Manufacturing Flexibility: Methods for Measuring the Impact of Product Variety on Performance in Process Industries  
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Manufacturers are experiencing pressures from powerful customers and market trends to simultaneously increase variety, reduce costs, and delivery smaller quantities more frequently. The research literature reports several examples of companies that suffered when they shifted to a marketing strategy that targeted low volume / high variety segments without also shifting their manufacturing strategy, thus resulting in misalignment and poor performance. This paper describes a framework and methodology for resolving the critical strategic issues of product pricing and process investment required to achieve the necessary manufacturing flexibility in product mix.

Two dimensions are vital in the decision to increase product variety: the characteristics of buyer behavior measured in terms of price sensitivity for the targeted market segments, and the current process choice decisions in manufacturing. The distinction between high and low volume batch processes is critical because of the important differences in capability and investment required between these processes.

Typically, low volume batch processes are designed with features such as low changeover times and high employee skill requirements that provide the flexibility needed to support a product variety strategy. High volume processes are normally designed with features such as short unit processing times, extensive process monitoring systems, and low employee skill requirements that enable low product costs to be achieved. The framework shown in Figure 1 suggests that a company contemplating a marketing strategy of increased product variety can face one of four possible general situations. In only one case, labeled (1), are the marketing and manufacturing strategies already aligned. Case (4) presents the most difficult challenge to the business because an increase in product variety is often achieved through low volume products that have increased changeover times and costs that are not compatible with the current high volume process and supporting infrastructure. Furthermore, although the new products may have the advantage of retaining existing customers or producing new sales growth, the customers in case (4) are price-sensitive and it is difficult to capture margin through pricing increases.

Although simply considering price sensitivity and an increased number of changeovers results in necessary complexity in strategic decision-making, many industrial processes also have additional intricate cost relationships between changeovers, process yields, and productivity that can depend on product volume.
This research presents relatively simple equations that can be used with currently available operating data to determine the range of batch sizes that would produce a given level of profit for various pricing and process choice configurations. The below graphs were based on results from the equations and display the contribution margin per process hour, a metric consistent with activity based costing and the theory of constraints.

In the example seen in Figure 2, the current process choice and pricing best supports the production of high volume products in long runs, so the contribution margin per process hour is substantially reduced for batch sizes smaller than 2 million units. If a price premium can be obtained, the curve shifts and the current process is able to support new products having batch sizes as small as 1 million units with contribution margins approximating those at 4 million units under the current pricing strategy. In other words, the shift in pricing strategy extends the range of batch sizes and product variety that can be supported at a given profit level by the high volume batch process. As shown in Figure 3, changes in process investment can change the shape of the curve, extending the range of batch sizes (and thus product variety) that can be supported by the current pricing strategy.

The model can encompass whatever factors are relevant to a company; examples in this paper included batch size, seasonality, holding costs, and whether products were produced in the natural cycle sequence. While the specific results shown in this paper are only relevant to the firm studied, the discussion is intended to demonstrate the type of information and methodology that can be used in debating pricing and process investment decisions. It is vital that companies understand the implications of their strategic alternatives, and this paper describes the means to do so.