Manufacturing Systems Complexity: Assessment of Static & Dynamic Complexity

Static Complexity:
The information required to describe the elements and the interdependencies of a manufacturing system (Shannon Entropy)

Dynamic Complexity:
The unpredictability of manufacturing system’s performance indicators (Lempel Ziv Complexity)


Manufacturing Systems Complexity: Flexibility and Complexity Trade-Off

- For the same numbers of connections, the less static complex system is the one presenting the highest Flexibility.

- Chain MFG Systems present higher utility values independently of the number of connections.

- The greatest differences are presented for the values of Flexibility and then Dynamic Complexity.

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

Manufacturing Systems

Manufacturing Systems Complexity: Chaos and Time Series Analysis

Bifurcation diagram of production rate ($Z$) as a function of $m$

Maximal Lyapunov exponent diagram 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.

Bifurcation diagrams and maximal Lyapunov exponents can be used for the graphical representation of the dynamic behaviour of manufacturing systems performance and for the optimization of the production rate.

Manufacturing Systems

Manufacturing Systems Complexity: Chaos and Time Series Analysis

- The development of the simulation model of the manufacturing system under study.
- The definition and execution of S sets of experiments, each set with different value of perturbation (ε), with R pairs of experiments per set.
- The determination of the average absolute difference of flowtime (FD) per experiments set.
- Nonlinear modeling—regression fitting of the results and determination of the complexity index MECI.