Effects of Batch Size on Safety Stock Levels: A Model for Flexible Low-Cost Market-Oriented Design for Manufacturing System

Farouk G. Attia, Robert Seaker
University of Houston, College of Technology, Houston, Texas 77204

Abstract

The manufacturing industry is undergoing major changes in the way products are designed and produced. Mass customization is forcing the industry to respond to "individual" customer requirements and yet it is expected to make products efficiently in large quantities. Global market demands have led to three distinct forms of production planning and control: the conventional manufacture-to-stock or the "Push" system, the Just-in-Time (JIT) manufacture-to-order or the "Pull" system, and a "hybrid" push-pull system based on delayed product differentiation. The hybrid type is the most difficult to optimize regarding overall system cost and efficiencies since it entails frequent integration of product design, process planning, inventory requirements, variable batch sizes, and other constraints of post-manufacturing delivery. The current study links the product design and manufacturing planning activities within the factory with order fulfillment objectives and the overall distribution network through a model for flexible, low-cost Design for Manufacturing (DFM) system.

Recent trends in DFM have an implied optimal target of zero inventory levels at all stages of the supply chain. Some volume of inventory, however, may be necessary to smoothen the production flow inside the factory while reducing lead times, thus increasing the overall profitability. One approach may be to introduce optimum levels of Work-in-Process (WIP) inventory into key stages of the production system. Computer simulation and modeling can aid DFM with the quest for business process re-engineering facing various constraints imposed by the product design and supply chain.

The current paper studies the effects of batch size on the strategic WIP levels and the order-to-ship cycles and discusses the methodology used for such an assessment. The order-to-ship cycle is the time between receiving a customer order and the shipment of finished goods against that order. Obviously, smaller order-to-ship cycles equate to higher customer service levels. Using real production data from a worldwide manufacturer, the current study investigates the application of the strategic WIP deployment and management of WIP levels using optimal batch size, for a customer responsive design for manufacturing system.

The paper also presents a computer simulation model developed using commercially available software that can be used in teaching Mechanical Engineering students about comprehensive and robust methods of assessing flexible low-cost factory technique used for linking product design and manufactuirng systems oriented to market requirements. The study presents an optimal scenario within the set of variables and parameters tested, wherein batches of

components can be built and deployed as strategic WIP that helps enable a low cost and customer responsive manufacturing system. Optimal batch sizes were obtained for a scenario, which balanced the WIP inventory carrying costs and the order to ship cycles. Multiple scenarios were tested from which a possible optimal scenario emerged that displayed a greatly improved order-to-ship cycle against an acceptable marginal increase in WIP inventory carrying costs.

FAROUK G. ATTIA
Dr. Farouk Attia is an Associate Professor of Mechanical Engineering Technology at the University of Houston, where he has taught since 1986. He has over 30 years of educational, research and industrial experience in the fields of Mechanical Engineering, Manufacturing and Automation, and Mechanical Systems Design. Dr. Attia has received several grants from NSF, Texas Higher Education Coordinating Board, and the Society of Manufacturing Engineers. He presented and published numerous articles in ASEE, AIAA, ASME, and SME conferences and journals. Dr. Attia is an active member of American Society for Engineering Education (ASEE), Society of Manufacturing Engineers (SME), and American Society of Mechanical Engineers (ASME).

ROBERT SEAKER
Robert Seaker is an Assistant Professor of Logistics at the University of Houston. He holds a Ph.D. and a M.S. degree from Pennsylvania State University and a B.S. degree from West Chester University. His primary research interests involve organizational factors that affect supply chain process implementations, supply chain economics and metrics, and the building and enhancement of general organizational theory. His publications have appeared in *Journal of Business Logistics*, *Logistics and Transportation Review*, *The International Journal of Logistics Management, International Journal of Quality* and *Reliability Management*, among others.