Planning for the expansion of capacities is vital for any growing organization. Capacity expansion planning primarily involves deciding the time(s), size(s) and location(s) of the future expansions. Operations Research methodology has helped in developing various models of capacity expansion. One of the most important inputs to these models is a projection of the capacity requirements during the planning horizon.

This thesis considers the capacity expansion problems of manufacturing organizations involved in producing a complex engineering product. A product when put to use generates replacement demand for worn out components. The net requirement for capacity at any machine centre during any future period in the planning horizon will consist of both the requirements for meeting the demand for the product and also for meeting the demand for spares. The present work considers the estimation of capacity for meeting the demand for spares and
planning for capacity expansion for meeting the aggregate requirements of
capacity at different machine centers of manufacturing facilities involved in
complex engineering products.

Demand for spares for products in service depends on the induction of the
products into service and many other factors related to the conditions of service.
Most existing models for estimation of spare part requirements for products in
service are based on theoretical failure distributions of parts in service. Simplifying
assumptions are often necessary to represent all the factors affecting spare part
consumption in the model. This makes the model deviate appreciably from reality.

This thesis presents an empirical model for estimation of future
requirements of spares for products in service based on the initiation of the
products into service and past consumption. The model can be applied directly
for estimating the capacity requirements of various machine centers used for
producing the parts in a manufacturing unit. A Lag Regression model has been
formulated with past requirements of capacity at machine centres, calculated
based on historic data on spares consumption as the dependent variable and
quantities initiated into service during corresponding periods as the lag variables.
Almon's methodology for transformation of lag variables and Principal Component
Analysis has been used in the development of the Lag Regression model. The
Lag Regression model has been used for estimation of future capacities of
different machine centres based on anticipated entry of further quantities of the
product into service.
An Integer Linear Programming model has been formulated for modeling the aggregate capacity expansion problem for meeting the future requirements of capacity. The capacity expansion model takes into consideration the deterioration of existing capacity and capacity replacements. General cost functions for capacity expansions have been considered besides maintenance and operating costs. The model seeks to minimize the total Present Worth of all costs associated with future capacity expansion plans.

To assess the appropriateness of the composite model data related to the capacity expansion problem for manufacture of a defence product by the Indian Ordnance Factories is considered. Statistical tests have been used to prove the validity of the capacity estimation model for spare parts manufacture. The model has also been externally validated using independent observations. The model was solved using LINDO to obtain the optimum capacity expansion plan for the planning horizon. The model is applicable in situations where the manufacturer of a product is also the exclusive supplier of the spares for the product.