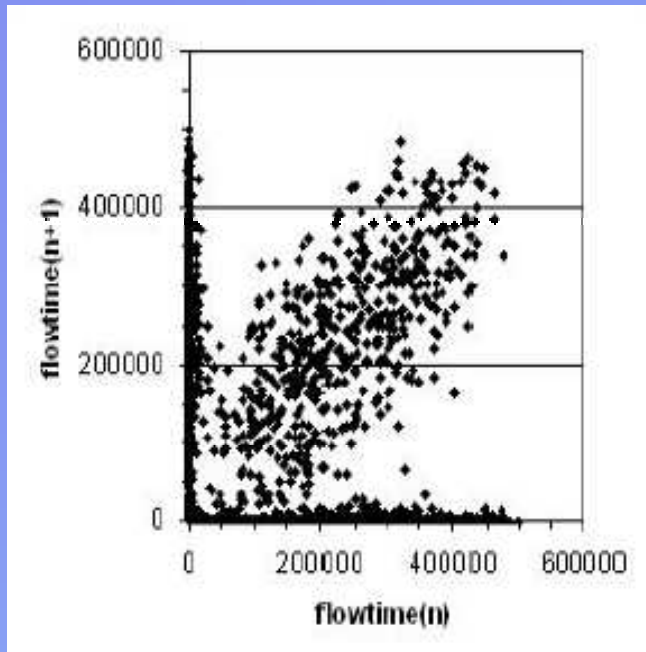
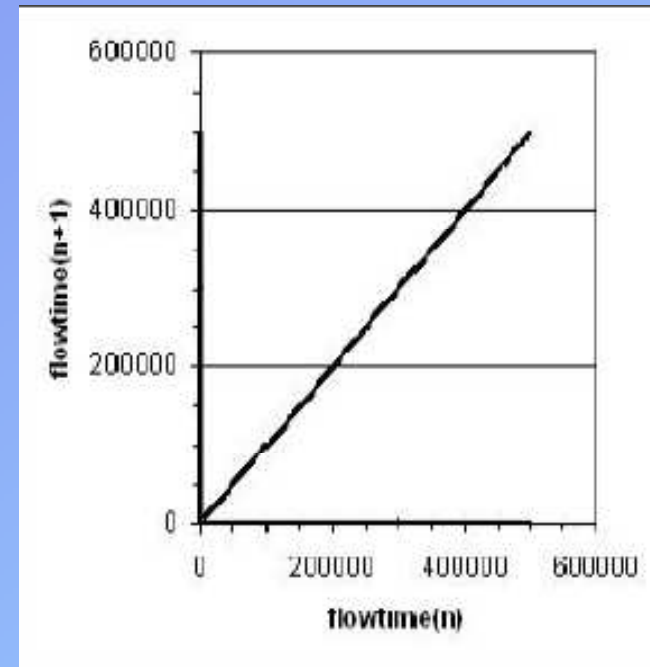


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Time-delay plot of the flowtime for scheduling a single machine using the Shortest Processing Time (SPT) rule. In a time delay plot, each value of data series is plotted on the Y-axis (abscissa) against the previous value on the X-axis (ordinate).

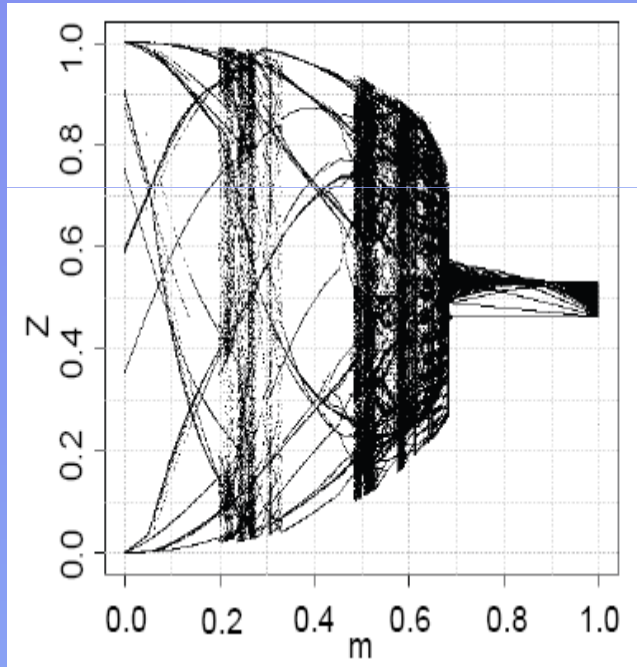


Time-delay plot of the flowtime for scheduling a single machine using a new rule.

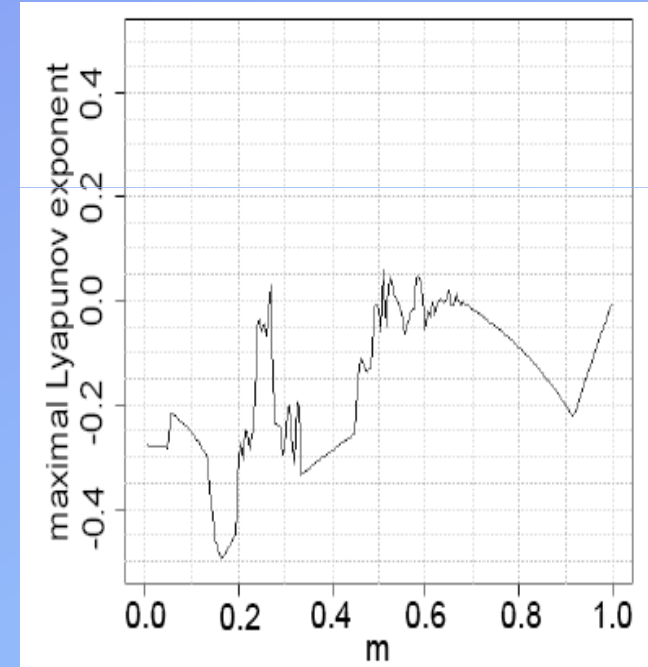
Phase portraits, time delay plots and non-linear time series analysis tools may be used for analysing the performance of a manufacturing system and for identifying optimized operational policies.

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Bifurcation diagram of production rate (Z) as a function of m .
 m : is a weighted parameter expressing the way the production rate is determined for every period. Large values of m imply that the production rate of the previous affects a lot the determination of the production rate for the next period

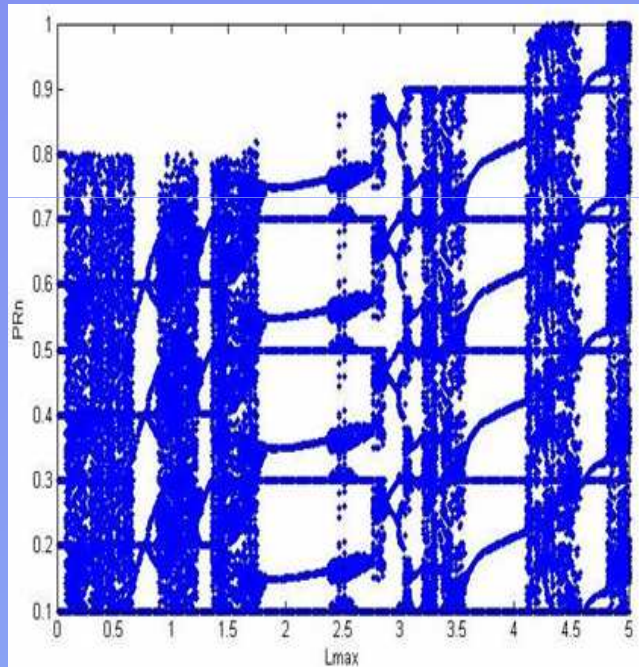


Maximal Lyapunov exponent diagram as a function of m .

Bifurcation diagrams and maximal Lyapunov exponents may be used for the identification of the values of the decision variables where production rate needs to be continuously adjusted and for the graphical representation of the expected behaviour of a production system.

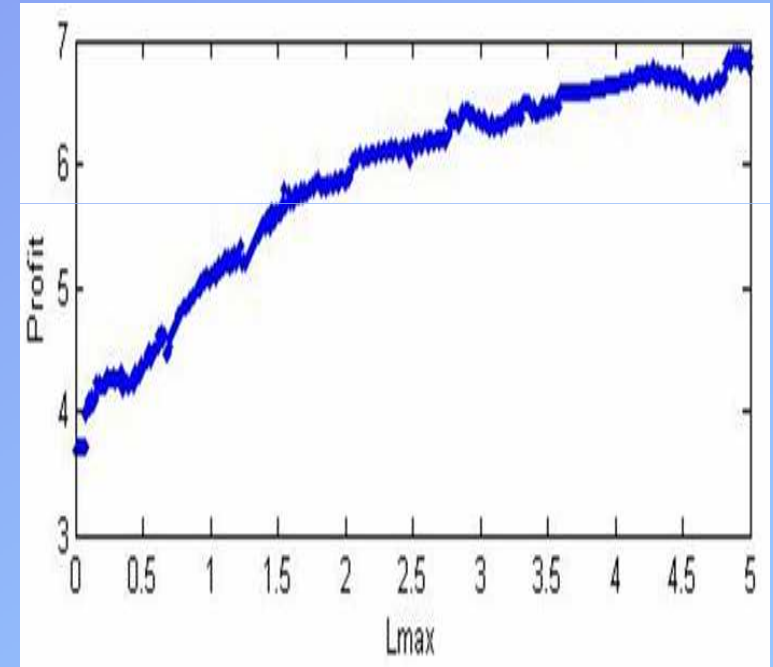
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Bifurcation diagram of production rate (PR) as a function of Lmax.

Lmax: the deflection rate parameter, for instance a specific customer could wait for a new highly customized car to be delivered in a few weeks or months (large Lmax), it would not be the case for commodities (low Lmax).

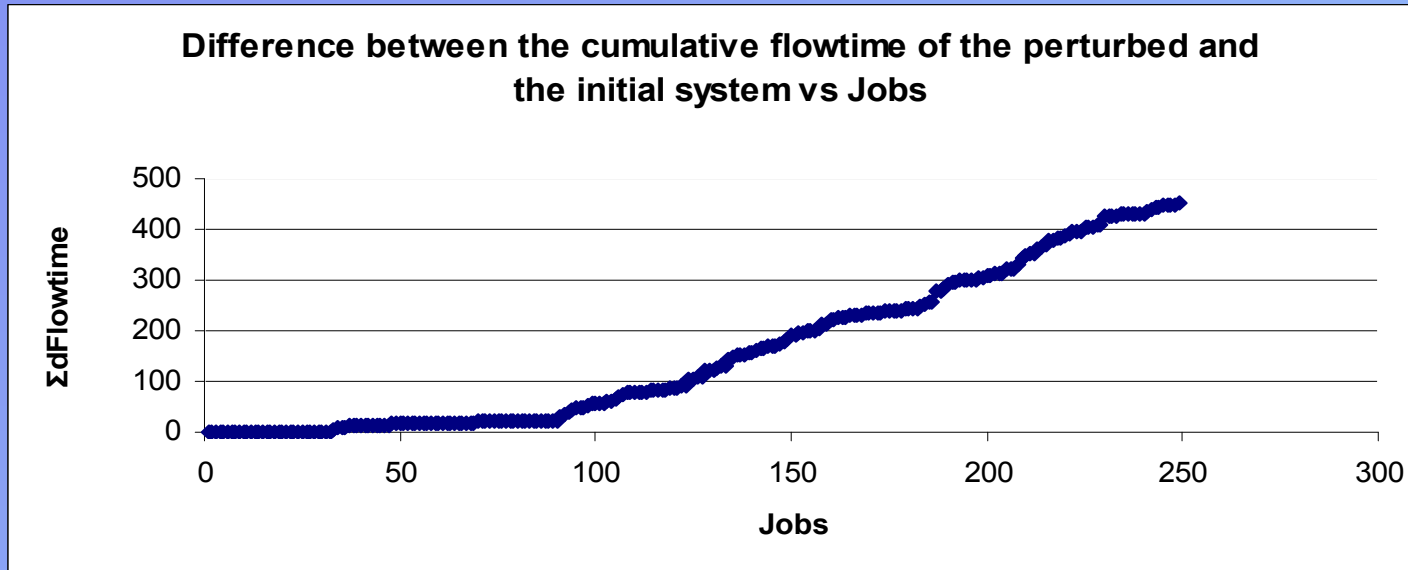


Profit diagram as a function of Lmax.

Bifurcation diagrams and maximal Lyapunov exponents combined with cost analysis may be used for the study of manufacturing systems with subcontractors.

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One of the main characteristics of chaos is sensitivity to small differences in initial conditions.

A simple production system has been perturbed increasing by 0,1 the processing time of the first job in the first machine. The difference between cumulative flowtime of the initial production system and the perturbed is presented in the above diagram.

Small change in the processing time produce large change of the cumulative flowtime in the long term.