Manufacturing-Marketing Interface: Simultaneous Evaluation of Product Line Extension/Trimming and Investment in Production Technology/Capacity Decisions

Abstract

Firms in various industries have realized the importance of variety, the fact corroborated by non-existence of single product firm. If each consumer's individual demand is fulfilled then firm is able to charge premium and earn higher revenue, but satisfying each consumer's tastes and preferences results in high cost of manufacturing. The tradeoff between higher revenue potential and higher manufacturing costs needs judicious choice of product variety and investment in manufacturing capabilities. In the absence of simultaneous evaluation of product line and investment in manufacturing technology /capacity decisions, the result is sub-optimal (profitability).

Research has indicated the need for a balance between the revenue and cost dimensions while determining the optimal product mix and investment in manufacturing technology/capacity, yet there is a scanty body of research that integrates product line decisions (extensions and trimming), and manufacturing technology (dedicated or flexible resources) and capacity decisions. This thesis involves problem of simultaneous evaluation of product line and investment in manufacturing technology/capacity decisions. The product line decisions are: line extension products to introduce, existing products to trim. These decisions lead to changes in demand volume and mix that created implications for manufacturing technology/capacity decisions. Manufacturing, based on trade-off between manufacturing costs (acquisition and unit operating) and ability to produce variety of product, has to decide

on investment and capacity allocation decisions. The model developed is a 0-1 MILP formulation with objective of maximizing the profit.

Some of the insights developed through analysis of test problem solutions indicate that:

The fixed cost of capacity acquisition is the most important factor in deciding level of optimal profit. The result shows that decisions about product line extension and trimming must take into consideration the acquisition cost of manufacturing technology/capacity, which is missing in the existing literature.

The second most important factor to explain profitability is incremental demand generated by line extension products through demand expansion & competitive draw. The incremental demand is attractive therefore more the demand expansion & competitive draw more number of line extension products are introduced. However, it requires evaluation of investment in manufacturing capacity because of changed demand volume and mix profile.

At high cannibalization levels it is more profitable to have higher proportion of flexible capacity in the total capacity. For the same level of cannibalization it is also observed that there is increasing tendency to manufacture products using only flexible capacity.

It is also observed that as unit operating cost of flexible capacity increases, number of line extension products introduced decreases indicating the importance of this manufacturing technology cost consideration for product line decisions and product variety outcome.

Through constraint tightening and additional valid inequalities developed in this thesis the computational effort of solving 0-1 MILP is reduced. The valid inequalities (cuts) are called as *C-P* and *T-P*. The results confirm that under various combinations of problem parameters both valid inequalities are beneficial in reducing computational complexity. In addition to computational complexity, it is confirmed that constraint tightening and additional valid inequality provide tight upper bound for LP relaxation problem.

Further, a primal-dual procedure is developed using interlinking variables, complicating constraints, break-points and complimentary slackness condition that yielded optimal solutions in case of 67.5% test problems and an additional 20% test problems had their solution within 5% of the optimal solution. On larger problem sizes the primal-dual procedure maintained solution quality as problem size increases. The primal-dual procedure was consistent in computational time and achieved more than 65% reduction in time compared to AMPL+CPLEX.