University of Michigan
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EECS 569

PRODUCTION SYSTEMS ENGINEERING

A Brief Course Description

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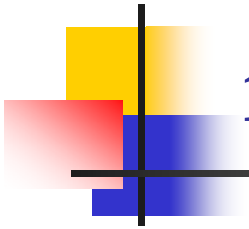
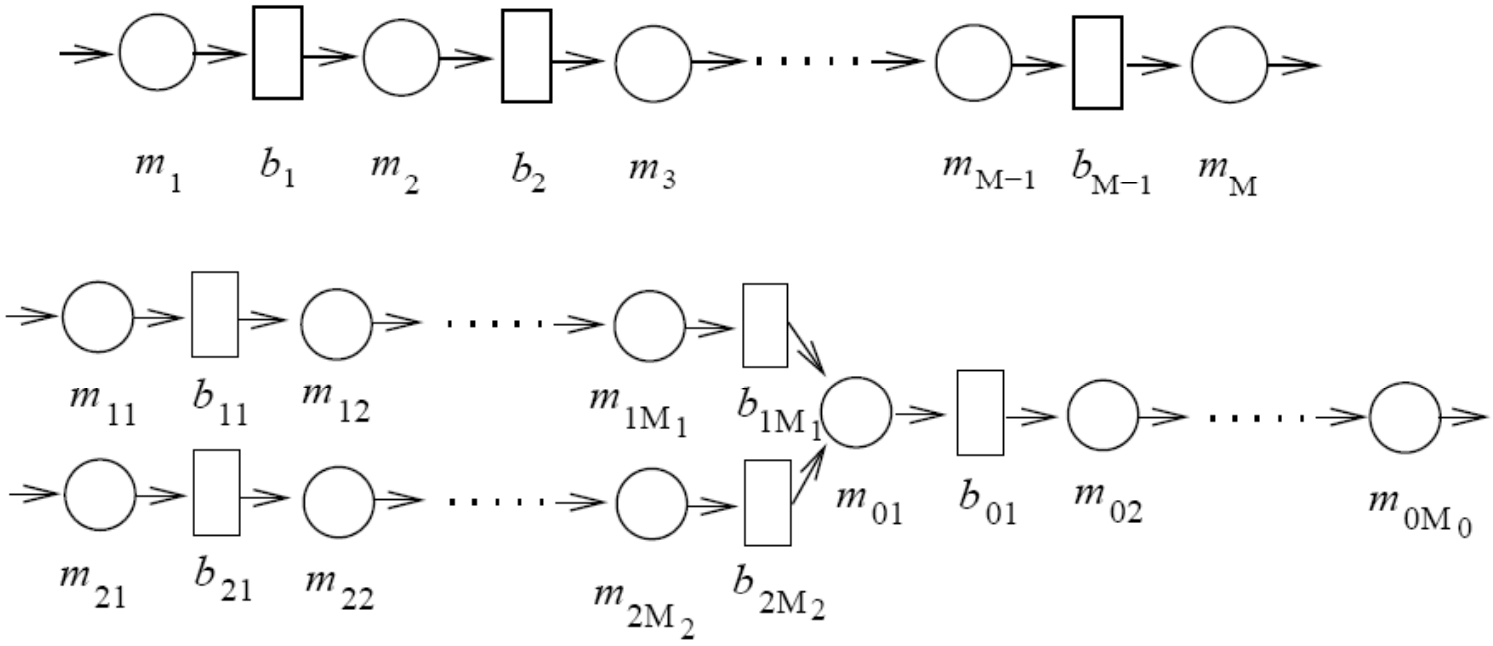


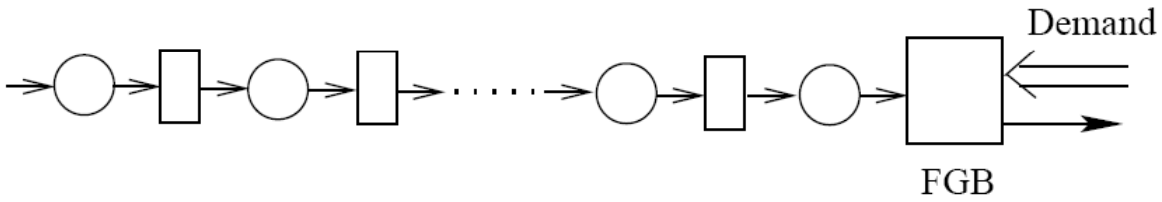
1. PSE Scenario

- ***Production Systems Engineering*** (PSE) is an emerging branch of Engineering intended to investigate fundamental principles governing production systems and utilize them for analysis, continuous improvement, and design.
- Productions systems are machines and buffers arranged to produce a desired product.
- The machines are assumed to be unreliable and the buffers finite; this makes production systems stochastic and nonlinear.
- Investigation of the resulting nonlinear stochastic equations is the main subject of PSE.

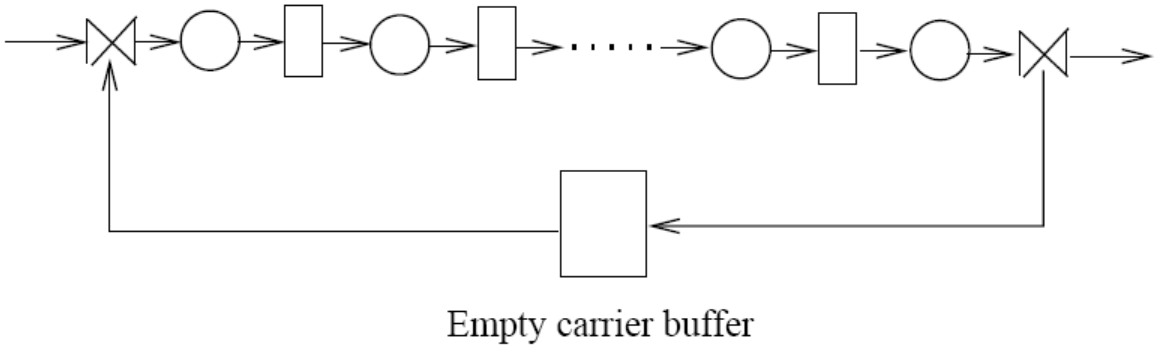
- The structure of systems addressed in PSE are *serial lines* and *assembly systems*:



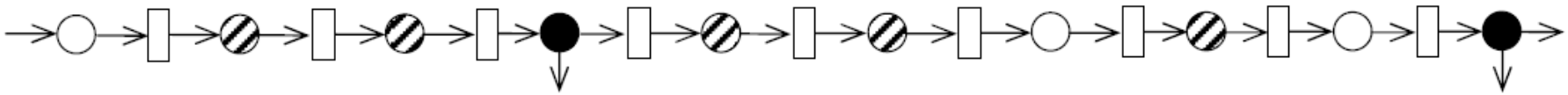
- Several variations, dictated by applications, are also addressed:
  - *Serial lines with FGB*



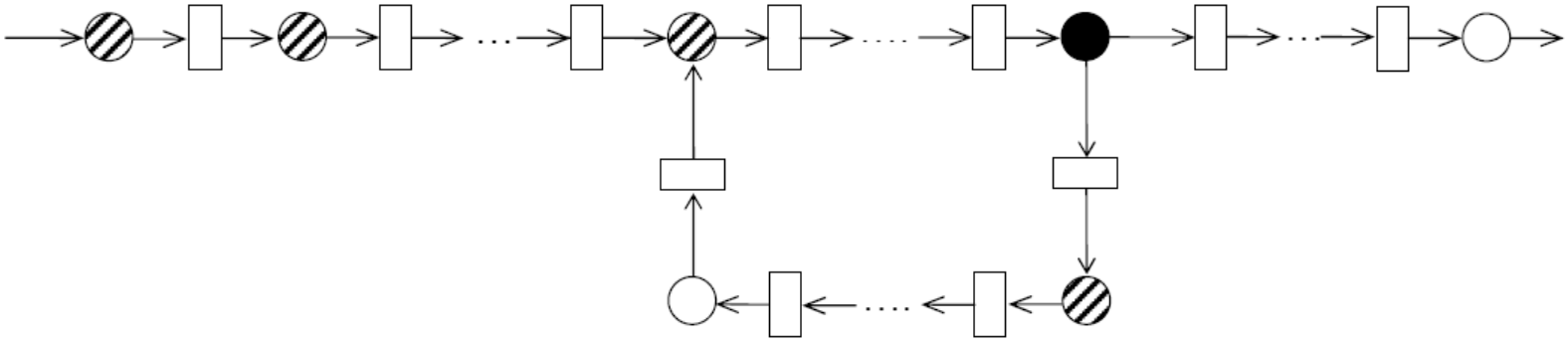
  - *Closed serial lines*

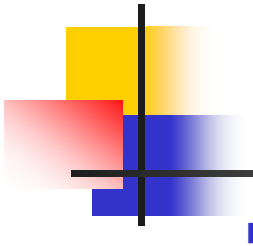


- *Serial lines with non-perfect quality and inspection machines*:

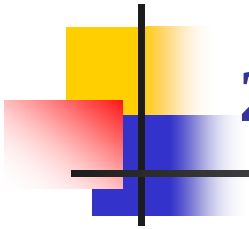


- *Serial lines with rework*:





- In each of the systems, the machines are assumed to have one of the following statistical characterizations:
  - *Bernoulli model*: the status of the machine is described by an i.i.d. sequence;
  - *Geometric model*: the state of the machine is described by a Markov chain;
  - *Exponential model*: the state of the machine is described by a Markov process;
  - *General model*: the state of the machine is described by a random process of a general nature.
- In the former cases, the investigations is based on the methods of Markov processes and their simplification (required by large dimensionality); in the latter empirical methods are used.



2. Problems Addressed in PSE

- **Mathematical modeling:** Consists of methods for constructing a mathematical model of production systems at hand with an acceptable fidelity.
- **Performance analysis:** Includes analytical tools for calculating production rate, work-in-process, probabilities of machine blockages and starvations, the level of customer demand satisfaction, etc.
- **Constrained improvability:** Develops methods for reallocating limited resources (such as workforce and buffer capacity) so that the throughput is increased.

- **Unconstrained improvability:** Consists of methods for identifying bottleneck machines and bottleneck buffers, i.e., machines and buffers that affect the production rate in the strongest manner. (Note that the worst machine and the smallest buffer are not necessarily bottlenecks in this sense.)
- **Lean buffer design:** Offers analytical tools for calculating the smallest buffer capacity, which is necessary and sufficient to obtain the desired efficiency of a production system.
- **Customer demand satisfaction:** Provides formulas for calculating the Due Time Performance, i.e., the probability to ship to the customer the desired number of parts during a fixed time interval.

- **Parts quality:** Presents methods for evaluating the rates of defective and non-defective parts production and for evaluating performance of production systems with rework.
- **System-theoretic properties:** Investigates fundamental structural properties of production systems, such as monotonicity, reversibility (or lack thereof), and transient characteristics of production lines.
- **PSE Toolbox:** Provides a user-friendly set of C++ programs that implements the methods and algorithms developed in PSE.
- **Case studies:** Describes numerous applications of PSE methods in various production systems, mostly in the automotive industry.