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EXPERIMENTAL STRATEGIES FOR THE ESTIMATION OF OPTIMUM OPERATING CONDITIONS IN SIMULATION STUDIES

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RESEARCH SUMMARY

An integral component of many simulation studies is the experimental strategy used in generating observations on the variables of interest and the statistical analysis of the resulting data. This research focuses on digital simulation experiments where the decision and response variables are continuous. Of particular interest is the application of the statistical and mathematical procedures that constitute response surface methodology (RSM) in a simulation environment. These techniques address two common goals of simulation studies: (1) the estimation of system response and (2) the determination of optimum operating conditions.

A basic assumption of RSM is that the response surface can be adequately approximated by lower order polynomial models over restricted regions of the factor space. The two graduating functions commonly used for this purpose are the first-order model

$$Y=\beta_0+\sum_{i=1}^{k}\beta_i x_i+\varepsilon$$

and the second-order model

$$Y=\beta_0+\sum_{i=1}^{k}\beta_i x_i+\sum_{i=1}^{k}\beta_{ii}x_i^2+\sum_{i<j}^{k}\sum\beta_{ij}x_i x_j+\varepsilon,$$

where Y denotes the response estimate and ε is a random error.

In a typical RSM study the optimum subregion of the factor space is unknown and the initial objective is its determination. The investigation generally begins in a region remote from the optimum one, and through a series of sequential experiments, proceeds systematically toward the region of optimum response. In the initial experiments, the first-order model can often provide an adequate estimate of the true response and is used to identify subsequent regions for exploration. The use of first-order models in this manner continues until either the model fails to adequately explain the response or the optimum region is tentatively identified. Both situations suggest the presence of curvature in the response surface and, for this reason, a higher order graduating function is employed in the exploration of subsequent subregions. The second-order polynomial model is generally the function used at this stage because of its mathematical tractability. Once the optimum region is located, this model serves as a tool for estimating the optimum factor settings and examining the sensitivity of the system.

A simulation of an inventory system is used in this presentation to illustrate the RSM techniques of steepest ascent, canonical analysis and ridge analysis. Also considered is the use of variance reduction techniques in conjunction with traditional RSM design criteria for the estimation of first and second-order graduating functions.