LOCAL DECISION RULES: COMPLEXITY OR CHAOS ?

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Introduction

This paper examines the impact of "local rules" on the stability and performance of a manufacturing system. The ability of systems to maintain themselves in, and move between, stable, complex and chaotic states has been widely documented.(Gleick, 1986, Waldrop, 1992). The Beer Game is an example of a social-technical system that quickly moves to and maintains itself in a chaotic state as a result of the "local rules" used by the actors. (Thomsen, Mosekilde and Sterman 1992, Paich and Sterman, 1993). Other research indicates that such "local rules" can produce "edge of chaos" states where systems are responsive and adaptive (Langton, Taylor, Farmer, Rassmussen, 1992).

The Research Problem

A simulation model was built of the interaction of local rules on a Kan Ban manufacturing system using a Toshiba BMC 63 Horizontal Machining Centre. The system has a set of formal rules for the operation of the system, re-order points and order quantities, for the parts that are manufactured for the assembly line. These rules are calculated by management and "hard wired" into the system on Kan Ban cards. In addition to these formal rules, there are informal "local rules" used by management and operators in their efforts to compensate for variability induced by the formal rules. These rules are:

Management — If a Kan Ban bin becomes empty while the Kan Ban card is in the queue, then put the card in the front of the queue.

Operators — If queue length is above about five, put your Kan Ban card at the front of the queue.

If you look like being busy, move cards of parts you are going to need into the queue before their re-order point is reached.

If you look like being busy and you are going to run out of parts and the machine operator is a friend, by-pass the Kan Ban queue altogether and ask the operator to make your part next.

The Simulations (The following rules were simulated.)

Rule 1 — Formal "hardwired" rules only

Rule 2 — Management's rule: "If a Kan Ban bin becomes empty while the Kan ban card is in the queue, then the card is put to the front of the queue."

Rule 3 — Operators' rule: If queue length is above about five, don't put the Kan ban card at the back of the queue, put it at the front.

Rule 4 — Rule 2 + Rule 3

The Modelling Tool

The software package "iThink" was used because it would model the continuous manufacturing process and the discrete process of local decision rules. The company's management had experience with the package which made explanation of the research and the results easier. The software was iThink RISC 3.0.6b6.2 running on a Power Mac 9500 using 65 MG of RAM.

Observations:

1 The application of Rule 2 (the manager's rule) produces greater stability than is present with Rule 1 (formal rules only)

2 The application of Rule 3 (the operators' rule) produces less stability than the manager's rule and during the periods of application appears to increase instability over the formal rules.

3 The application of both Rules 2 and 3 appears to create greater stability than either rule on its own, especially at the end of the simulation of Part 12 where a marked change in stock level indicates performance better than for the application of Rule 2.

4 Total application of Rules 2 and 3 together are fewer than Rules 2 and 3 applied separately.

5 Total system performance, measured in total stock-out hours (sohrs), is best under the application of Rules 2 and 3.

Rule 1	Rule 2	Rule 3	Rule 2 + 3
5040 sohrs	1743 sohrs	5314 sohrs	1788 sohrs

Conclusions

The application of local rules, in this computer simulation, produce both increases and decreases in system stability. Rule three decreases total performance, rule two and rule two and three produce best performance. There is indication of complex adaptation in the performance the sub-system.

References

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Waldrop, M. M. Complexity, the emerging science at the edge of order and chaos. Viking, London. 1992

Enquiries

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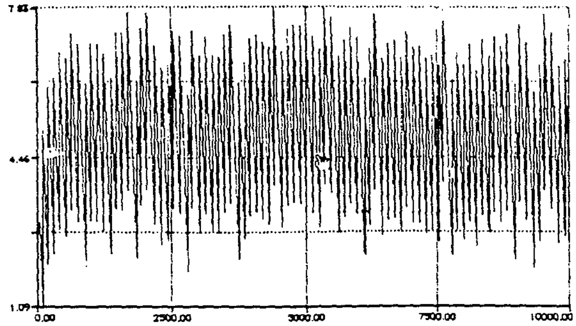
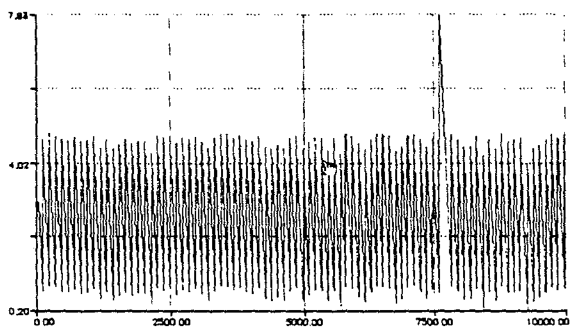
Part 12 Rule 1



Rule Frequency

Part 12 Rule 2



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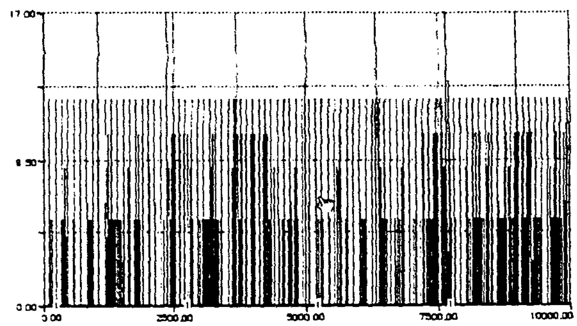
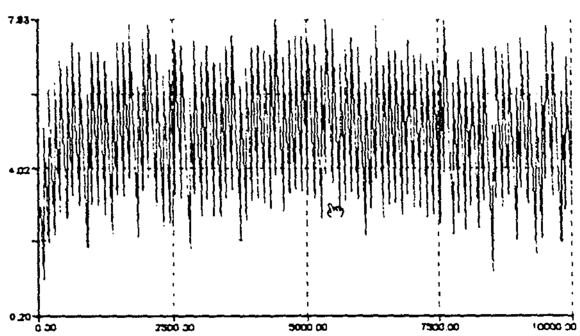


Part 12 Rule 3



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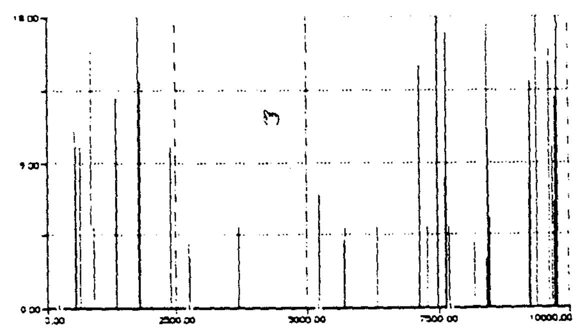
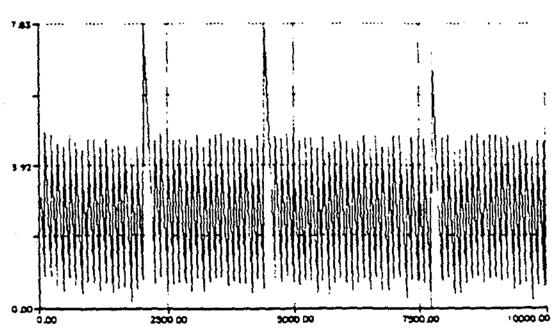


Part 12 Rule 2 + 3



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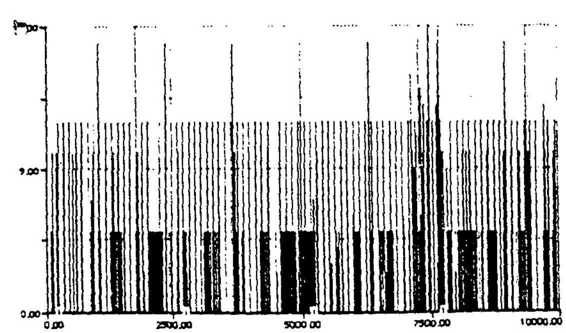
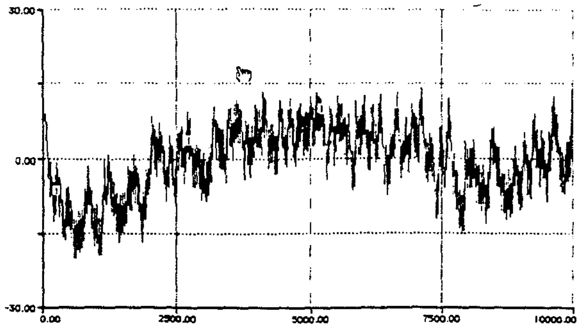


Appendix 1: Part Levels and Ferquency of Rule Applications

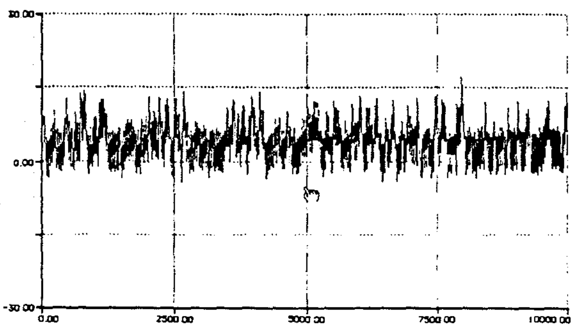
Part 5 Rule 1

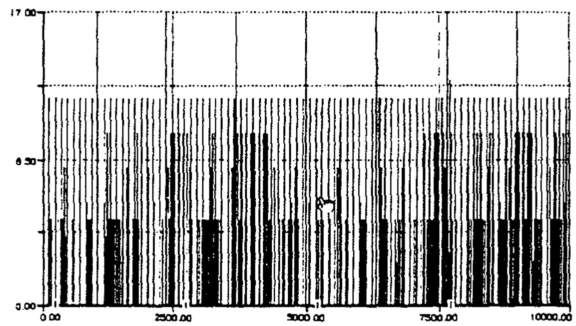
Rule Frequency



Part 5 Rule 2

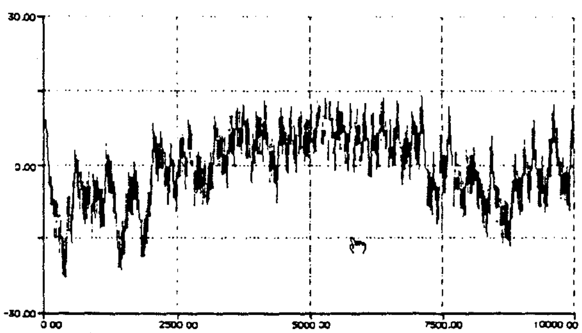
Rule Frequency

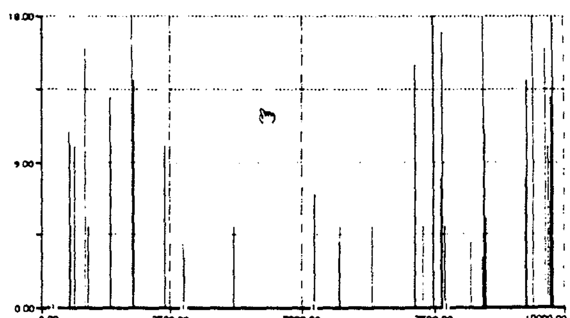




Part 5 Rule 3

Rule Frequency





Part 5 Rule 2 + 3

Rule Frequency