

The Logistics Equation and Fractal Dimension in Escalators Operations

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Abstract : The logistics equation has never been used or studied in scientific fields outside the field of ecology. It has never been used to understand the behavior of a dynamic system of mechanical machines, like an escalator. We have studied the compatibility of the logistic map against real measurements from an escalator. This study has proven that there is good compatibility between the logistics equation and the experimental measurements. It has discovered the potential of a relationship between the fractal dimension and the non-linearity parameter, R , in the logistics equation. The fractal dimension increases as the R parameter (non-linear parameter) increases. It implies that the fractal dimension increases as the phase of the life span of the machine move from the steady/stable phase to the periodic double phase to a chaotic phase. The fractal dimension and the parameter R can be used as a tool to verify and check the health of machines. We have come up with a theory that there are three areas of behaviors, which they can be classified during the life span of a machine, a steady/stable stage, a periodic double stage, and a chaotic stage. The level of attention to the machine differs depending on the stage that the machine is in. The rate of faults in a machine increases as the machine moves through these three stages. During the double period and the chaotic stages, the number of faults starts to increase and become less predictable. The rate of predictability improves as our monitoring of the changes in the fractal dimension and the parameter R improves. The principles and foundations of our theory in this work have and will have a profound impact on the design of systems, on the way of operation of systems, and on the maintenance schedules of the systems. The systems can be mechanical, electrical, or electronic. The discussed methodology in this paper will give businesses the chance to be more careful at the design stage and planning for maintenance to control costs. The findings in this paper can be implied and used to correlate the three stages of a mechanical system to more in-depth mechanical parameters like wear and fatigue life.

Keywords : logistics map, bifurcation map, fractal dimension, logistics equation

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