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H. Brian Hwarng is an Associate Professor at the Department of Decision Sciences and a former Academic Director of Asia-Pacific Executive (APEX) MBA Program, School of Business, National University of Singapore. He received his Ph.D. in Industrial and Management Systems Engineering from Arizona State University, USA. Prior to joining National University of Singapore, he worked as an Industrial Engineer for Delta Electronics in Taiwan and as a Material System Analyst for Allied-Signal Aerospace in Phoenix, Arizona, USA. His current research interests focus on applying computational algorithms and techniques such as chaos analysis, neural networks and simulation modeling to investigate system dynamics and quality issues in the context of process control and supply chain management. His pioneer works in pattern recognition on statistical process control charts have been widely cited. He was a recipient of the 2000 Commonwealth Fellowship Award in the UK and has been involved in a global supply chain modeling effort for Glaxo Wellcome and a large-scale innovative technology research project for the specialty chemical industry. Brian is a member of the Decision Science Institute (USA), a senior member of the American Society for Quality (ASQ), of the ASQ Six Sigma Forum and a life-time member of Alpha Pi Mu (American Industrial Engineering Honor Society).

Decisions and chaos in a complex supply chain

A supply chain involves multiple entities encompassing activities of moving goods and adding value from the raw material state to the final delivery stage. Along the chain, there exist various types of uncertainties, e.g. demand uncertainty, production uncertainty and delivery uncertainty. Making decisions as to how much and when to replenish, often involves a feedback process triggering interaction between system entities, which may result in system nonlinearity. A time delay is observed when there is a lag between when a decision is made and when its effect is felt, which often further complicates the interaction between entities. Feedback, time delay and interaction are inherent to many processes in a supply chain. Feedback, time delay and interaction induce variability, instability and complex behaviors that make supply chain management awfully challenging.

In this talk, I would like to discuss, under various supply chain factors, how decisions concerning inventory replenishment contribute to the complex dynamics and chaotic behaviors. We are interested in a general class of multi-level supply chains that can be represented by the well-known beer distribution model. Various supply chain factors are considered, such as demand pattern, ordering policy, demand-information sharing and lead time, with different options or levels. Simulation models are developed to observe system dynamics, particularly the inventory across all levels of the supply chain. Using the Lyapunov exponent, we quantify the degree of system chaos in terms of inventory across all supply chain levels.

The primary purpose of this talk is to share our findings, from a chaos perspective, on (1) how inventory replenishment decisions may impact a complex supply-chain system; (2) how various supply-chain factors act or interact to affect the system dynamics which in many cases lead to chaos; and (3) some managerial insights into more effective management of supply chains.