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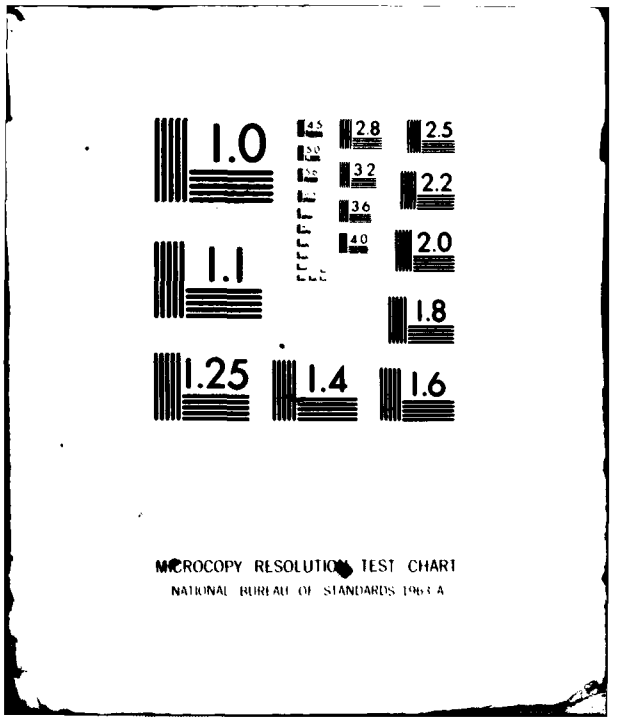
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Research in Group Replacement of a Multicomponent System Subject to Deterioration / The Discounted Problem and Some Extensions

Final Report

Boghos D. Sivazlian

June 25, 1980

U. S. Army Research Office

Contract No. DAAG29-79-C-0119

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Gainesville, Florida 32611

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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-Replacement Theory
-Partial Fractions

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Research was conducted on problems of life cycle cost analysis, replacement problems and partial fraction expansion. The report contains summaries describing the research and the principal results in each of these areas. This information is supplemented by a list of publications.

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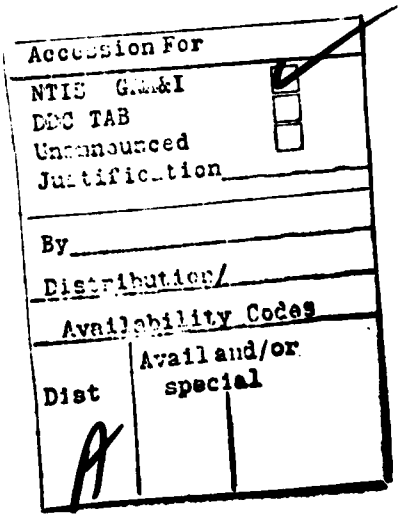
ABSTRACT

Research was conducted on problems of life cycle cost analysis, replacement problems and partial fraction expansion. The report contains summaries describing the research and the principal results in each of these areas. This information is supplemented by a list of publications.



1. STATEMENT OF PROBLEMS AND RESULTS

A. Life Cycle Cost Analysis Under Uncertainty in Systems Lifetime

The concept of probabilistic life in cost analysis has been receiving considerable attention in recent literature. It is shown that the survival or reliability function of the system plays a significant role in the construction of economic models in life cycle cost analysis. The survival function is defined as the probability that the system will survive (not fail) to at least a specified time t. The concept of equivalent uniform annual cash flow and capitalized cost are developed for this probabilistic situation and specific formulas are developed involving the Laplace transform of the survival function. In comparing alternatives, it is shown that solutions to the probabilistic models need not be the same as those to deterministic models. The analysis is also extended to incorporate the energy cost appearing in the form of an exponential function reflecting the energy escalation rate charges which are considered in the analysis of modern economic models involving energy function.

B. A Dyadic Age-Replacement Policy for a Periodically Inspected Equipment Item Subject to Random Deterioration

A periodic review replacement system is considered. The amount of deterioration over successive periods forms a sequence of identically and independently distributed random variable. A replacement policy of the dyadic type is in effect whereby the used equipment item is discarded and immediately replaced by a new identical equipment if at the end of a period the old equipment has service aged by an amount in excess of S or has been in operation for exactly N periods whichever comes first. Using a theorem on renewal reward processes, an expression for the total steady-state expected cost per period is derived, consisting of a fixed replacement cost and a linear cost of operation. Optimal value of S and N that minimize this steady-state cost are computed for a few numerical examples, when the service aging per period has a gamma distribution.

C. Hysteresis Effect in Discounted Replacement Problems

This work investigates a new class of repair (replacement) problems called the hysteresis age problem. This problem is concerned with the amount of recovery of service age following a repair, extreme cases of which are minimal repair and age replacement (major repair). A mathematical formulation for the discounted hysteresis age problem is presented using the functional equation technique. Optimal age replacement policies which minimize the total expected discounted cost are examined for a linear hysteresis function.

D. An Efficient Method for Performing Partial Fraction Expansion

An escalation method for performing partial fraction expansions is presented for the case that the complete list of zeros of the denominator of the proper rational function is known. Expressions for the number of divisions and multiplications required are developed. The new method requires fewer such arithmetic operations than does the method of Henrici. A numerical example is provided.

2. PUBLICATIONS

1. "Life Cycle Cost Analysis Under Uncertainty in Systems Lifetime," B. D. Sivazlian, The Engineering Economist, Vol. 25, No. 2, 1980.

2. "A Dyadic Age-Replacement Policy for a Periodically Inspected Equipment Item Subject to Random Deterioration," B. D. Sivazlian and S. N. Iyer, European Journal of Operational Research, (to appear).

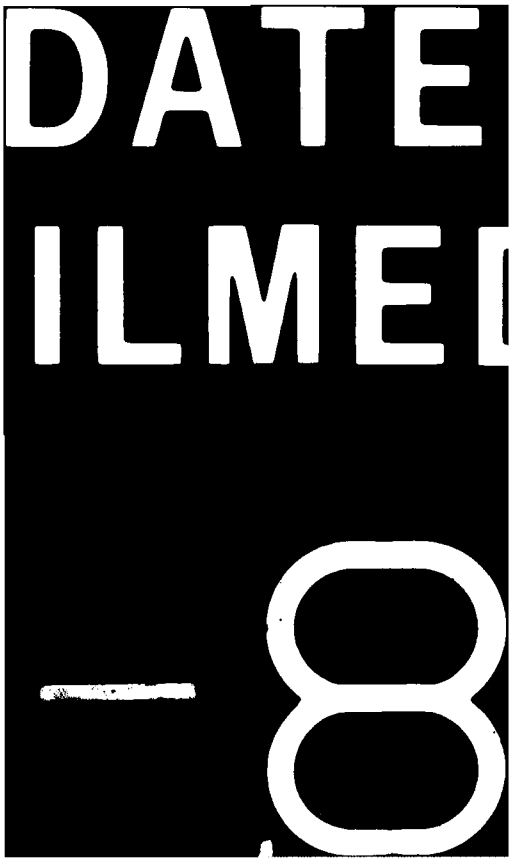
3. "Hysteresis Effect in Discounted Replacement Problems," J. F. Brown and B. D. Sivazlian, AIIE Transactions, (submitted).

4. "An Efficient Method for Performing Partial Fraction Expansion," J. F. Mahoney. Technical report N:80-11, Department of Industrial and Systems Engineering, University of Florida, Gainesville, Florida, Feb. 1980.

3. PARTICIPATING SCIENTIFIC PERSONNEL

1. J. F. Mahoney, Associate Professor, Industrial and Systems Engineering Department.

2. S. N. Iyer, Graduate Student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