Reliability for multi-state capacitated manufacturing networks with distillation processes

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In a manufacturing network, there often exist operations that produce the same products or semi-products of different qualities. Such a phenomenon can be described by a distillation process using a specialized D-node introduced by Fang and Qi (2003) where the flow enters a D-node has to be distributed according to a pre-specified vector of ratios associated with its outgoing arcs. The existence of D-node complicates the manufacturing process since it creates the relation of flow dependency. In particular, to send flow successfully from a source node to a sink node, an augmenting subgraph containing many paths instead of an augmenting simple path has to be constructed, since the flow passing through a D-node has to be distributed to all of its outgoing arcs. As a result, when the capacity associated with each arc obeys a multi-state probability distribution, calculating the system reliability of shipping a given amount of flows for a multi-state capacitated manufacturing network containing D-nodes becomes a difficult task. This paper focuses on techniques to derive the system reliability for such a multi-state capacitated manufacturing network containing D-nodes. We will first introduce polynomial-time preprocessing techniques that simplify the problem structure, and then propose algorithms for calculating the network reliability. In addition, we also investigate the problem of constructing a manufacturing network with multi-state arc capacity that satisfies the reliability lower bound with minimum total cost, and study the problem of stochastic shortest path using our proposed solution methods as well.

***Keywords*:** network reliability, multi-state arc capacity, manufacturing network, distillation process

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