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Analysis of production line with finite buffers and a general service term

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Abstract

This paper considers a production line with continuous loading at the first automation service station or machine and buffers placed forward the queuers. Each machine operates within an indefinite service time. There is much data available on modeling and analysis of the transfer lines. However, most of the results are for the steady-state operation. The system under consideration operates within the finite time interval. A method is suggested to study the production line. According to the method, we chart the system operation process; calculate of distribution formula for the remaining durations of time period of the system being in the states marked at the chart. Then we calculate the state indexes. A detailed description of the states allows calculating, for example, blocking machine indexes and machine down time probabilities and durations.

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Keywords: production line, finite time interval, chart of the system operation process, remaining durations, blocking machine indexes, machine down time probabilities and durations

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1. Introduction

Functioning of a real production line is a complicated process and falls a long way short of any simplified description. Real system service time as a rule does not obey the exponential distribution as the process runs during a real shift rather than infinite time. Therefore, it is clearly an important task to investigate production line characteristics.

Tandem queueing systems modulate the line manufacture flow. Manufacturing line is a linear network of machines separated by buffer storages. The majority of studies investigate two–stage tandem queue within exponentially distributed processing times. These systems are observed under general conditions, reliability of devices (reliable – unreliable) and types of buffers (finite - infinite), for example [1 – 7]. In [8, 9] the Markov systems capacity was assessed. The systems consisted of five or more machines within unequal service periods. The Markov systems transient results were discussed in [10].

A multiphase system research suggests a method aimed at continuous and discrete random processes [16]. In [17] the method was applied to obtain machines blocking characteristics of a four-phase unbuffered tandem queueing systems with continuous loadings**.**

2. Method description

The following assumptions are made:

- the system consists of three successive reliable machines which perform single-line service;
- the first machine receives demands continuously. The second and the third machines have two objects capacity buffers;
- if the buffer placed forward the machine is filled up the served object blocks the service station;
- service time T_i for *i*-machine has a random value and is characterized by general distribution function formula $F(t_i)$;
- the system operates within the t_O period.

According to the method, we chart the system operation process including its states and states transitions. We define state as a set of durations of simultaneous service processes. Finite time interval represents a state as any other duration. However when the duration ends up all other processes are suspended. Each state is assigned with a number. A state ends up when the machine service time or finite time interval is over. So the general process enters another state. At the chart it is represented by an arrow. The machine (phase) that completed the service is a point when an adjoint state transits to the next state. The machine gets a number at the chart marked at the arrow in brackets.

The first application served by the first machine and the finite time interval make up the system initial state. At the Figure 1 both are marked as 1_1 and O accordingly. *T* is omitted. The figure critical distinction from the chart is represented particularly in [18], are *one-side* transitions. It helps to explore system indexes during the target periods.

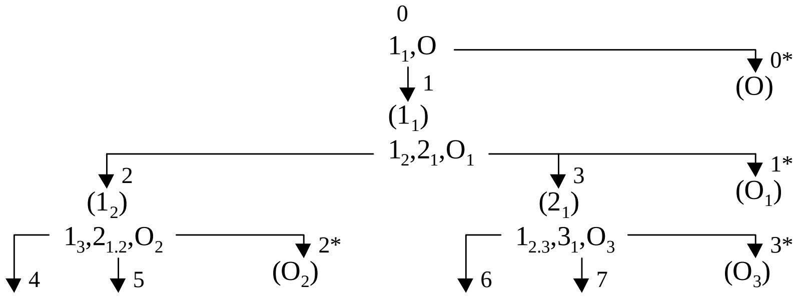

Fig. 1. First part of tandem queue system operation scheme.