ABSTRACT

Optimal System Spare Configuration
based on the Present Worth of Operational Costs
under a Policy of Cannibalization. (December 1976)
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An economic model is developed for determining optimal spare provisioning requirements when a system is subject to cannibalization; in this context, cannibalization is defined as the process of using the good components of a terminally failed unit as a source of replenishment spares for future component failures in other units.

The model analyzes four components of a system's net operational costs: the manufacturing or procurement costs, the repair/replacement costs, the cannibalization costs, and a compensating revenue or return function, which is treated as a negative cost. The net cost is explicitly a function of the number of multi-component units deployed, the spare configuration for each component type, the time period over which the system is to be used, and the continuous annual interest rate. The model is a present worth analysis, which reduces all future costs and revenue to a single equivalent present value. Consequently, alternative spare configurations must be compared over the same period of time.

The author develops a stochastic analysis of the repair/replacement and cannibalization processes, and derives general formulas for the time dependent repair/replacement, and cannibalization probability; the expressions are based upon general failure and replacement density functions. He also performs a State Transition Analysis, using an Absorbing State Markov Process, to model the consumption of spare components.

The cost model may be subject to one or more constraints, which provide bounds on the required number of spares for each component type.

An example is presented, and numerical solutions are obtained for the net present worth of the operational costs for several time horizons and interest rates. The respective present worth calculations are performed using the method of Gaussian Quadrature for the numerical integrations.