Continuum models for interacting machines

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Abstract

A review of continuum models for production flows involving a large number of items and a large number of production stages is presented. The basic heuristic model is based on mass conservation and state equations for the relationship between the cycle time and the amount of work in progress in a factory. Heuristic extensions lead to advection diffusion equations and to capacity limited fluxes. Comparisons between discrete event simulations and numerical solutions of the heuristic PDEs are made. First principle models based on the Boltzman equation for a probability density of a production lot, evolving in time and production stages are developed. It is shown how the basic heuristic model constitute the zero order approximation of a moment expansion of the probability density. Similarly, the advection diffusion equation can be derived as the first order Chapman-Enskog expansion assuming a stochastically varying throughput time. A discussion on the similarities and differences of industrial production networks and biological networks is also presented.