BACHELOR FINAL PROJECT

EINDHOVEN UNIVERSITY OF TECHNOLOGY
Department of Mechanical Engineering
Systems Engineering Group

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Title	Dynamics of an Abstract Cyclic Production System

Subject

Consider an abstraction of a production system. M machines numbered $1, \ldots, M$ produce M types of products numbered $1, \ldots, M$. Each product undergoes two steps. Products of type i are first *created* at machine i and then moved to machine $i+1$ (in case $i = M$ then interpret $i+1$ as 1). At machine $i+1$, products of type i are further *processed* and then leave the system. Thus each machine (i) can perform two types of operations: *creation* of products of type i and *processing* of products of type $i-1$. Products queue at the machines while waiting for their *processing* step. Thus the system contains M queues which we denote by $X_1, \ldots, X_M$. Queue X_i is for products of type i and is next to machine $i+1$. Student: make a drawing for $M = 3$ to ensure you understand (bring it to the first meeting).
The machines need to divide their time between *creating* and *processing*. Assume they do so by giving preemptive priority to *processing*. This means that when ever X_{i-1} is not empty, machine i will work on *processing*. Otherwise, the machine will work on *creating* and will be preempted (stopped) at the instant in which X_{i-1} becomes non-empty. It is evident that the machines never idle.
A general goal is to understand under which conditions such a production system may operate in a stable manner. This may shed a light on the understanding of more complex and realistic production systems.
As an approximation, assume that material (products) are a continuous quantity. Associate the positive production rates λ_i and μ_i with product i. λ_i is the rate at which product i is *created* at machine i. μ_i is the rate at which product i is *processed* from queue X_i at machine $i+1$. Thus for example if for $t \in [5.7, 10]$, X_i is not empty then $4.3 \times \mu_i$ units of product i are removed from X_i during this time.
Denote by $X_i(t)$ the continuous non-negative quantity of material at queue X_i at time t. Further assume that the initial conditions $\{X_i(0)\}$ are given. This fully defines the dynamics of $\{X_i(t)\}$.

Assignment

(a) Create a useful computational tool (software) for generating the trajectories of $\{X_i(t)\}$ given different parameters, M, μ_i, λ_i and initial conditions. Attempt to characterize stability (this depends on M, μ_i, λ_i).
(b) Find and implement the system of equations for production rates under the assumption of stability.

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