



## MIT SCALE RESEARCH REPORT

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**Value of Advanced Order Information in Sequence Dependent Make-To-Order Manufacturing**  
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## **Value of Advanced Order Information in Sequence Dependent Make-To-Order Manufacturing**

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### **EXECUTIVE SUMMARY**

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In industries such as steel, paper, synthetics and polymers, several products are manufactured at the same facility and a changeover from one product to another leads to additional setup costs and loss of productive capacity. Often the setup time and costs also depend on the sequence in which the products are manufactured. This is termed as manufacturing with sequence-dependent setups. Typically, in environments where there are sequence dependent setups, the make to order (MTO) approach to manufacturing is used. The production plans and schedules are based on already received firm orders from the customers.

In such an environment the value of proper production scheduling is tremendous, as production scheduling in a sequence dependent MTO environment involves a tradeoff between on-time delivery and minimizing setup as well as inventory holding costs. Based on the available orders, the manufacturer has to make a decision about what to produce and when. Having a higher batching interval is beneficial, as more orders can be aggregated together for production, reducing the number of changeovers and consequently the costs associated.

However, time based competition is forcing companies to reduce lead-times. Lead time reduction is an ongoing initiative in most large manufacturing organizations as customers require shorter and shorter leadtimes. This could be explained by the fact that placing orders with longer acceptable lead-times makes the businesses to deal with higher levels of uncertainty and the costs associated with it. This is the major reason why order information in MTO environment is limited.

This thesis researches the advantages from obtaining advanced order information for a sequence dependent MTO manufacturer.

We first formulate a mixed integer program to maximize gross profit for deterministic demand. A Monte-Carlo simulation approach is then used to sample from an assumed demand distribution and the optimization model is run for multiple random samples of demand. We define an information revelation function that shows the volume of orders known at every instant of time. This function has two parameters  $a$  and  $b$ ;  $a$  characterizes when the additional information arrives, for instance, as a result of an incentive program; and  $b$  reveals the volume of that additional information. In the base-case, the information revelation function has both parameters  $a$  and  $b$  set as zero.

Our simulations reveal the dependencies of expected gross profits, their confidence boundaries and standard deviations of gross profits on changes in parameters of information revelation function.

## Value of Advanced Order Information in Sequence Dependent Make-To-Order Manufacturing

The main contribution of the thesis is an assessment of the value of advance order information in make-to-order sequence dependent manufacturing. This knowledge can help organizations in creating a time based discount system, to compensate a customer for the additional exposure to uncertainty.

For a reasonably chosen set of cost and utilization parameters, we conclude that when full information is available for the entire planning horizon, there is a potential to increase the expected gross profits by up to 54% to as compared to the base-case scenario.