7.2 FAS with Generalized CSPSs

7.2.1 Introduction

An ordered-entry array of the multiple-production stations connected by conveyors [13] is focused on management views [16], and is here called the flexible assembly system (FAS), meaning that it is flexible in processing and routing. The system-centered approach is an ordered-entry type queue [1, 6, 10, etc.] and the station-centered approach involves unit-stations coordination [2–4, 11].

The FAS manager faces stochastic variations such as arrival/service times, which causes stochastic system balancing problems for absorbing the variations. However, there is no effective design method for FAS from past studies, except the simple design method in [3, 4], and the lead time in reliability is ignored.

We apply a two-stage design method [9, 17] to stochastic system balancing problems through the station-centered approach. The FAS is then regarded as a coordination/balancing problem between the unit stations of Generalized CSPSs [5, 8], and is called the simple FAS [3, 4, 14]. This chapter presents a useful management design approach for the simple FAS in view of the cost and lead time views [14].

First, the simple FAS is briefly outlined. Next, the two-stage design procedure is presented for both types of the existing and installation problems of production facility. Third, an optimal design example is shown and discussed numerically. Finally, the production matrix tables of both types are given, and a strategic relation of economic traffic \((d, K)\) and lead time is discussed.

7.2.2 Simple FAS Model

7.2.2.1 Definitions and Notation

The simple FAS consists of multiple unit stations (Generalized CSPSs) of an unloading type [12, 13], and their coordination/balancing problem is considered as the two-level structure (Fig. 7.2.1). There are buffer-design problems of each station at
the lower level, and the coordination problem of buffers by the mean of the interarrival time (cycle time), \( d \), in the upper level.

Under the cycle time of \( d \), the buffers, the capacity of the reserve at station \( i, N_i \) and the look-ahead time at station \( i, c_i \), are decided under the cycle time, \( d \), and the number of Generalized CSPSs, \( K \), according to the respective minimization of the total expected operating cost at station \( i, EC_i \) in the lower level. The respective information \( (N_i, c_i) \) in \( EC_i \) is communicated to the upper level. By iterations, the cycle time, \( d \), and the buffers \( (N_i, c_i) \) are decided in order to minimize the total expected cost of system \( TC = \sum_i EC_i \) in the upper level.

Then, it is assumed that the usables flow according to Poisson arrival at the mean interarrival time, \( d \). The service time in each station is supposed to follow the Erlang distribution. Under these assumptions, each station individually decides the two buffer variables, capacity of reserve \( (N_i) \), and look-ahead time \( (c_i) \) in order to minimize the total expected operating cost, \( EC_i \).

The usables are removed in to reserve and wait to be processed. If the operator is busy, the usables become overflows without removing. The stored useables in the reserve at each station are processed, removed to the bank, and become finished products. The overflowed useables at the \( i \)-th station become inputs into the \((i+1)\)-th station. The look-ahead time, \( c_i \), at the \( i \)-th station is the control variable in the optimal operating policy called RdSRP [8, 12].

Fig. 7.2.1 2-level structure of simple FAS