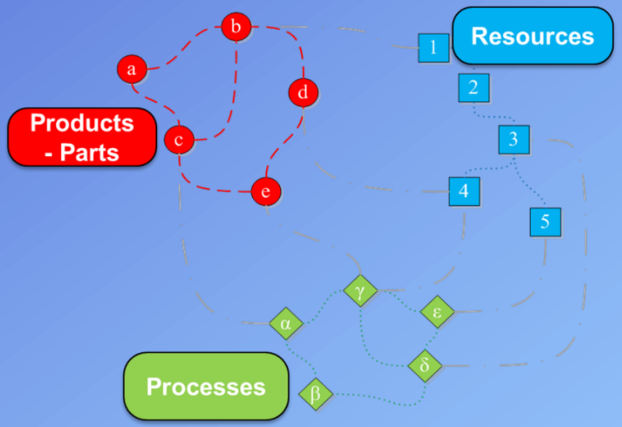
Manufacturing Systems

Manufacturing Systems Complexity:
Assessment of Static & Dynamic Complexity



Manufacturing System

<u>Static Complexity:</u>

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

0 Lempel Ziv values 1

Least Complex -
Predictable
Deterministic Behaviour

Most Complex -
Unpredictable
Stochastic Behaviour

<u>Dynamic Complexity:</u>

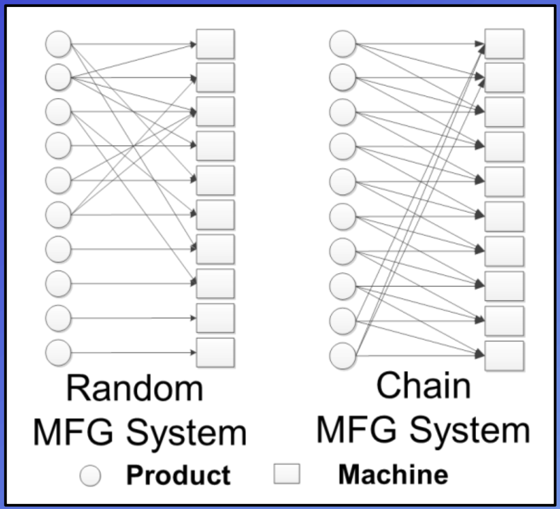
The unpredictability of manufacturing system's performance indicators (Lempel Ziv Complexity)

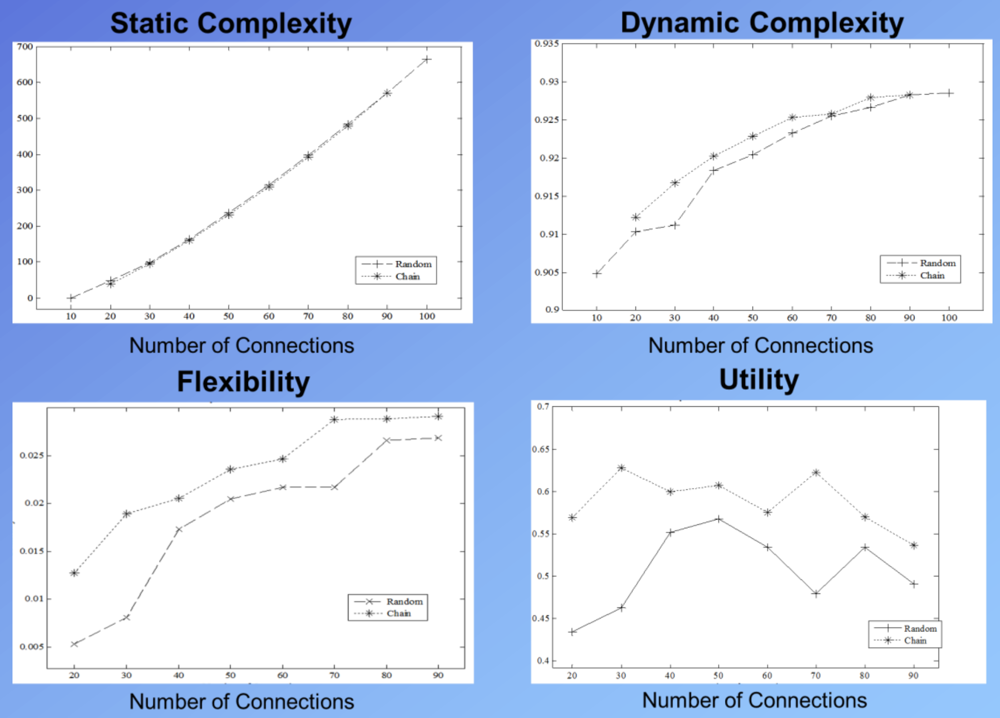
K. Efthymiou, A. Pagoropoulos, N. Papakostas, D. Mourtzis, G. Chryssolouris, "Manufacturing Systems Complexity an assessment of manufacturing performance indicators unpredictability", (DET 2011), 7th International Conference on Digital Enterprise Technology, Athens, Greece, pp. 383-391 (2011) ISBN 978-960-88104-2-6

K. Efthymiou, A. Pagoropoulos, N. Papakostas, D. Mourtzis, G. Chryssolouris, "Manufacturing Systems Complexity Review: Challenges and Outlook", (CIRP-CMS2012) 45th CIRP Conference on Manufacturing Systems, Athens, Greece, Procedia CIRP Volume 3, pp.644-649 (2012)

Manufacturing Systems

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

G. Chryssolouris, K. Efthymiou, N. Papakostas, D. Mourtzis, A. Pagoropoulos, "Flexibility and Complexity: is it a trade off?", International Journal of Production Research (2013)

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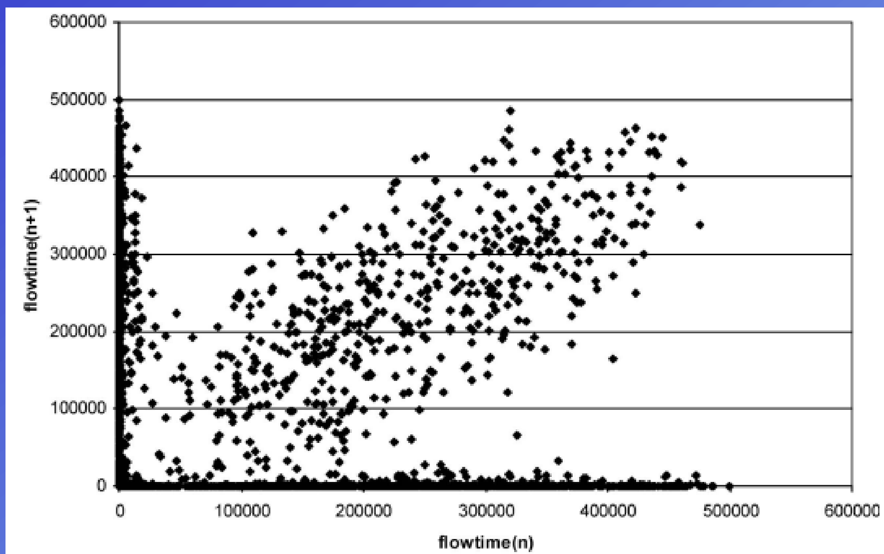
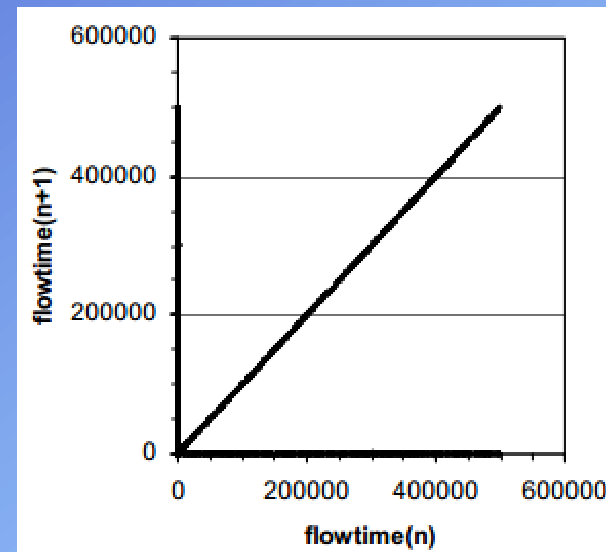
Manufacturing Systems Complexity:
Chaos and Time Series Analysis



Time-delay plot of the flowtime after scheduling a single machine using the Shortest Processing Time (SPT) rule.



Time-delay plot of the flowtime after scheduling a single machine employing a time delay plot based dispatching rule.

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.

G. Chryssolouris, N. Giannelos, N. Papakostas, D. Mourtzis, "Chaos Theory in Production Scheduling", CIRP Annals, Volume 53, No.1, pp. 381-383 (2004)

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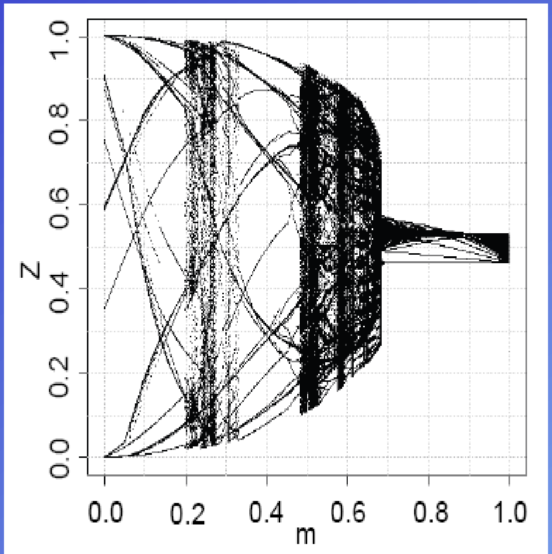
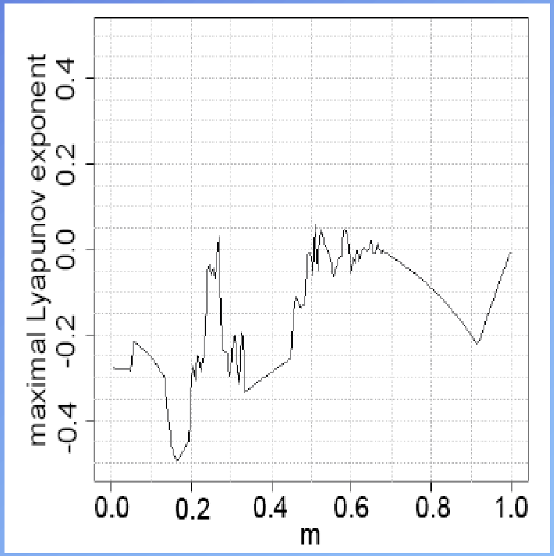
Manufacturing Systems Complexity:
Chaos and Time Series Analysis



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

N. Papakostas, D. Mourtzis, "An Approach for Adaptability Modeling in Manufacturing - Analysis Using Chaotic Dynamics", Annals of CIRP-Manufacturing Technology, Volume 56, No.1, pp.491-494 (2007)

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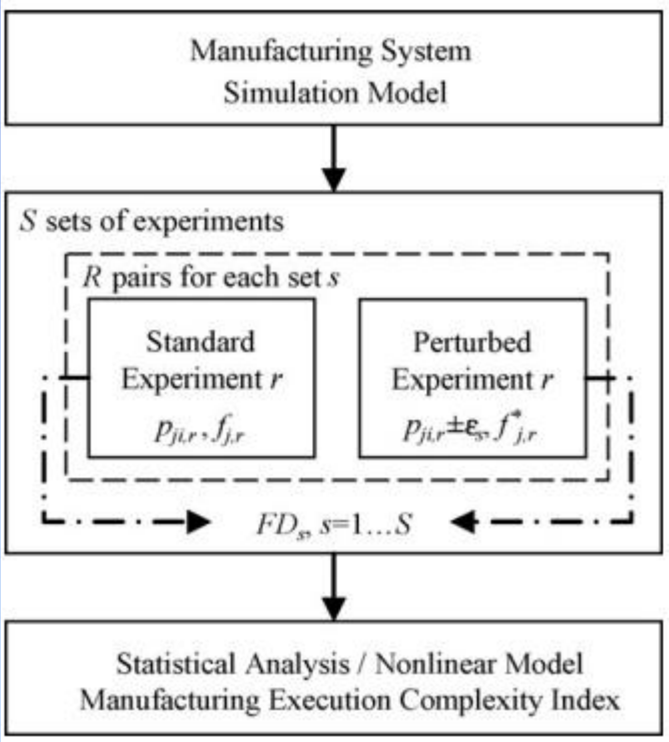
Manufacturing Systems Complexity:
Chaos and Time Series Analysis

- 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.



N. Papakostas, K. Efthymiou, D. Mourtzis, G. Chryssolouris, "Modeling the complexity of manufacturing systems using nonlinear dynamics approaches", CIRP Annals - Manufacturing Technology, Volume 58, No.1, pp.437-440 (2009)