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Factory Communication System for Customer-Based Production Execution: An Empirical Study on the Manufacturing System Entropy

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Abstract : The manufacturing industry is currently experiencing a paradigm shift into the Fourth Industrial Revolution in which customers are increasingly at the epicentre of production. The high degree of production customization and personalization requires a flexible manufacturing system that will rapidly respond to the dynamic and volatile changes driven by the market. They are a gap in technology that allows for the optimal flow of information and optimal manufacturing operations on the shop floor regardless of the rapid changes in the fixture and part demands. Information is the reduction of uncertainty; it gives meaning and context on the state of each cell. The amount of information needed to describe cellular manufacturing systems is investigated by two measures: the structural entropy and the operational entropy. Structural entropy is the expected amount of information needed to describe scheduled states of a manufacturing system. While operational entropy is the amount of information that describes the scheduled states of a manufacturing system, which occur during the actual manufacturing operation. Using Anylogic simulator a typical manufacturing job shop was set-up with a cellular manufacturing configuration. The cellular make-up of the configuration included; a Material handling cell, 3D Printer cell, Assembly cell, manufacturing cell and Quality control cell. The factory shop provides manufactured parts to a number of clients, and there are substantial variations in the part configurations, new part designs are continually being introduced to the system. Based on the normal expected production schedule, the schedule adherence was calculated from the structural entropy and operation entropy of varying the amounts of information communicated in simulated runs. The structural entropy denotes a system that is in control; the necessary real-time information is readily available to the decision maker at any point in time. For contractive analysis, different out of control scenarios were run, in which changes in the manufacturing environment were not effectively communicated resulting in deviations in the original predetermined schedule. The operational entropy was calculated from the actual operations. From the results obtained in the empirical study, it was seen that increasing, the efficiency of a factory communication system increases the degree of adherence of a job to the expected schedule. The performance of downstream production flow fed from the parallel upstream flow of information on the factory state was increased.

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