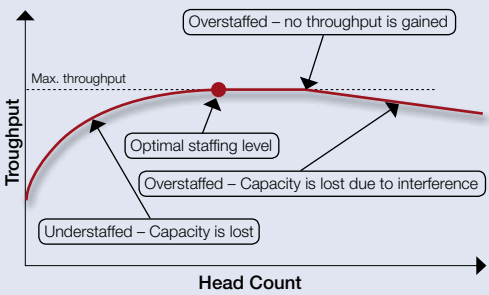

Fig 2 – Classic relationship between throughput against head count

The increase in throughput resulting from increased staffing levels in understaffed situations – shown on the left hand side of Figure 2 – is not linear and is governed by the law of diminishing returns. The optimal staffing level is defined as the lowest staffing level at which maximum throughput is reached. Once this level is passed, additional staff will yield no increase in throughput. Once a certain point is reached, the consequence of further staffing to the fab is a reduction in throughput, caused by poor focus, excessive training, less ownership, reduced alertness, overcrowding and lower quality of work.

Traditionally, this optimal staffing level is calculated using targets for activities to be carried out per hour or direct utilization for maintenance technicians. Although simple to implement, this method has several drawbacks:

1. It makes no distinction between bottleneck and non-bottleneck equipment
2. It does not take into account the inherent variability of uptime, WIP levels or other events
3. It contains inaccuracies based on differing activity levels for different equipment

To move beyond this method of allocating staffing, simulative or analytical methods can be used to model machines as entities requiring servicers and servicing. The frequency of machine service requirements is often seen to follow a Poisson distribution and the duration of these events as an exponential decay distribution. This analysis is then used to calculate production losses and workload percentages for given staffing levels – the exact parameters differ from fab to fab. Maximum allowable percentages for each criterion are then stipulated. The model identifies the lowest staffing level that simultaneously satisfies both criteria at each work center. Naturally, the higher the number of people assigned to a work center is, the lower production loss and workload percentages.

However, as has been demonstrated, overstaffing reduces productivity and ultimately throughput (as well as driving up labor costs unnecessarily). We need to calculate and implement the optimum staffing level that minimizes the negative effects of insufficient and excessive staffing.

An efficient fab will try to maximize the production time of its bottleneck by minimizing its downtime and idle time. This implies that higher losses should be accepted in non-bottleneck areas. However, a good staffing model must allow for different labor productivity and equipment utilization levels in the individual work centers, so that bottlenecks can be managed accurately.

Giving European labor a competitive edge

As we have seen, labor productivity and resource utilization are generally the key factors in maintaining the position of European semiconductor companies in the market. Despite the challenges of high labor costs and low flexibility, European labor must make an effort to maintain cost competitiveness with the Far East by increasing productivity, and take advantage of the rising labor costs in the east, thus offering a credible alternative.

To do this, European manufacturers must empower their staff to take operational decisions, respond effectively to operational problems and be flexible enough to maximize throughput whatever the situation. Structural improvements can be put in place to ensure that operational decisions are made in a timely manner and that serious issues can be escalated as soon as they arise.

Typically, escalation of floor level issues go through several layers of management until there is a resolution. Lean thinking, by contrast, emphasizes the importance of empowerment at floor level so that action can be taken early on. This often requires training and on-going monitoring to ensure floor level staff have the opportunity, capability and ability to make the decisions for which they are responsible. The result is that responsibility for actions and floor performance is pushed closer to the floor, cutting out unnecessary communication and meetings to transfer information. Floor level issues are resolved quickly and floor performance is increased.

Once floor level staff are able to take control and responsibility for the running of the floor, empowerment can go further, releasing planning tasks to the floor, so that staff there can respond to the situation and make adjustments to staffing levels, moving flexible labor to prioritized tasks, actively reducing production losses and increasing workload without increasing labor costs. By utilizing the ability of floor level staff, a European fab can reduce labor costs by enhancing the utilization of its staff.

Competing on technology and cost

To summarize, European manufacturers must stop seeing the Asian market as an insurmountable ideal and strive towards cost control and parity with Asia as an essential part of their objectives. Competitive pricing can be achieved if handled in a structured and mathematical way. Future-oriented demand visibility ensures that operators always have the most recent information, enabling them to flourish despite the inherent variability of demand in the current semiconductor industry. Having the flexibility to bear increased risks by starting unconfirmed orders also helps to ensure a stable manufacturing environment.

In this stable environment, the traditional staffing models based on piece rate or hourly rate activities can be discarded in favor of a more advanced, flexible and responsive approach, in which operators and technicians are modeled as servers working with machines to increase those activities which add value while reducing production losses. By doing this, labor costs can be maintained at a competitive level without compromising performance of the fab. Beyond this, empowerment of operators and floor level staff leads to further flexibility and responsiveness to floor level situations, creating higher and more stable throughput coupled with even lower production losses and labor costs.

Although the cost structure challenges in Europe may not allow for total cost parity with Asia, significant steps can be taken towards it by ensuring that resources are planned, allocated and utilized accurately and to their full extent, European manufacturers can build a solid customer service platform from which technological innovation, product offerings and delivery performance can give them a significant edge in this key world market.

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