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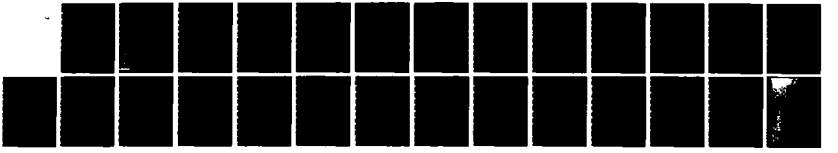

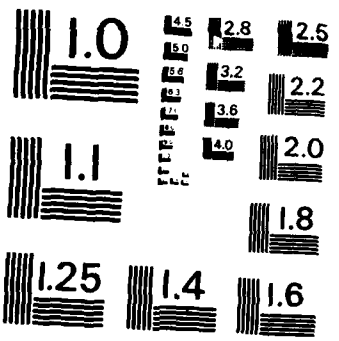

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FINAL REPORT:

RESEARCH ON STATISTICAL METHODS FOR APPLICATION TO NAVY PROBLEMS

by

Dennis E. Smith

— STATISTICS —

— OPERATIONS RESEARCH —

— MATHEMATICS —

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Applied Research in Statistics - Mathematics - Operations Research

FINAL REPORT:

RESEARCH ON STATISTICAL METHODS FOR APPLICATION TO NAVY PROBLEMS

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TECHNICAL REPORT NO. 106-14

June 1984

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I. INTRODUCTION

This final technical report, prepared under Contract No. N00014-75-C-1054, summarizes a research investigation conducted by Desmatics, Inc. under sponsorship of the Office of Naval Research. The Desmatics research focused on the development of improved statistical methods for addressing "real-world" problems, primarily for application in the Navy's Pollution Abatement and Ship Auxiliary Machinery Program.

Under this contract, Desmatics investigated statistical methodology and developed statistical techniques to aid the Navy in reaching the goal of this program. Desmatics' involvement and accomplishments during the overall research effort have been documented in 16 formal technical reports and 96 informal technical notes distributed to cognizant Navy engineers. The technical reports, which generally address basic statistical research, have also been submitted to the Defense Technical Information Center. In addition, four presentations based on this research have been made at technical meetings, and two journal articles have been published. The following sections briefly summarize the research accomplished under this contract and provide reference lists of all technical reports (with abstracts), technical notes, journal articles, and presentations resulting from this research effort.

II. RESEARCH SUMMARY

The U.S. Navy is tasked, through its Pollution Abatement and Ship Auxiliary Program, with ensuring that possible pollution from Navy ships is kept to an acceptable minimum and that auxiliary machinery is performing optimally within operational constraints. The ultimate goal of this program is to provide improved equipments and procedures for existing and future ships.

Meeting this goal requires extensive development and evaluation tasks. These tasks are not necessarily straightforward, since improvement is not defined by a single quantity, but rather by a number of interrelated factors such as efficiency, reliability, maintainability, weight, cost, etc. The development and evaluation phases tend to be relatively complex in nature. These phases generally involve the preparation of test plans tailored to specific experimental requirements and the efficient acquisition, appropriate analysis and proper interpretation of the experimental results.

During the course of its research effort, Desmatics, Inc. was involved in a number of Navy experimental programs, primarily at the David W. Taylor Naval Ship Research and Development Center and at the Naval Research Laboratory. Within each of these research programs, the participation of Desmatics centered on the development of the most appropriate statistical techniques for the problems being addressed. Because of the nature of these problems, a major portion of the Desmatics research effort was devoted to data analysis and experimental design topics. Because the technical problems being considered were generally

subject-matter dependent, Desmatics staff members worked closely with Navy scientists and engineers.

Desmatics also devoted attention to the development of statistical methodology which may have application to several pertinent Navy problems. For example, in many of the programs with which it was involved, Desmatics was required to develop a test plan for a contemplated experiment. Unfortunately, there exist situations in which an experiment may be unavoidably interrupted (and ended) before it is completed. Even a well-designed experiment interrupted before its completion may prove inefficient, posing serious data analysis problems and leaving important questions unanswered. Desmatics explored the development of "interruptible" designs, which limit the adverse effects of an incomplete experimental program.

III. DESMATICS TECHNICAL REPORTS

The following pages contain a complete listing of the technical reports prepared under Contract No. N00014-75-C-1054. These reports may be obtained from the Defense Technical Information Center (DTIC). For each report, the following information is given:

(1) Desmatics Technical Report Number

(2) Report Date

(3) DTIC Number

(4) Title

(5) Author(s)

(6) Abstract

Desmatics Report Number: 106-1 Date: September 1975

DTIC Number: AD-A015324

Title: A RIDGE ANALYSIS CAVEAT

Author: Dennis E. Smith

Abstract: The experimenter concerned with obtaining optimum conditions may use ridge analysis to analyze a fitted second order surface. Unfortunately, unthinking "cookbook" application of ridge analysis may give misleading results. This report discusses some situations which illustrate this.

Desmatics Report Number: 106-2 Date: August 1976

DTIC Number: AD-A029280

Title: WHEN RIDGE ANALYSIS OF RESPONSE SURFACES FAILS

Author: Dennis E. Smith

Abstract: The method of ridge analysis may be used in connection with a fitted second order response when the objective is the location of optimum conditions. This report establishes necessary and sufficient conditions under which application of ridge analysis fails.

Desmatics Report Number: 102-3 **Date:** September 1976

DTIC Number: AD-A030586

Title: A SMALL-SCALE INVESTIGATION OF STATISTICS FOR DETERMINING THE NUMBER OF CLUSTERS IN A DATA BASE

Authors: Dennis E. Smith and Robert L. Gardner

Abstract: In construction of a predictive mathematical model of impact acceleration injury, changes in evoked potential response may serve to provide important information. In attempting to determine whether a number of different types of changes exist, cluster analysis may be used. This report describes a limited Monte Carlo examination of four statistics (used in conjunction with Ward's hierarchical clustering algorithm) for identifying the number of clusters built into a simulated ten-dimensional data space.

Desmatics Report Number: 106-3 **Date:** November 1976

DTIC Number: AD-A032051

Title: OPTIMIZATION OF A COMPUTER SIMULATION RESPONSE

Author: Dennis E. Smith

Abstract: Based on results to date, the statistical technique of Response Surface Methodology (RSM) appear to be well-adapted to use in seeking an optimum simulation response. This report summarizes the optimum-seeking problem, reviews the framework of RSM, and describes an "automated RSM" computer program which has been developed as an alternative to manual applications of these statistical techniques. Program interface and data preparation are discussed. In addition, easily-followed examples are presented to illustrate program output and major aspects of the RSM optimum-seeking process.

Desmatics Report Number: 106-4 **Date:** February 1977

DTIC Number: AD-A036666

Title: A STATISTICAL STUDY OF GRAB SAMPLING IN A CLOSED ENVIRONMENT

Authors: Dennis E. Smith and Terry L. King

Abstract: Maintaining the quality of an enclosed environment (e.g., aboard a submarine) requires monitoring of the environment by means of sampling procedures. One general type of sampling procedure is "grab sampling", in which atmospheric samples are obtained, essentially instantaneously, in evacuated flasks. This report describes an experiment to determine (1) whether differences exist in the performance of four grab sampling methods, and (2) whether a delay in analyzing the samples affects the results (i.e., whether the samples have a shelf life).
Eleven contaminants, each at a high and a low concentration level, were used in the study. Grab samples of these contaminants were analyzed at ten day intervals from the time sampling occurred until seventy days had elapsed. Although the experiment did not reveal differences in grab sampling methods, it did indicate that, for most of the contaminants, the samples do have a shelf life.

Desmatics Report Number: 106-5 **Date:** September 1977

DTIC Number: AD-A045138

Title: IS RIDGE REGRESSION A PANACEA?

Author: Dennis E. Smith

Abstract: Consider the usual regression model $\underline{y} = \underline{X}\beta + \underline{\varepsilon}$ where $\underline{X}$ is a matrix of full rank, β is a vector of unknown parameters, and $\underline{\varepsilon}$ is a vector of random errors such that $E(\underline{\varepsilon}) = \underline{0}$ and $\text{Var}(\underline{\varepsilon}) = \sigma^2\underline{I}$. The procedure known as ridge regression has been offered as an alternative to ordinary least squares for estimating β, particularly in those situations where "severe" multicollinearity exists in $\underline{X}$. Ridge regression involves the use of a ridge estimator, which takes the form $\hat{\beta}(k) = (\underline{X}'\underline{X} + k\underline{I})^{-1}\underline{X}'y$ where $k \geq 0$.
The properties of ridge regression relative to those of ordinary least squares are discussed. Although ridge regression does appear to offer promise, its use as a routine analysis method is not without shortcomings. Therefore, the question in the title is answered in the negative.

Desmatics Report Number: 106-6 **Date:** October 1977

DTIC Number: AD-A045406

Title: RIDGE REGRESSION FOR NONSTANDARD MODELS

Authors: Terry L. King and Dennis E. Smith

Abstract: In the usual regression model $\underline{y} = \underline{X}\beta + \underline{\varepsilon}$ with $\underline{X}$ of full rank and $\underline{\varepsilon} \sim N(\underline{0},\sigma^2\underline{I})$, the ordinary least squares estimator $\hat{\underline{\beta}} = (\underline{X}'\underline{X})^{-1}\underline{X}'\underline{y}$ has extremely large mean square error when $\underline{X}$ is an "ill-conditioned" matrix. Hoerl and Kennard [Technometrics, Vol. 12, No. 1, pp. 55-67 (1970)] have proposed replacing $\hat{\underline{\beta}}$ by the ridge estimator $\hat{\underline{\beta}}^*(k)=(\underline{X}'\underline{X} + k\underline{I})^{-1}\underline{X}'\underline{y}$ in these cases. Although Hoerl and Kennard considered the regression problem in correlation form, there is nothing in their procedure that makes this ma datory.
This paper compares ridge estimators for β that arise in the biasing factor (k) is applied at different stages f standardization (i.e., centering and scaling), and shows which estimators are identical and which are different. In addition, results of a small-scale simulation are discussed.

Desmatics Report Number: 106-7 **Date:** February 1979

DTIC Number: AD-A065139

Title: TOLERANCE LIMITS AND VARIABLES SAMPLING PLANS: SOME POWER CALCULATIONS FOR THE NORMAL AND LOGNORMAL DISTRIBUTIONS

Authors: Terry L. King and Dennis E. Smith

Abstract: In this technical paper, tables for the power of a one-sided statistical hypothesis test are presented for the situation in which the statistic is distributed as a noncentral t under both the null and alternative hypothesis. Specifically, power and sample size problems are considered for a one-sided tolerance limit and for a variables sampling plan. Examples are also included to illustrate how these tables can be used in hypothesis testing situations and for determining sample size requirements in some estimation procedures.

Desmatics Report Number: 112-4 Date: January 1980

DTIC Number: AD-A080572

Title: OPTIMAL DESIGNS FOR ESTIMATION OF THE TWO-PARAMETER LOGISTIC FUNCTION

Authors: Leslie A. Kalish and Dennis E. Smith

Abstract: In this report, optimal designs for weighted least squares and maximum likelihood estimation of the two-parameter logistic function are constructed. In particular, four criteria for optimality are considered: D, A, E and G-optimality. The D and G-optimality criteria are found to be invariant to changes in scale while the A and E-optimality criteria are not. Practical problems which arise in the implementation of the optimal designs are discussed.

Desmatics Report Number: 106-8 Date: April 1980

DTIC Number: AD-A082771

Title: FIRST-ORDER "INTERRUPTIBLE" DESIGNS

Authors: Dennis E. Smith and Denise D. Schmoyer

Abstract: Even a well-designed experiment interrupted before its intended completion may prove inefficient, posing serious data analysis problems and leaving important questions unanswered. This report addresses the construction of "interruptible" designs for those cases where a first-order model is assumed and factors at only two levels are considered. The maximum $|\underline{X}'\underline{X}|$ criterion was used in developing "interruptible" designs for two different design strategies which attempt to limit the information lost if an experiment is prematurely ended. The resulting designs for four to nine factors are evaluated and selection of an "interruptible" design is discussed.

Desmatics Report Number: 106-9 Date: April 1980

DTIC Number: AD-A084041

Title: AN INVESTIGATION OF A STATISTICAL PROCEDURE FOR MONITORING TWO-SAMPLE LIFE TESTS

Authors: Leslie A. Kalish and Dennis E. Smith

Abstract: A statistical procedure is described for comparing two lifetime distributions when the data is reviewed repeatedly over time. The procedure provides the capability of early decision while maintaining both a fixed significance level and a fixed maximum length for the entire experiment. The effects which staggered entry, number of looks at the data and maximum test length have on power and expected test length are discussed. An application is made to a bearing fatigue-life test.

Desmatics Report Number: 112-5 Date: May 1980

DTIC Number: AD-A085004

Title: OPTIMAL AUGMENTATION OF EXPERIMENTAL DESIGNS FOR ESTIMATION OF THE LOGISTIC FUNCTION

Authors: Leslie A. Kalish and Dennis E. Smith

Abstract: A criterion for optimal augmentation of an experimental design is applied to the problem of estimating the logistic function. A simulation study is conducted to evaluate the procedure in the two-parameter case. Examples in the development of impact acceleration injury prediction models are given.

Desmatics Report Number: 106-10 Date: July 1980

DTIC Number: AD-A087491

Title: COMPARISON OF SEVERAL ESTIMATORS FOR THE VARIANCE OF A NORMAL DISTRIBUTION WHEN OUTLIERS MAY BE PRESENT

Authors: Dennis E. Smith and Denise D. Schmoyer

Abstract: Although much research has been directed at dealing with outliers, particularly for a $N(\mu,\sigma^2)$ distribution, little work has been devoted to estimating σ^2 when outliers may be present. This report describes a comparison of some proposed estimators of σ^2 for the case of data which, except for spurious observations, results from a $N(\mu,\sigma^2)$ distribution. All the estimators considered are nonadaptive and can accommodate up to n/2 outliers from a sample of size n. Monte Carlo simulation was used for the comparison of MSE, which was selected as a measure of performance. Interval estimates based on several of the estimators are also considered.

Desmatics Report Number: 106-11 Date: June 1982

DTIC Number: AD-A115786

Title: INTERRUPTIBLE SUPERSATURATED TWO-LEVEL DESIGNS

Authors: James L. Rosenberger and Dennis E. Smith

Abstract: Interruptible designs possess a robustness against possible premature termination of an experiment. We consider such two-level designs for a first-order model and present interruptible sequences which lead to the D-optimal saturated design for four to nine factors. Premature termination of the experiment at any stage results in a supersaturated design with minimum loss of information about the factors. The loss for these designs which is measured by the pairwise orthogonality between columns, is compared with that of the worst case for randomly ordered sequences.

Desmatics Report Number: 106-12 **Date:** August 1982

DTIC Number: AD-A118245

Title: DATA INTEGRATION: COMBINING REAL-WORLD AND SIMULATION DATA

Author: Dennis E. Smith

Abstract: In this paper we discuss a topic we label "data integration," which addresses the problem of combining information from a simulation model with that from the corresponding real-world situation. Although data integration is related to simulation validation, it does not focus on a yes/no decision about whether or not a model is valid. Instead, it is concerned with whether or not the simulation data is useful.

Desmatics Report Number: 106-13 **Date:** November 1983

DTIC Number: AD-A135621

Title: BINOMIAL ACCEPTANCE SAMPLING PLANS FOR EVALUATING OIL-WATER SEPARATOR PERFORMANCE

Author: Kevin C. Burns

Abstract: Binomial acceptance sampling is described and alternative sampling schemes based on the lognormal distribution are discussed. Tables are provided to aid in the choice between alternative binomial sampling plans. In addition, a computer program is given which may be used to extend the tables to other situations.

IV. TECHNICAL NOTES

In addition to the technical reports listed in the previous section, Desmatics also prepared 96 technical notes based on its participation in various Navy statistical problems. These informal technical notes were submitted to cognizant Navy scientists and engineers to communicate statistical design plans, data analysis results, and recommendations for the particular problem under consideration. The following pages provide a list of these technical notes.

Technical Note No.	Date	Title
None	7 Jul 75	PRELIMINARY SAMPLING PLAN
None	14 Nov 75	SUGGESTED EXPERIMENTAL DESIGN FOR TEST CHAMBER GRAB SAMPLE EXPERIMENTATION
None	10 Dec 75	AN OUTLINE OF THE GRAB SAMPLE EXPERIMENTATION
None	27 Apr 76	TENTATIVE PLANS FOR CHARCOAL BED EXPERIMENT
None	19 May 76	REVISED PLANS FOR CHARCOAL BED EXPERIMENT
None	18 Jun 76	ORDER OF TESTING FOR CHARCOAL BED EXPERIMENT
None	21 Jul 76	OUTLINE OF TIME-INTEGRATED SAMPLING EXPERIMENT
None	20 Aug 76	DISCUSSION OF GRAB SAMPLE EXPERIMENT
None	5 Jan 77	NOTES ON THE NSRDC THRESHOLD PROBLEM
None	6 Jan 77	PRELIMINARY NOTES ON THE GARRETT SEPARATOR LABORATORY EXPERIMENTS
None	26 Jan 77	NOTES ON TESTING THE EFFECTS OF THE PUMP ON THE PERFORMANCE OF THE 10N/MP OIL-WATER SEPARATOR
None	30 Mar 77	SUGGESTED EXPERIMENTS FOR MOLECULAR SIEVE CO_2 REMOVAL PROGRAM
None	4 Apr 77	SUGGESTED EXPERIMENT FOR SUBMARINE ATMOSPHERE SAMPLING
None	18 May 77	A STATISTICAL APPROACH FOR SEEKING OPTIMAL PUMP EFFICIENCY
None	1 Jun 77	DESCRIPTIVE STATISTICS OF THE PERFORMANCE OF THE 10N/MP OIL-WATER SEPARATOR
None	2 Jun 77	TABLES FOR USE IN DETERMINING THE NUMBER OF SAMPLES TO BE TAKEN IN ORDER TO MEET SPECIFIC EFFLUENT CRITERIA
None	6 Jun 77	PLANS FOR A STATISTICAL COMPARISON OF THE INTEX AND EPA METHODS OF MONITORING OIL/WATER CONCENTRATIONS

Technical Note No.	Date	Title
None	24 Jun 77	ANALYSIS OF THE EFFECT OF THE PUMP ON THE 10N/MP OIL-WATER SEPARATOR
None	24 Jun 77	RELATIONSHIP BETWEEN OIL AND SUSPENDED SOLIDS IN THE 10N/MP OIL-WATER SEPARATOR
None	23 Aug 77	NOTES ON SOME STATISTICAL ASPECTS OF THE TECHEVAL
None	7 Oct 77	COMMENTS ON THE ANALYSIS OF VARIANCE IN THE GRAB SAMPLING STUDY
None	14 Oct 77	RANDOMIZATION PLAN FOR SUBMARINE ATMOSPHERE SAMPLING
None	31 Oct 77	EXPERIMENT FOR STUDYING ROTOR TRANSFER EFFICIENCY
106-1	2 Nov 77	A COMPARISON OF THREE CRITERIA FOR ACCEPTING A NEW OIL-WATER SEPARATOR SYSTEM
106-2	4 Nov 77	A DISCUSSION OF THE JULY 1977 PUMP EFFICIENCY EXPERIMENTS
106-3	14 Nov 77	SUGGESTED EXPERIMENT FOR INVESTIGATING THE EFFECTS OF MODIFICATIONS ON THE PERFORMANCE OF THE DD963 BALLAST OIL POLLUTION ABATEMENT SYSTEM
106-4	16 Nov 77	POSSIBLE MODIFICATIONS TO THE STATISTICAL BASIS FOR ACCEPTING OR REJECTING AN OIL/WATER SEPARATOR SYSTEM
106-5	21 Nov 77	STATISTICAL EXPERIMENTS TO DETERMINE MAXIMUM CO_2 REMOVAL RATES
106-6	14 Dec 77	A COMPARISON OF TWO EXPERIMENTAL PLANS FOR EXAMINING DIFFERENCES DUE TO THE SOLVENT USED IN THE ANALYSIS OF OIL IN WATER
106-7	28 Dec 77	ANALYSIS OF THE CO_2 SORBENT BED EXPERIMENT
106-8	16 Jan 78	SUPPLEMENTARY DISCUSSION OF THE CO_2 SORBENT BED EXPERIMENT
106-9	9 Feb 78	A STATISTICAL EXPERIMENT FOR INVESTIGATING CATALYST YIELD

Technical Note No.	Date	Title
106-10	13 Mar 78	A STATISTICAL EXPERIMENT FOR INVESTIGATING THE EFFECTS OF FIVE FACTORS ON CATALYST YIELD
106-11	3 Apr 78	STATISTICAL ANALYSIS OF TWO EXPERIMENTS FOR COMPARING TWO SOLVENTS USED IN THE ANALYSIS OF OIL IN WATER
106-12	3 May 78	REVISED EXPERIMENT FOR INVESTIGATING THE EFFECTS OF FIVE FACTORS ON CATALYST YIELD
106-13	5 May 78	WEIGHTED VS. ORDINARY LEAST SQUARES IN PREDICTING TOTAL ACTUAL DIRECT CONTRACT HOURS FROM CUMULATIVE DATA
106-14	7 Jun 78	A DISCUSSION OF METHODS FOR PREDICTING TOTAL ACTUAL DIRECT CONTRACT HOURS
106-15	14 Jun 78	CO_2 REMOVAL: STATISTICAL ANALYSIS OF EXPERIMENTAL DATA
106-16	28 Jun 78	CO_2 REMOVAL: REGRESSION ANALYSIS OF *KGA COEFFICIENT*
106-17	30 Jun 78	STATISTICAL ANALYSIS OF A TIME-INTEGRATED SAMPLING EXPERIMENT
106-18	12 Jul 78	AN EVALUATION OF PREDICTIONS OBTAINED FROM A GRAB SAMPLING EXPERIMENT
106-19	11 Jul 78	PROCEDURES FOR IMPLEMENTING WEIGHTED LEAST SQUARES FOR PREDICTING TOTAL DIRECT CONTRACT HOURS
106-20	13 Jul 78	A COMPARISON OF FIVE METHODS OF PREDICTING TOTAL DIRECT CONTRACT HOURS USING HISTORICAL DATA
106-21	17 Aug 78	A SUGGESTED EXPERIMENT FOR DETERMINING OPTIMUM PERFORMANCE OF A SPECIFIC DEVICE
106-22	29 Aug 78	STATISTICAL ANALYSIS OF AN EXPERIMENT FOR STUDYING ROTOR TRANSFER EFFICIENCY
106-23	4 Oct 78	COMMENTS ON A TEST PLAN FOR ROTARY KILN DETOXIFICATION

Technical Note No.	Date	Title
106-24	12 Oct 78	TESTING FOR A QUADRATIC RELATIONSHIP BETWEEN ACTUAL DIRECT CONTRACTING HOURS AND BILL OF MATERIAL HOURS
106-25	6 Nov 78	CO_2 REMOVAL: FOLLOW-UP ANALYSIS
106-26	9 Nov 78	A STATISTICAL ANALYSIS OF THE RESULTS OF AN EXPERIMENT TO STUDY EMBT PARAMETRIC EFFECTS
106-27	13 Nov 78	A REVISED EXPERIMENT FOR DETERMINING THE BEST PERFORMANCE OF A SPECIFIC DEVICE
106-28	15 Dec 78	STATISTICAL CONSIDERATIONS IN TESTING THE EFFECTIVENESS OF FIBER OPTICS FOR BEARING INSPECTION
106-29	21 Dec 78	PREDICTION EQUATIONS FOR CATALYST YIELD
106-30	5 Jan 79	ROTOR TRANSFER EFFICIENCY: A STATISTICAL SUPPLEMENT
106-31	12 Feb 79	AN ANALYSIS OF NON-ADDITIVE MODELS FOR PREDICTING EMBT PARAMETER EFFECTS
106-32	14 Mar 79	A REEVALUATION OF THE ANALYSIS OF A GRAB SAMPLING EXPERIMENT
106-33	12 Apr 79	FURTHER MODEL DEVELOPMENT FOR PREDICTING EMBT PARAMETRIC EFFECTS
106-34	25 Apr 79	RISKS ASSOCIATED WITH MODEL SELECTION FOR PREDICTING TOTAL CONTRACTING HOURS
106-35	25 Apr 79	INVESTIGATION OF THE EXTRAPOLATING ABILITIES OF EMBT MODELS
106-36	29 May 79	PERFORMANCE, RELIABILITY AND MAINTAINABILITY TEST PLAN FOR OIL CONTENT MONITORS
106-37	9 Jul 79	PRELIMINARY INVESTIGATION OF THE POSSIBILITY OF EXTRAPOLATING EMBT RESULTS FROM ONE SUBMARINE TO ANOTHER
106-38	9 Jul 79	ADDITIONAL SIMULATION RUNS NEEDED TO DEVELOP A DEPTH-DEPENDENT MODEL FOR PREDICTING EMBT PARAMETRIC EFFECTS

Technical Note No.	Date	Title
106-39	23 Jul 79	STATISTICAL EXPERIMENTS TO EVALUATE MEA BOILER-STRIPPER CHARACTERISTICS
106-39A	24 Aug 79	NOTES FOR EMBT PROGRAM REVIEW
106-40	3 Oct 79	PRELIMINARY INVESTIGATION OF BEARINGS: CORRELATION OF ANDEROMETER AND FIBER OPTICS SCORES
106-41	2 Nov 79	STATISTICAL ANALYSIS OF THE REVISED EXPERIMENT FOR DETERMINING THE BEST PERFORMANCE OF A SPECIFIC DEVICE
106-42	28 Nov 79	EXPERIMENTAL PLAN FOR INVESTIGATING ANDERON LEVELS OF DEEP GROOVE BEARINGS
106-43	29 Nov 79	A STATISTICAL EXPERIMENT FOR THE VORTEX CLARIFIER
106-44	7 Jan 80	INVESTIGATION OF EXTENDED RESIDENCE TIME OF OIL/WATER SEPARATOR
106-45	9 Jan 80	A PROPOSED TEST FOR COMPARING BEARING FATIGUE LIVES
106-46	18 Jan 80	ANALYSIS OF BIOSPHERICS DISPERSER STUDY
106-47	25 Feb 80	MODIFICATION OF TEST PLAN TO INCORPORATE LABORATORY BIAS INTO TECHNICAL EVALUATION OF OIL CONTENT MONITORS
106-48	26 Feb 80	ESTIMATION OF LABORATORY BIAS AND VARIANCE FOR TECHNICAL EVALUATION OF OIL CONTENT MONITORS
106-49	4 Apr 80	FURTHER INVESTIGATION OF BEARINGS: CORRELATION OF ANDOMETER AND FIBER OPTICS SCORES
106-50	4 Apr 80	EXPERIMENTAL RESULTS FROM INVESTIGATING ANDERON LEVELS OF DEEP GROOVE BEARINGS
106-51	13 May 80	STATISTICAL ANALYSIS OF THE VORTEX CLARIFIER EXPERIMENT
106-52	29 Jul 80	ESTIMATING TOTAL ENERGY OF A SYSTEM FROM SERIES OF CURRENT AND VOLTAGE
106-53	22 Aug 80	TWO ALTERNATIVE TEST PLANS FOR THE BOILER STRIPPER STUDY

Technical Note No.	Date	Title
106-54	24 Sep 80	A PRELIMINARY COMPARISON OF EMBT SIMULATION AND EXPERIMENTAL DATA
106-55	5 Jan 81	RESULTS OF THE STATISTICAL ANALYSIS OF BILGE WASTE GENERATION DATA
106-56	7 Jan 81	STATISTICAL ANALYSIS OF A FOLLOW-UP STUDY OF ANDERON LEVELS OF DEEP GROOVE BEARINGS
106-57	4 Jun 81	COMMENTS ON A RELIABILITY DEMONSTRATION TEST PLAN
106-58	13 Jan 82	AN EXAMINATION OF THE RELATIONSHIP BETWEEN IN-SITU AND OUT-OF-MACHINE BEARING NOISE MEASUREMENTS
106-59	5 Feb 82	CONFIDENCE INTERVALS FOR PREDICTING OUT-OF-MACHINE READINGS FROM IN-SITU MEASUREMENTS
106-60	26 Feb 82	AN ANALYSIS OF THE CORRELATION BETWEEN EFFLUENT OIL CONCENTRATION AND FLOW RATE DURING REFUELING OPERATIONS
106-61	20 Apr 82	A STATISTICAL EXPERIMENT FOR THE TUBE SETTLER CLARIFIER
106-62	2 Jun 82	STATISTICAL ANALYSIS OF THE BALLAST OCM LOOP EXPERIMENT
106-63	28 Sep 82	FURTHER ANALYSIS OF THE BALLAST OCM LOOP EXPERIMENT
106-64	1 Dec 82	ON THE ESTIMATION OF THE RATIO OF POISSON PARAMETERS WHERE SHIFTING INTENSITIES ARE PRESENT
106-65	13 Dec 82	ANALYSIS OF EFFLUENT OIL CONCENTRATIONS DURING REFUELING OPERATIONS (also letter)
106-66	28 Jan 83	STATISTICAL ANALYSIS OF PHASE II BALLAST OCM LOOP EXPERIMENT
106-67	4 Feb 83	MOMENTS OF A TRUNCATED NORMAL DISTRIBUTION

Technical Note No.	Date	Title
106-68	11 Feb 83	TWO RELIABILITY TEST PLANS FOR THE VACUUM SEWAGE COLLECTION SYSTEM
106-69	18 Jul 83	A PRELIMINARY NOTE ON THE COMPARISON OF THREE LUBRICANTS
106-70	15 Mar 84	A STATISTICAL ANALYSIS OF ORGANOTIN RELEASE RATES
106-71	2 Apr 84	ERROR PROPAGATION IN THE MEASUREMENT OF ORGANOTIN LEACH RATES
106-72	12 Apr 84	THE EFFECT OF pH ON ORGANOTIN LEACH RATES
106-73	8 May 84	ANALYSIS OF BEARING DATA FROM EQUIPMENT IN THE VIBRATION MONITORING PROGRAM

V. JOURNAL ARTICLES AND PRESENTATIONS

In addition to the technical reports and notes listed in the previous two sections, significant research findings have been documented in two journal articles. Research accomplishments have also been presented at four scientific meetings. A listing of journal publications and technical presentations prepared under this contract is given below:

A. JOURNAL PUBLICATIONS

FIRST-ORDER INTERRUPTIBLE DESIGNS by Dennis E. Smith and Denise D. Schmoyer, Technometrics, Vol. 24, pp. 55-58, Feb. 1982.

INTERRUPTIBLE SUPERSATURATED TWO-LEVEL DESIGNS by James L. Rosenberger and Dennis E. Smith, Communications in Statistics, 1984 (to appear).

B. TECHNICAL PRESENTATIONS

AUTOMATED RESPONSE SURFACE METHODOLOGY AND ITS APPLICATION TO OPTIMUM-SEEKING IN DIGITAL COMPUTER SIMULATION, ORSA/TIMS Joint National Meeting, Nov. 1975.

A STATISTICAL STUDY OF ATMOSPHERIC SAMPLING FROM AN ENCLOSED INHABITED ENVIRONMENT, Ninth Materials Research Symposium, Apr. 1978.

COMPARISON OF SEVERAL ESTIMATORS FOR THE VARIANCE OF A NORMAL DISTRIBUTION WHEN OUTLIERS MAY BE PRESENT, American Statistical Association Annual Meeting, Aug. 1981.

COMBINING REAL-WORLD AND SIMULATION DATA, ORSA/TIMS Joint National Meeting, Oct. 1981.

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1. REPORT NUMBER 106-14	2. GOVT ACCESSION NO. AD-A142 331	3. RECIPIENT'S CATALOG NUMBER
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This final technical report prepared under Contract No. N00014-75-C-1054 summarizes a research investigation conducted by Desmatics, Inc. under sponsorship of the Office of Naval Research. The Desmatics research focused on the development of improved statistical methods for addressing "real-world" problems, primarily for application in the Navy's Pollution Abatement and Ship Auxiliary Machinery Program.

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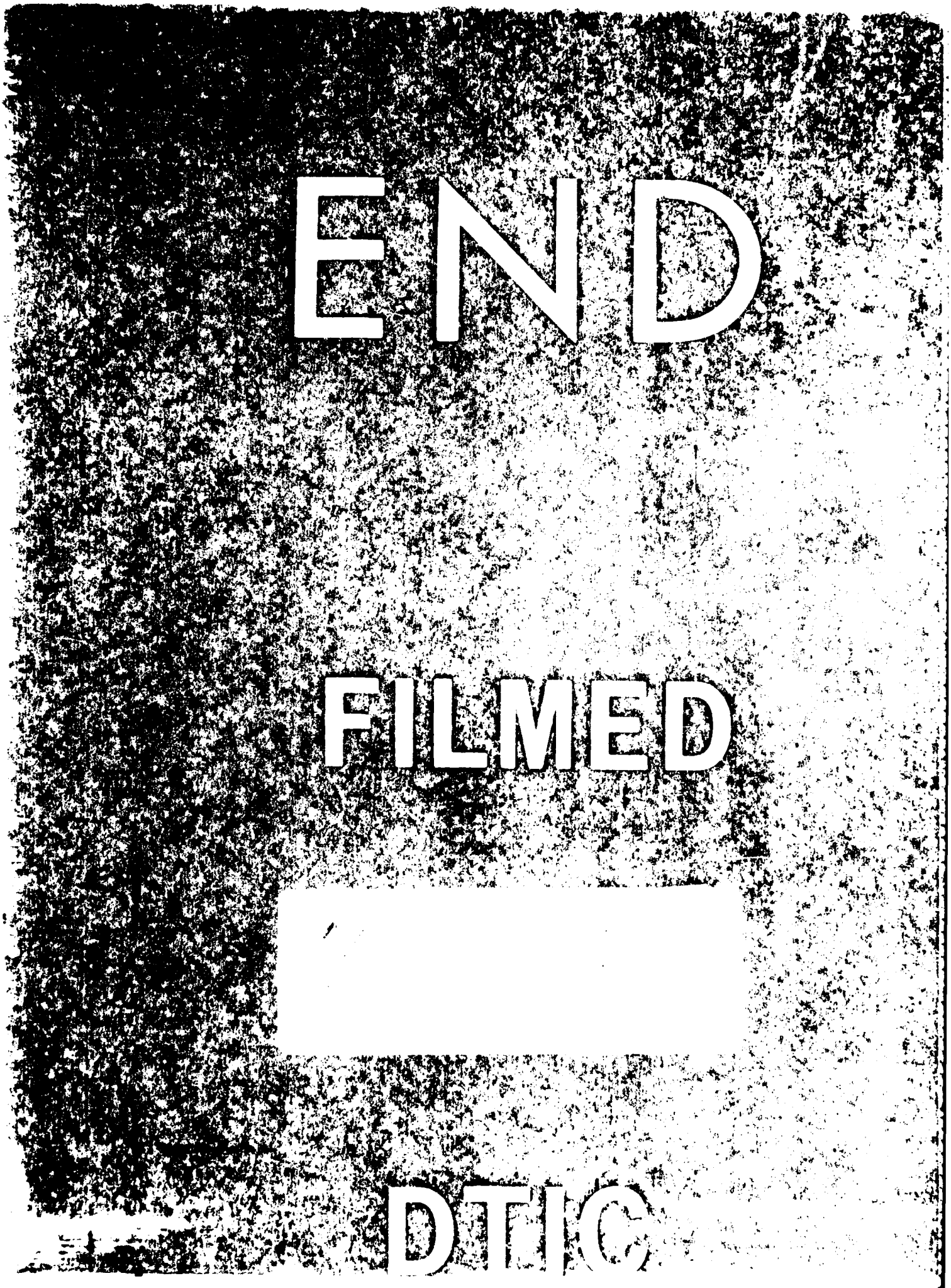
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