Chapter 16
Modelling the Long-Term Cost Competitiveness of a Semiconductor Product with a Fuzzy Approach

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ABSTRACT

Unit cost is undoubtedly the most critical factor for the competitiveness of a product. Therefore, evaluating the competitiveness of a product according to its unit cost is a reasonable idea. The current practice assesses the competitiveness at a number of check points in the product life cycle, and then averages the results. This approach is computationally simple but theoretically doubtful. This study evaluates the long-term cost competitiveness of a semiconductor product based on its cost learning model from a new viewpoint – the trend in the mid-term competitiveness. Using a fuzzy value to express the long-term cost competitiveness, the flexibility in the interpretation and implementation of the evaluation result is increased. A practical example is used to illustrate the proposed methodology.

INTRODUCTION

Competitiveness is the ability and performance of a firm, sub-sector or country to sell and supply goods and/or services in a given market. Competitiveness engineering is a systematic procedure, including a series of activities of assessing and enhancing competitiveness. Competitiveness assessment is a one of the major tasks. There have been many relevant references in this field, but most of them focused on exploring the factors affecting competitiveness (such as cost, quality, customer satisfaction, technical competence, etc.) and ways to improve competitiveness (such as balanced scorecard, blue ocean strategy, lean production, green supply chain, learning organization, etc.). How to assess competitiveness in a quantitative way is rarely discussed.

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Competition in the semiconductor manufacturing industry has reached an unprecedented level of intensity. Typical products of this industry include dynamic random access memory (DRAM), flash, application-specific integrated circuits, etc. For sustainable development under such a difficult environment, semiconductor manufacturers come up with various ways to improve their competitiveness, such as alliances, becoming fabless, outsourcing, and developing next-generation technologies.

Porter (1979), is a pioneering study in this field. He came to the five forces that influence the competitiveness of an enterprise such as the threat of substitute products, the threat of established rivals, the threat of new entrants, the bargaining power of suppliers, and the bargaining power of customers. However, these invisible forces mostly come from outside the company, and it is also difficult to assess their impact. Armstrong (1989) advocated that a competitive semiconductor manufacturer should meet four principles, including continuous measurable improvement, statistical thinking, constraint-focus and people development/empowerment. Jenkins et al. (1990) stressed the importance of quality, and described how to design quality into products and processes. Dr. Robert Helms, CEO of International SEMATECH, remarked, "In our industry, it used to be that the big companies eat the small. Today, the fast run over the slow" (Helms, 2001). Leachman (2002) benchmarked ten semiconductor manufacturing facilities to identify the factors that influence competitive semiconductor manufacturing (CSM). Peng and Chien (2003) focused on how to create values for customers. Shortening cycle time, producing high-quality products, on-time delivery of orders, continual reducing costs, and improving efficiency were considered as the most direct and effective ways. Recently, Walsh et al. (2005) observed that the competitiveness and long-term success of an enterprise is closely related. Although Liao and Hu (2007) claimed that knowledge transfer is an important factor for the competitiveness of semiconductor manufacturers. However, according to Crowder's view, the leadership of manufacturing science and technology will not necessarily deliver a competitive advantage (Crowder, 1989).

The traditional way to measure the competitiveness of a semiconductor manufacturer is to interview stakeholders, such as its past and present key management personnel, marketing and technological consultants, professional analysts, major capital equipment suppliers, and even competitors (Leachman, 2002; Walsh et al., 2005). This process is subjective. It may lead to imprecise assessment that may not be suitable for quantitative analyses. In practice, another frequently used approach is the hierarchical assessment approach, in which several aspects of competitiveness are to be evaluated, and then a simple (weighted) average method is used to integrate the assessment results. However, such a treatment is unfounded in practice and questionable. Moreover, competitiveness is a subjective and uncertain concept, but the existing methods cannot maintain this flexibility. On the other hand, quantitative measures such as market share (Walsh et al., 2005; Defree, 2007) and revenues (Walsh et al., 2005; Defree, 2007) has been very sensitive to market conditions that are beyond our control, and need to be compared with those of the competitors or with the average levels in the whole industry. In addition, these measures are not the sources but rather the outcomes of competitiveness. Moreover, the mid-term financial performance is difficult to predict.

The competitiveness of a manufacturer comes from all of its products. A product is competitive because it is trendy, has good quality, can be manufactured with low costs, etc. Based on this belief, Chen (2007) proposed a systematic procedure to assess the yield competitiveness of a product. However, even if a product is competitive in some ways, it may not be competitive in other ways. For example, some semiconductor products have high yields at the later stages of their product life cycles, but their costs are still too high to generate profits. On the competitive-

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