Abstract

The class of scheduling problems investigated in this dissertation is motivated by stochastic scheduling of multi product manufacturing systems with switchover costs and/or switchover times. The dynamic scheduling methodology developed here is applicable in general to many discrete activity scheduling problems arising in manufacturing, computer, and communication systems. The scheduling problem is formulated in the modeling framework of multi-class queues in heavy traffic. The solution methodology is based on Brownian approximations and uses an extended version of the multi armed bandit problem with diffusion dynamics.

Specifically, consider a flexible machine center which caters to multiple classes of products with significant setup times and/or setup costs involved in switching from one class of products to another. A holding cost is incurred for making a customer wait for service. The processing times and inter-arrival times are allowed to have arbitrary distributions. Our objective is to evolve a scheduling policy that would minimize the infinite horizon discounted cost. This scheduling problem, especially in the presence of setup costs and/or setup times, has defied analytical tractability and has remained an open problem except in very special cases. In this dissertation, we originate a solution methodology for this problem in a general setting by invoking an approach based on diffusion approximations for multiclass queues in heavy traffic. The use of diffusion approximations creates a tractable control and optimization framework, with just the knowledge of only the first two moments of arrival and service processes. In this setting, the scheduling problem is transformed into a stochastic control problem in a multi-dimensional framework, with an interesting variant of the multi armed bandit problem embedded within it. The methodology leads to an elegant and computationally efficient index strategy for dynamic scheduling, which at any decision epoch assigns an index to each product class as a function of the current state of the system.

Results from extensive simulation studies articulate the efficacy of the index policy over well-known heuristic scheduling policies available in the literature. Furthermore, the methodology can be adapted or extended to many interesting dynamic and stochastic scheduling problems arising in the areas of manufacturing, computer, and communication systems.