Optimization and Control of Production Operations
Utilizing Mathematical Flow Models. (August 1968)
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During recent years the phenomenal growth in size and complexity of our economy and our industrial organizations has brought about an intense need for improved techniques of management and control of production operations. The foremost method presently in use for controlling production costs is the Standard Cost System; however, this paper proposes a new technique which overcomes most of the shortcomings of the Standard Cost System.

The electrical engineer for years has been utilizing methods which establish mathematical expressions for the components and their interactions within highly complex electronic systems. The concept of "transfer functions" and block diagram flow has been especially useful for solving problems in servomechanism (feedback control) systems. Since these methods have been found to be so highly successful in the analysis of electronic systems, their use is now extended to the analysis of less technical but just as complex production problems.

The analysis of the cost contributed by each stage of a production process is often complicated by interaction between the various stages. In an attempt to determine these costs, mathematical models are developed which decompose the system into a series of

small components which are analyzed separately. Then by appropriately combining the effects of the components the response of the system is obtained.

The adaptability of the servo theory approach to problems other than those of production costs and yields makes it an even more general and useful management tool. Some of these other applications which are discussed are the cash flow problem wherein the capital turnover time can be accurately estimated, the processing or procurement time for custom orders, and the problem of calculating the effective operational availability of a particular system.

Several cost reduction techniques are also proposed and explained. Some of these involve determination of optimum production rates and yields through both graphical and mathematical means. Another involves the use of dynamic programming for optimizing the placement of inspection stations. A procedure is also presented which will minimize the total cost of production through optimum sequencing of the process operations.

Since many production systems are designed to produce more than one type of product, a method for optimizing the profit on a multiproduct system is presented. This method makes use of the lattice search technique in conjunction with the servo models constructed earlier. The result is an optimum set of operating conditions for a system which otherwise would have required exhaustive analysis.

Although the servo cost models offer distinct advantages over existing methods for controlling and reducing cost, their use has some inherent disadvantages. The two principal disadvantages are the complexity of the models as the system under analysis becomes very large and the increasing loss of accuracy due to round off as the number of models in the system increases. These disadvantages are overcome through the use of a simulation program written for a high speed digital computer.