Industrial system dynamics

by Kris Adendorff

There is considerable evidence that industrial systems do not perform in a stable fashion despite diligent design and operation. Operation of a dynamic system is often *chaotic or may verge on chaos.* The novel use of Chaos Theory to study such undesirable characteristics and in doing so to determine how to ameliorate such behaviour deserves consideration.

The use of quantitative models of industrial processes is a well established, widespread phenomenon. The models are either deterministic or probabilistic, often make use of iterative methods for purposes of optimisation, frequently only furnish steady state solutions, and are invariably non-linear. They have nevertheless traditionally been applied to widely divergent situations.

Among many features, Chaos Theory offers modelling methods which provide time-varying solutions to *flow problems of Systems of Congestion* emphasising transient *and steady state behaviour.*

At this juncture it would be befitting to demonstrate the results of a model of a system which serves to entertain tourists in a large European city.

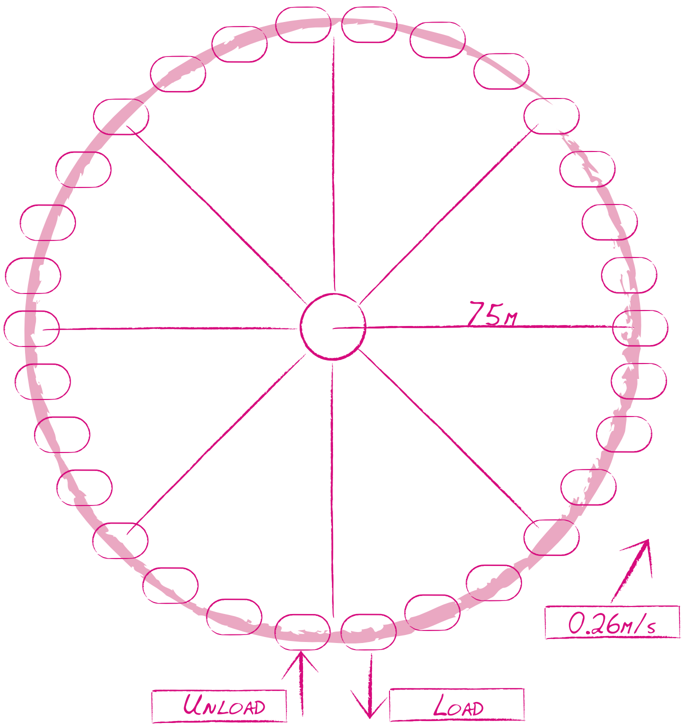
The system is a large Ferris[1)] wheel designed for leisurely viewing of the city skyline. The wheel is equipped with 30 equally spaced cabins each accommodating 25 adults. The wheel which is 150 metres tall rotates twice in an hour (Figure 1).

During certain periods of the day in the peak tourist season the total system is a prime example of *chaotic congestion*. The temporal system population value based on a chaos driven iterative process is as follows:

The growth and decay of the total system population with the passage of time closely agrees with actual observations on site which at times attain a maximum value of 1500 persons on a particular day (Figure 2).

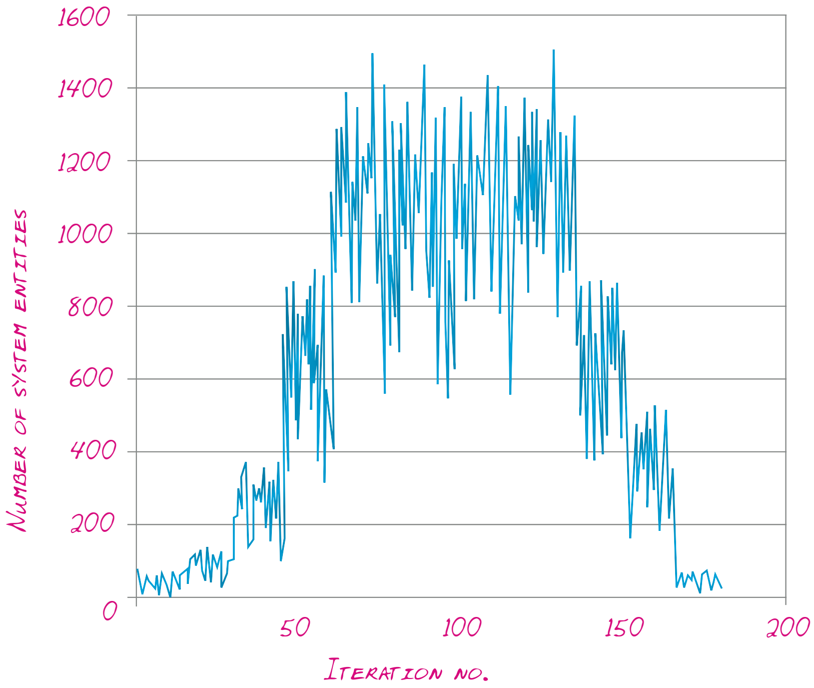
For purposes of demonstration a suggestion on how the system population could be decreased could inter alia be by increasing the speed of rotation of the wheel to a maximum value constrained by the ergonomics of embarkation and disembarkation.

Implementation of such a measure in practice furnishes an improved state of congestion as shown in Figure 3.

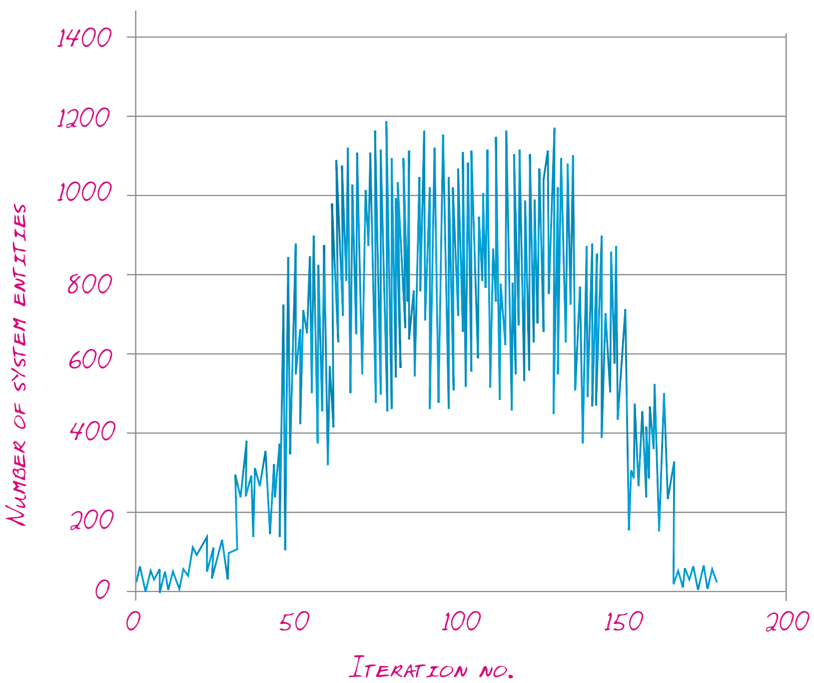


→ 1.

[1] George Washington Gale Ferris: American Engineer who designed a wheel for an Exposition in Chicago in 1893: An amusement device consisting of a large power-driven wheel having suspended seats which maintain a horizontal position while the wheel rotates in a vertical plane.



→ 2.



→ 3.

The design of an iterative dynamical system model requires one to consecutively

- comprehend the structure of the entire system of congestion,
- emphasise those facets of the system structure which are to be modelled accurately,
- identify which parts of the system do not significantly affect the system dynamics,
- use available system data so that iterative system manipulation is achieved,
- assess how the system may be amended beneficially,
- select suitable methods of chaotic orbit generation,
- shape the system orbit effectively, and
- finally obtain the desired optimum system objective.

In conclusion the supposition that *simple robust models may deliver useful credible solutions to complex design and operation problems* does have considerable merit.

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References

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