NATIONAL BUREAU OF STANDARDS REPORT
8089

PROJECTS and PUBLICATIONS
of the
APPLIED MATHEMATICS DIVISION

A Semiannual Report

January through June 1963

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
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NATIONAL BUREAU OF STANDARDS
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A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

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NBS PROJECT
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U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

APPLIED MATHEMATICS DIVISION

January through June 1963

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* Part time — ** Postdoctoral Resident Research Associate — *** Guest Worker
° On leave of absense — °° Temporary appointment — °°° Student Trainee

Contents

° Only unclassified material is included in this report.

Status of Projects

June 30, 1963

1. NUMERICAL ANALYSIS

RESEARCH IN NUMERICAL ANALYSIS AND RELATED FIELDS
Task 1101-12-11110/55-55

Origin: NBS Authorized 8/29/54
Manager: Philip J. Davis
Full Task Description: July - September 1954 issue, p. 1

Status: CONTINUED. F. W. J. Olver has completed a paper on error bounds for J. C. P. Miller's algorithm for the computation of functions from recurrence relations. He is now completing an investigation of error bounds for the Hankel asymptotic expansions of Bessel functions of large argument. He has given a series of eight lectures on selected topics in the theory of special functions at the Boulder Laboratories. He has also been advising the mathematics group there on the construction of algorithms for the automatic computation of Bessel functions for complex arguments and complex orders.

A conference on Approximation is being organized by the Society for Industrial and Applied Mathematics to take place for one week during the autumn at Gatlinburg, Tennessee, and F. W. J. Olver is acting as chairman of the Program Committee.

S. Haber continued to work on a survey of the theory of equidistribution mod 1, and on problems of numerical quadrature. He found a new derivation of a family of formulas for numerical integration over $(-\infty, \infty)$, which led to a convergence theorem. He proposed a modification of the Monte Carlo method of integration which, it is hoped, will lead to considerably smaller errors in some cases.

Maxine Rockoff has been preparing her work on iterative solutions of certain linear systems for publication.

R. DeMar has strengthened a theorem he had proved earlier concerning the existence of a function in a certain class of entire functions of exponential type which satisfies a set of conditions $\mathcal{L}_n(f) = a_n$; $n = 0,1,2,\cdots$ for given sequences $\{\mathcal{L}_n\}$ of linear functionals and $\{a_n\}$ of complex numbers, so that it now applies to more general classes of functions. He also proved a uniqueness theorem for a sequence of linear functionals whose generating functions are of the form W^n for some function W regular on a simply connected domain B. The univalence of W on B, which was known to be a necessary condition for the class of entire functions of exponential type whose Borel transforms are regular on the complement of B to be a uniqueness class for these functionals, is shown to be also sufficient. He made some further progress on the problem of determining conditions on a sequence $\{a_n\}$ in order that the sequence $\{\Delta^n f(a_n)\}$ of linear functionals have as large a uniqueness class as $\{\Delta^n f(0)\}$.

Status of Projects

E. C. Johnsen has been investigating the existence of special types of v,k,λ abelian group difference sets (G,D). He has shown that for certain abelian groups G, no difference sets D exist having the inverse multiplier: $g \rightarrow g^{-1}$, $g \in G$. In particular, when G is cyclic no such difference sets exist. It is known, however, that such difference sets do exist for other abelian groups. Another type which he is investigating consists of those (G,D) where for $g \in G$, $g \neq D$ if and only if $g^{-1} \notin D$. These can only exist for Hadamard design cases, i.e., where $v = 4m-1$, $k = 2m-1$, $\lambda = m-1$, $m \geq 2$ an integer. Some results for this type have been obtained and further results are expected.

Publications:

(1) Packing inequalities for circles. P. Davis. Michigan Journal of Mathematics 10, pp. 25 - 31, March 1963.

(2) The invariance of symmetric functions of singular values. M. Marcus and H. Minc (The University of Florida). Pacific Journal of Mathematics 12, No. 1, pp. 327 - 332, 1962.

(3) The maximum number of zeros in the powers of an indecomposable matrix. M. Marcus and Frank May. Duke Mathematical Journal 29, No. 4, pp. 581 - 588, December 1962.

(4) Lower bounds to eigenvalues using operator decomposition of the form B^*B. N. W. Bazley and D. W. Fox (Applied Physics Laboratory, Johns Hopkins University). Archive for Rational Mechanics and Analysis 10, 1962.

(5) Linear operations on matrices. M. Marcus. In manuscript.

(6) The zeros of infrapolynomials with prescribed values at given points. O. Shisha (with Prof. J. L. Walsh). To appear in the Proceedings of the American Mathematical Society.

(7) Bounds on ratios of means. O. Shisha (with Dr. G. T. Cargo). Journal of Research NBS, 66B, No. 4, pp. 169 - 170 (1962).

(8) Zeros of polynomials and fractional order differences of their coefficients. O. Shisha (with Dr. G. T. Cargo). To appear in the Journal of Mathematical Analysis and Applications.

(9) The segmental variation of Blaschke products. G. T. Cargo. Duke Mathematical Journal 30, No. 1, pp. 143 - 150, March 1963.

(10) Error bounds for first approximations in turning-point problems. F. W. J. Olver. To appear in the Journal of the Society for Industrial and Applied Mathematics.

(11) Error bounds for asymptotic expansions in turning-point problems. F. W. J. Olver. Submitted to a technical journal.

(12) Error analysis of Miller's recurrence algorithm. F. W. J. Olver. To appear in Mathematics of Computation.

(13) Uniqueness classes for difference functionals (Abstract). R. F. DeMar. Notices, American Mathematical Society 10, No. 1, p. 91, January 1963.

(14) On a theorem concerning existence of interpolating functions. R. F. DeMar. Submitted to the Transactions of the American Mathematical Society.

Status of Projects

(15) A uniqueness theorem. R. F. DeMar. To be published in Proceedings of the American Mathematical Society.
(16) Matrix rational completions satisfying generalized incidence equations. E. C. Johnsen. Submitted to a technical journal.
(17) The inverse multiplier for Abelian group difference sets. E. C. Johnsen. To appear in the Canadian Journal of Mathematics.

RESEARCH IN MATHEMATICAL TOPICS APPLICABLE TO NUMERICAL ANALYSIS
Task 1101-12-11411/55-56

Origin: NBS Authorized 8/13/54
Sponsor: Office of Naval Research
Manager: Morris Newman
Full Task Description: July - September 1954 issue, p. 5

Status: CONTINUED. M. Newman has continued his investigations of the modular group. He has proved that every normal congruence subgroup of the t x t modular group is a principal congruence subgroup, provided that the level of the group is prime to 6 if $t = 2$ and prime to 2 if $t > 2$. The same result has also been proved for the symplectic modular group.

A complete description of the normal subgroups of genus 1 of the modular group has been given by M. Newman, in terms of certain exponential congruence conditions to be satisfied by certain elements of the group.

M. Newman and J. R. Smart have completed a manuscript entitled "Symplectic modular groups". The principal result of this paper is that if A is symplectic modulo n then there is a $B \equiv A \pmod{n}$ such that B is symplectic.

M. Newman and J. Lehner are continuing their study of hyperelliptic subgroups of the modular group.

K. Kloss used the Bendix G-20 computer at Carnegie Institute of Technology to tabulate $p(n)$, the number of partitions of n, modulo 11^7 and modulo 13^7, for $0 < n \leq 25{,}000$. Auxiliary tables were prepared, listing the numbers $n \leq 25{,}000$ such that $13^k \mid p(n)$ or $11^k \mid p(n)$, for each positive integer $k < 7$. It was noted that about 2/11 of the values of $p(n)$ investigated were divisible by 11. Other, shorter, computations of $p(n)$ modulo a power of a prime were made. It was found that there are no primes t with $11 < t < 67$ for which a congruence of the form

$$p(mt + k) \equiv 0 \pmod{t}$$

holds for all $m \geq 0$.

At the request of M. Newman, K. Kloss investigated the problem: are there any primes $p \equiv -1 \pmod{12}$ such that $Q_p = p^2 + p + 1$ is also prime and $3^p \equiv 1 \pmod{Q_p}$? (This is a special case of the well-known conjecture that, if p and q are distinct primes, then $\frac{p^q-1}{p-1}$ and $\frac{q^p-1}{q-1}$ have no common factors.)

Status of Projects

For each prime $p < 500{,}763$, with $p \equiv -1 \pmod{12}$, the Bendix G-20 calculated Q_p and, if Q_p was prime, found $3^p \pmod{Q_p}$. None of the values of p investigated satisfied $3^p \equiv 1 \pmod{Q_p}$.

K. Kloss continued to supervise the PILOT computation of the Wilson remainders, defined for primes p by

$$W_p \equiv \frac{(p-1)! + 1}{p} , \quad 0 \le W_p < p .$$

The numbers W_p are now known for all $p < 450{,}000$. The computations are being continued as machine time permits. An extensive amount of work has been done in punching the PILOT output onto cards and preparing the table for possible publication. A completed table, at least for $p < 450{,}000$, should be available by September 1.

K. Kloss programmed Vandiver's criterion for the numerical investigation of Fermat's Last Theorem on the Bendix G-20. (See "An Application of High Speed Computing to Fermat's Last Theorem", by H. S. Vandiver et al., Proc. Nat. Acad. Sci. 40 (1954), pp. 25 - 33.) Because of insufficient time, no new results were obtained. The work will be continued using the PILOT computer.

K. Goldberg has continued his investigation of the coefficients in the iterates and powers of $f(z) = z + a_1 z^2 + a_2 z^3 + \cdots$. Let π denote the partition $1 \cdot k_1 + 2 \cdot k_2 + \cdots + n \cdot k_n = n$, and define the operator ψ_π by

$$\psi_\pi h_\pi = \sum_{n=0}^{\infty} z^n \sum_{\sum i k_i = n} h_\pi a_1^{k_1} a_2^{k_2} \cdots a_n^{k_n} / k_1! k_2! \cdots k_n!$$

Then $\psi_\pi^{-1}\{f(z)/z\}^{s+1}/f'(z) = \sum_{j=0}^{m} (-1)^j j! \sigma_j (s-j)^{(m-j)}$ and

$$\psi_\pi^{-1}\{f^{-1}(z)/z\}^{s+1}/f^{-1\prime}(z) = (-s-n-\delta)^{(m-2)}(s^2 + s - n^2 - n + 2\sigma_2)$$

where $m = k_1 + k_2 + \cdots + k_n$ and $\prod_{j=1}^{n}(1 + jt)^{k_j} = \sum_{j=0}^{m} \sigma_j t^j$.

J. Reed and K. Goldberg are continuing their work in developing a mathematical model of a certain type of human competitive behavior. They have succeeded in randomizing the input and are now concentrating on achieving an output which can be correlated with actual records.

Publications:

(1) Hadamard matrices of order cube plus one. K. Goldberg. In manuscript.
(2) A recurrence on integral vectors. K. Goldberg. In manuscript.

Status of Projects

(3) The powers of the iterates of a formal power series. K. Goldberg. In manuscript.
(4) Incidence spaces and algebras. K. Goldberg and E. C. Dade. In manuscript.
(5) Group generated incidence spaces and applications. K. Goldberg and E. C. Dade. In manuscript.
(6) Random notes on combinalysis. K. Goldberg. In manuscript.
(7) A proposed computer based model. K. Goldberg and J. G. Reed. In manuscript.
(8) The sum of the elements of the powers of a matrix. M. Marcus and M. Newman. Pacific Journal of Mathematics 12, 627 - 635 (1962).
(9) Tables of genera of groups of linear fractional transformations. H. Fell, M. Newman, E. Ordman. Journal of Research NBS, 67B, 61 - 68 (1963).
(10) A note on modular groups. M. Newman. Proceedings of the American Mathematical Society 14, 124 - 125 (1963).
(11) Note on a subgroup of the modular group. M. Newman and J. R. Smart. Proceedings of the American Mathematical Society 14, 102 - 104 (1963).
(12) Copositive and completely positive quadratic forms. M. Hall and M. Newman. Proceedings of the Cambridge Philosophical Society 59, 329 - 339 (1963).
(13) Bounds for cofactors and arithmetic minima of quadratic forms. M. Newman. Journal of the London Mathematical Society 38, 215 - 217 (1963).
(14) Modulary groups of t x t matrices. M. Newman and J. R. Smart. Duke Mathematical Journal 30, 253 - 257 (1963).
(15) Symplectic modulary groups. M. Newman and J. R. Smart. To appear in Acta Arithmetica.
(16) Weierstrass points of $\Gamma_o(n)$. J. Lehner and M. Newman. To appear in Annals of Mathematics.

2. MATHEMATICAL TABLES AND PROGRAMMING RESEARCH

MATHEMATICAL TABLES

The following long-range mathematical table projects are being carried in the Computation Laboratory. Progress continues as dictated by the relative priority in the overall program of the Laboratory and by available funds. All of the table projects were inactive during the past quarter because priority was given to the preparation of the forthcoming "Handbook of Mathematical Functions."

1102-40-11112/47-2 TABLES OF COULOMB WAVE FUNCTIONS

1102-40-11112/51-8 TABLES OF POWER POINTS OF ANALYSIS OF VARIANCE TESTS

1102-40-11112/52-37 TABLES OF SPHEROIDAL WAVE FUNCTIONS

1102-40-11112/52-57 TABLES OF THE SIEVERT INTEGRAL

HANDBOOK OF MATHEMATICAL FUNCTIONS
Task 1102-40-11421/57-216

Origin and Sponsor: National Science Foundation Authorized 12/27/56
Manager: Irene A. Stegun
Full task description: October - December 1956 issue, p. 10

Status: CONTINUED. Of the 29 chapters of the volume, page proofs for seven chapters remain to be checked.

AUTOMATIC CODING
Task 1102-12-11120/55-56

Origin: NBS Authorized 9/29/54
Manager: P. Walsh
Full task description: July - September 1954 issue, p. 11

Status: TERMINATED. The development of a stored-program monitor system for the 7090 was abandoned because IBM developed a monitor system and because a disk memory was not acquired. The IBM monitor system IBSYS was obtained, checked out, and placed on a stand-by status. When its imperfections are sufficiently removed it will probably replace the currently used Bell Monitor System. A Cobol compiler was checked out and placed in a ready-for-use status.

3. PROBABILITY AND MATHEMATICAL STATISTICS

RESEARCH IN PROBABILITY AND MATHEMATICAL STATISTICS
Task 1103-12-11131/63-1259

Origin: NBS Authorized 10/1/62
Manager: Joan Raup Rosenblatt
Full task description: July-December 1962 issue, p. 11

Status: CONTINUED.

(1) Introductory book for physics students. An introductory book on data analysis for college students of physics is to be written by C. Eisenhart and T. A. Willke for the Momentum Books series, published for the Commission on College Physics of the American Association of Physics Teachers by D. Van Nostrand Co. Plans for the preparation of the manuscript are in an early stage. Together with the projected monograph on precision and accuracy (July-December 1962 issue), this project motivates the Laboratory's work on the properties of estimators based on small samples.

(2) "Practical properties" of statistical techniques. The Laboratory is making an effort to prepare for publication certain materials from the files of unpublished reports and working papers. The first of a series of such publications has appeared: "Tables describing small-sample properties of the mean, median, standard deviation, and other sample statistics in sampling from various distributions", by Churchill Eisenhart, Lola S. Deming, and Celia S. Martin. This publication will make generally available most of the tables announced in three abstracts in the Annals of Mathematical Statistics, 19, pp. 598-600 (1948).

The second of this series of publications is in preparation. Under the title "Miscellaneous studies in probability and statistics: distribution theory, small-sample problems, and occasional tables", it will include "Distribution of the ratio of two F variates having n-1 and n degrees of freedom" by J. M. Cameron and Cyrus Derman, "Some notes on the Cauchy distribution" by Cyrus Derman, "The better one out of two" by E. P. King, "Variance of medians and pseudo-medians" by Mary G. Natrella, and "Probability points of order statistics in random samples of size n from a uniform distribution over (0,1)".

Janace Speckman has completed the first draft of a note on the properties of a measuring procedure in which observations are made until two identical values have been obtained, this duplicated value serving as an estimate of the mean. The mean squared error of such an estimator is compared with the mean squared error of a fixed sample size estimator, the arithmetic mean, when the fixed sample size is taken to be the expected sample size of the estimation process described above, for rounding lattices with several widths and several locations relative to the population mean.

Bruce Hoadley is investigating the properties of various techniques for linear regression and polynomial curve-fitting, under the assumption that the predictor variable is observed with error.

John Van Dyke completed a working paper entitled "Fitting $y = \beta x$ when the variance depends on x."

Status of Projects

John Van Dyke resumed work on the calculation of percentage points for the coverage of tolerance intervals whose expected coverage is specified (Wilks, 1961), for samples from the normal distribution.

Janace Speckman is pursuing the following studies on topics related to the measurement of precision and accuracy for NBS calibration programs. (i) The robustness of R-charts based on normal distribution theory. With Mary C. Croarkin, she is conducting an empirical-sampling study of the distribution of the range from normal, chi-square, log-normal, and uniform distributions. (ii) The normalizing effect of using various transformations of the sample variance s^2.

(3) Design and analysis of experiments. J. M. Cameron prepared a note entitled "Computation of a basis for a vector space and its complement", extending his algorithm for obtaining an orthogonal set of individual degrees of freedom for error.

(4) Handbook on experimental statistics. The Ordnance Engineering Design Handbook Experimental Statistics, prepared by Mary G. Natrella, has been issued by the Department of the Army. In order to make this handbook available to the public, it is planned that it be published by the NBS. The NBS edition is in press.

(5) Bibliography. Lola S. Deming has completed the last of a series of bibliographies that deal with various specific subjects in the field of statistics. The preceding six bibliographies of the series gave references for the period 1930 - 1957. The new one brings up to date, through 1960, each of the subjects: correlation and regression theory; time series; limit theorems; Markov chains and stochastic processes; frequency functions, moments, and graduation; theory of estimation and testing of hypotheses, sampling distributions, and theory of sample surveys.

(6) Background and evolution of the method of least squares. Churchill Eisenhart is writing up his historical findings on "The background and evolution of the method of least squares." In this connection he has found that the Principle of the Arithmetic Mean seems to have originated in Western Europe sometime in the latter half of the 16th century A.D., and appears to have evolved from the Method of Reversal for eliminating (or, at least, reducing) the effects of systematic errors, that is, from the technique of taking measurements in pairs such that the two members of a pair are affected by systematic errors of (approximately) equal magnitude but of opposite signs, in which case the arithmetic mean of the pair is (at least, more nearly) free from the effects of these errors.

The earliest implicit instance that he has found of the practice of taking the arithmetic mean of a number of measurements of the same quantity is in William Borough"s A Discourse of the Variation of the Compasse, or Magneticall Needle (1581); the earliest explicit instance is in Henry Gellebrand's A Discourse Mathematical on the Variation of the Magneticall Needle (1635). A very explicit instance is to be found on p. 726 of the Phil. Trans. for 1668. Not until around the middle of the eighteenth century, however, does the practice seem to have become widely (but not universally) followed.

Status of Projects

The practice of taking several measurements of a single quantity by the same method under essentially the same circumstances - a necessary precursor to taking the arithmetic mean of such measurements - seems to have originated early in the 16th century A.D. in connection with the efforts of mariners to devise a method for determining the longitude of a ship at sea from observations on the deviation of a compass needle from the true north, termed the variation or declination of the needle, which had been found by Columbus and others to be northeasterly to the east of the Azores, and northwesterly to the west of the Azores.

Publications:

(1) Roger Joseph Boscovich and the combination of observations. Churchill Eisenhart. Actes du Symposium International R. J. Boskovic, 1961, pp. 19 - 25 (Beograd 1962).
(2) An algorithm for obtaining an orthogonal set of individual degrees of freedom for error. Joseph M. Cameron. Journal of Research NBS, 67B, 19 - 22, January - March 1963.
(3) Selected bibliography of statistical literature: supplement, 1958 - 1960. Lola S. Deming. Journal of Research NBS, 67B, 91 - 133, April - June 1963.
(4) Tables describing small-sample properties of the mean, median, standard deviation, and other statistics in sampling from various distributions. Churchill Eisenhart, Lola S. Deming, and Celia S. Martin. NBS Technical Note 191, June 1963.
(5) Ranking laboratories by round-robin tests. W. J. Youden. Materials Research and Standards 3, 9 - 13, January 1963.
(6) On the pedestrian queueing problem. George Weiss. Bulletin International Statistical Institute, XXXIX, Part 4, 163 - 168, 1962.
(7) Realistic evaluation of the precision and accuracy of instrument calibration systems. Churchill Eisenhart. Journal of Research NBS, 67C, 161 - 187, April - June 1963.
(8) Precision of simultaneous measurement procedures. W. A. Thompson, Jr. Journal of the American Statistical Association, 58, No. 302, 474 - 479, June 1963.
(9) Factorial designs and the direct product. Badrig Kurkjian (Harry Diamond Laboratories) and Marvin Zelen. Bulletin International Statistical Institute, XXXIX, Part 2, 509 - 519, 1962.
(10) An analysis of pedestrian queueing. George Weiss. To appear in Journal of Research NBS, Section B (Mathematics and Mathematical Physics).
(11) A note on contingency tables involving zero frequencies and the $2\hat{I}$ test. H. H. Ku. To appear in Technometrics.
(12) On a rank sum test for outliers. W. A. Thompson, Jr. and T. A. Willke. To appear in Biometrika.
(13) Experimental statistics. Mary G. Natrella. To appear as NBS Handbook 91.

Status of Projects

MEASUREMENT OF RELIABILITY
Task 1103-12-11130/56-182

Origin: NBS Authorized 3/23/56
Manager: Joan Raup Rosenblatt
Full task description: January - March 1956 issue, p. 13

Status: CONTINUED. George Weiss has completed a paper on optimal inspection programs for randomly failing equipment. The optimum periodic program is found for a system having an arbitrary reliability function. Such a program has the virtue of simplicity even if it may not be optimal in an absolute sense. Some results on random inspection programs are also given.

Publications:

(1) Confidence limits for the reliability of complex systems. Joan R. Rosenblatt. Statistical Theory of Reliability, pp. 115 - 148 (edited by Marvin Zelen, The University of Wisconsin Press, Madison), 1963.
(2) A survey of some mathematical models in the theory of reliability. George Weiss. Statistical Theory of Reliability, pp. 3 - 51 (edited by Marvin Zelen, The University of Wisconsin Press, Madison), 1963.

Status of Projects

HYPERVELOCITY IMPACT
Task 1104-12-11418/63-1373

Origin and Sponsor: Applied Physics Laboratory, Johns Hopkins University — Authorized 4/22/63

Manager: Barry Bernstein

Objective: To analyze for numerical solution the problem of determining the size and shape of cratering in hypervelocity impact of a projectile with a target.

Background: The basic mathematical model for hypervelocity impact is a fluid dynamical one. The assumptions on which this model is based are the usual conservation laws, others based on compressibility data, along with the assumption that there is no elastic or plastic shear, and that the fluid is inviscid. Very few results based on this model are known, and those that do exist are not illuminating. Further, the termination of cratering is of great importance, but no phenomenological model for this process exists.

Status: NEW.

4. MATHEMATICAL PHYSICS

RESEARCH IN MATHEMATICAL PHYSICS AND RELATED FIELDS
Task 1104-12-11141/55-57

Origin: NBS Authorized 9/1/54
Manager: W. H. Pell
Full task description: July - September 1954 issue, p. 27

Status: CONTINUED. In connection with its application to the solution of problems in the theory of non-linear ordinary differential equations, A. Ghaffari has been making a comparative study of the stroboscopic method of Minorsky, the Mandelstam-Papalexi (M.P.) method, and the asymptotic methods of Krylov-Bogoliubov-Mitropolsky (K.B.M.). It is seen that:

(1) The M.P. method and the stroboscopic method are similar and derived directly from the theory of Poincaré. The stroboscopic method, however, transforms the initial nonautonomous system into the autonomous form, while the M.P. method operates directly with the nonautonomous system. As might by expected, the calculating procedure in these two methods is different.

(2) The K.B.M. approach is, in its final stage, analogous to the stroboscopic method, although the intermediate procedure is different in the two methods.

(3) The stroboscopic method occupies an intermediate position between the M.P. and K.B.M. methods. It has a common starting point with the M.P. method, while with the K.B.M. approach it has a common algebraic problem at the end of calculations, leading to the determination of the stationary state.

A. Ghaffari has prepared a manuscript concerning the application of the stroboscopic method to Duffing Equation with viscous damping.

B. Bernstein and E. A. Kearsley, of Section 6.05, have developed a new theory of elasticity for incompressible materials. In this theory there may be a cross effect between shear and pressure. In 1954, Ericksen (ZAMP 5, 466-489) derived all the deformations which are allowed by an arbitrary isotropic material satisfying the usual equations of incompressible elasticity. Bernstein and Kearsley have shown that, in general, the new theory admits the same deformations.

L. E. Payne and J. H. Bramble have completed a paper which deals with the effect of errors in the elastic moduli appearing in the Navier equations on bounds for the solutions of these equations subject to appropriate boundary conditions. A byproduct of this research is an interesting theorem regarding the approach of the solution of this boundary value problem to the solution of the problem for an incompressible medium.

Drs. J. P. Vinti and R. M. Langer have studied methods for measuring or compensating the drag on a manned satellite of the earth. In particular, they have shown that even at relatively low altitudes it is feasible to use external jets to maintain such a satellite in a purely gravitational orbit. With the jets turned off, they have shown that the drag, and thus the air density and the time of passage through perigee, can be measured both by a dynamical method and a static method. They suggest that equipping a manned satellite in this manner would provide a primitive zero-g space laboratory, whose operation would give valuable experience in the design of the large zero-g laboratories of the future.

Status of Projects

Publications:

(1) On Rayleigh's nonlinear vibration equation. A. Ghaffari. To appear in the Proceedings of the International Symposium on Non-linear Vibrations, sponsored by the Academy of Sciences of the Ukrainian SSR, Kiev, USSR, September 12 - 18, 1961.
(2) Higher approximations with the stroboscopic method. A. Ghaffari. To appear in Proceedings of Second International Conference on Non-linear Vibrations, Warsaw, Poland, September 18 - 21, 1962.
(3) Conditions for second order waves in hypo-elasticity. B. Bernstein. Transactions of the Society of Rheology 6, 263 - 273, 1962.
(4) A study of stress relaxation with finite strain. B. Bernstein (with E. A. Kearsley and L. Zapas). To appear in the Transactions of the Society of Rheology.
(5) Pointwise bounds in the first biharmonic boundary value problem. L. E. Payne and J. H. Bramble. To appear in the Journal of Mathematics and Physics.
(6) Error bounds in the pointwise approximation of solutions of elastic plate problems. J. H. Bramble and L. E. Payne. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).
(7) Drag compensation and measurement in manned satellites: feasibility study. R. M. Langer and J. P. Vinti. To appear in the Journal of Research NBS, Section C (Engineering and Instrumentation).

THEORY OF SATELLITE ORBITS
Task 1104-12-11441/62-1166

Origin: NBS Authorized 1/9/62
Sponsor: National Aeronautics and Space Administration
Manager: J. P. Vinti
Full task description: January - March 1962 issue, p. 12

Status: CONTINUED. The analysis of the drag-free motion of an artificial satellite by J. P. Vinti has been continued. Current work is concerned with the study of perturbations of the orbit due to deviations from true oblateness such as equatorial asymmetry.

Vinti's standard orbit is the solution of a separable problem on the motion of a satellite in the gravitational field of an oblate planet with axial and equatorial symmetry. In the case of the earth it accounts for some 99% of the deviation of the earth's gravitational field from sphericity.

For a drag-free orbit the most important forces not accounted for are those arising from the higher zonal harmonics of the planet's field. Vinti has now evolved a scheme for including these effects in the orbit, with specific applications to the third harmonic, which is associated with the pear shape of the earth, and the residual fourth harmonic, which gives rise to the well known critical inclination. The secular and short-periodic effects of this remaining 1% of a spherical deviation are of the second order in the oblateness parameter J_2 and that of the long-periodic effects is of the first order in J_2.

Although inclusion of these perturbing effects doubles the length of the algorithm for computing the orbit, the algorithm remains much shorter than that of any other method of comparable accuracy.

Publications:

(1) The spheroidal method for satellite orbits. J. P. Vinti. To be published in Proceedings of the International Association of Geodesy.
(2) The spheroidal method for satellite orbits. J. P. Vinti. Notes, Summer Institute for Dynamical Astronomy, Yale University, July 19, 1962.
(3) Zonal harmonic perturbations of an accurate reference orbit of an artificial satellite. J. P. Vinti. Submitted to a technical journal.

PLASMA RESEARCH
Task 1104-12-11140/59-422

Origin: NBS Authorized 6/30/59
Manager: C. M. Tchen
Full Task Description: April - June 1959 issue, p. 15

Status: CONTINUED. C. M. Tchen has completed his investigation in the kinetic theory of rapidly varying plasmas and a report has been prepared. He has continued the investigation of the formulation of a kinetic foundation for the theory of turbulence, using the BBGKY method. Two papers were presented by Dr. Tchen at the 6th International Symposium on Ionization Phenomena in Gases, Paris, July 8 - 13, 1963, and he was an invited participant in the 4th International Space Science Symposium, Warsaw, Poland, June 3 - 11, 1963. He also presented lectures on kinetic theories of plasmas and magnetohydrodynamics at the following institutes in Europe: Plasma Physics Institute, Garching, Germany; Institute for High Temperature Research, Technical University, Stuttgart, Germany; Institute for the Structure of Materials, Philipps University, Marburg, Germany; Laboratorium voor Massascheiding, Amsterdam, Netherlands; Institute Battelle, Centre de Recherche de Genève, Geneva, Switzerland.

DYNAMICS OF PLASMAS
Task 1104-12-11417/62-1157

Origin: NBS Authorized 10/3/61
Sponsor: National Aeronautics and Space Administration
Manager: C. M. Tchen
Full Task Description: October - December 1961 issue, p. 12

Status: CONTINUED. C. M. Tchen has continued his investigations in the area of plasma oscillations with collective correlation. Four reports of a preliminary nature have been prepared, as follows:

Status of Projects

(a) Kinetic equation for rapidly varying plasmas
(b) Diffusion of the correlation function for a plasma
(c) Approximate theory on the collective correlation of plasmas
(d) Plasma oscillations with collective correlations

Report (a) is concerned with the derivation of a kinetic equation for a plasma, in the form of a generalized Fokker-Planck equation, including the effects of "memory", so that it is applicable to rapidly varying processes. The dielectric property of the plasma was found to depend on the time varying distribution function and on a memory effect. The result may be applied to the calculation of the transport properties of plasma with high frequencies.

Report (b) considered the temporal development of the shielding process from an initial distribution into the equilibrium Debye-Hückel distribution. The result finds its applications in plasmas with unsteady correlations.

Report (c) extended the work of report (b) to include the collective behavior. The approximation referred to in the title was based on the transformation of the collective equation into a non-collective form.

In report (d) the longitudinal oscillations were investigated by including the effects of correlations. Since it is the collective behavior which sets up the oscillations, its role both in the singlet distribution function and the pair correlation function was investigated.

C. M. Tchen and W. L. Sadowski have begun work in the direction of numerical solution of the non-linear Vlasov equation for a plasma. This investigation will be carried out on the IBM 7090 at NBS. They have recently visited the Plasma Physics Institute at Garching, Germany. A program which they have written was put on the 7090 of the Institute. The results and the code are being sent to NBS.

C. M. Tchen presented two papers entitled "Plasma oscillations with collective correlations" and "Interaction of a plasma source with a uniform magnetic field", at the 6th International Symposium on Ionization Phenomena in Gases, Paris, July 8 - 13, 1963. He also was invited to, and participated in, the 4th International Space Science Symposium, Warsaw, Poland, June 3 - 11, 1963. Between these meetings, Dr. Tchen presented the following lectures:

(1) "Kinetic Problems in Plasmas", Plasma Physics Institute, Garching, Germany, June 18, 1963.

(2) "Kinetic Equation and Landau Damping", Institute for High Temperature Research, Technical University, Stuttgart, Germany, June 19, 1963.

(3) "Kinetic Equations of Plasmas", Institute for the Structure of Materials, Philipps University, Marburg, Germany, June 21, 1963.

(4) "Interaction of Plasma Flows with Magnetic Fields", Laboratorium voor Massascheiding, Amsterdam, Netherlands, June 24, 1963.

(5) "Kinetic Theories of Plasmas", Institute Battelle, Centre de Recherche de Genève, Geneva, Switzerland, June 28, 1963.

Publication:

(1) Collective correlation of plasmas. C. M. Tchen. Czechoslovak Journal of Physics 12, 516 - 521 (1962).

5. OPERATIONS RESEARCH

OPERATIONS RESEARCH
Task 1105-12-11115/61-546

Origin and Sponsor: NBS Authorized 12/30/60
Manager: Alan J. Goldman
Full task description: October - December 1960 issue, p. 3

Status: CONTINUED. The following investigations in various fields of operations research were carried out by members of the staff:

(1) C. Witzgall and A. J. Goldman continued investigating mathematical models of distribution networks. C. Witzgall studied several specific models, and topics in mathematical programming and topology, related to optimal location of a processing facility. The dual problem was shown in some cases to be of quadratic programming type.

(2) J. Levy and W. Sillars investigated the effects of buffer capacity in a simple flow system. P. Meyers carried out a simulation study of a stochastic sorting process, and numerical studies of alternative policies for encoding information to be used in classification.

(3) H. Fell and J. Mather investigated topics in linear algebras. A conjecture of D. Kleinman, that any number in (0,1) has an initial repeating block of digits in its representation to some base, was proved numerically using only bases ≤ 50.

(4) J. Levy and A. J. Goldman (with W. G. Hall and S. Peavy of 11.02) participated in a Commerce Department analysis of a proposed transportation activity. L. S. Joel and A. J. Goldman (with D. Labovitz of 12.05) assisted the Interagency Committee on Oceanography in connection with an operations research study.

(5) A. J. Goldman continued collaboration with M. Zelen (Mathematics Research Center, U. of Wisconsin) on a paper dealing with least squares estimation.

Publications:

(1) Maximal cellular Boolean functions. A. J. Goldman and B. K. Bender. Journal of Research NBS, 67B, pp. 77 - 84 (1963).
(2) Recognition of completely mixed games. A. J. Goldman. Journal of Research NBS, 67B, pp. 23 - 29 (1963).
(3) Review of "Systems: Research and Design." A. J. Goldman. Technometrics 5, pp. 130 - 131 (1963).

Status of Projects

AIR DEFENSE
Task 1105-12-11415/61-544

Origin and Sponsor: U. S. Army Air Defense Command Authorized 9/30/61
Manager: Lambert S. Joel
Full Task Description: July - September 1961 issue, p. 13

Status: TERMINATED. L. S. Joel (with J. Beiman and W. G. Hall, 11.02) completed the computer program for the first simulation model. A. J. Goldman examined some related mathematical problems.

COMBINATORIAL MATHEMATICS
Task 1105-12-11455/62-1205

Origin: NBS Authorized 5/2/62
Sponsor: Office of Naval Research
Manager: Jack Edmonds
Full task description: April - June 1962 issue, p. 15

Status: CONTINUED. J. Edmonds completed papers (1) on an algorithm for matching, (2) on a polyhedron with 0,1-vertices, and (3) on the surface duality of graphs.

Paper (2) contains a theorem (generalizing the Birkhoff-von Neumann theorem) which describes the convex hull of the vectors of zeroes and ones associated with the matchings in a given arbitrary graph. The theorem is virtually the first of its kind--in that the convex hull is not the one suggested directly by the combinatorial problem.

Edmonds extended the matching theory to "optimum degree-constrained subgraphs": in a graph G with integer capacities d_i at its nodes v_i and numerical weights on its edges, find a subgraph H of G such that the weight-sum of the edges in H is maximum and such that H contains no more than d_i edges meeting node v_i. A good algorithm is found. So far, this problem is unique among types of "integer programs" in being found to have an algorithm whose difficulty increases only algebraically rather than exponentially with the size of the graph G.

Witzgall and Zahn developed a modification of the algorithm for determining maximum-cardinality matchings of graphs which facilitates computer implementation and provides additional theoretical insight. Witzgall has coded the modified algorithm for the 7090 computer and code-checking problems were successfully run.

J. Mather presented at the Princeton Graph and Combinatorics Conference a classification of "The planar immersions of a graph."

While at Princeton this academic year, Edmonds directed (1) the weekly "Combinatorial problems and games seminar" and (2) a 3-day "Graph and Combinatorics Conference." The conference, attended by a hundred mathematicians from the U. S. and Canada, was devoted strictly to current research in combinatorial mathematics. Twenty invited papers were presented. Abstracts of these will be included in a Princeton Logistics Project report to the Office of Naval Research.

6. MATHEMATICAL AND COMPUTATIONAL SERVICES

1102-40-11645/56-0166 SCF-LCAO SOLUTION OF SOME HYDRIDES
Origin and Sponsor: NBS, Section 5.9 (now in Division 15)
Manager: P. J. Walsh
Full task description: January - March 1956 issue, p. 27
Status: CONTINUED. Work has been initiated to re-write the self-consistent-field programs. A new super-matrix program was completed by J. D. Waggoner. When the control program is re-written to avoid having to use a compatibility program, the speed of the overall routine will be greatly increased by all the modifications. Useful results that have been obtained with the present programs include approximate Hartree-Fock results for BH, CH, CH_2, He, H_2, CH_4, NH_4^+, and BH_4^-.

1102-40-11645/56-0186 MECHANICAL MEASUREMENTS OF GAGE BLOCKS
Origin and Sponsor: NBS, Section 2.5
Manager: B. S. Prusch
Full task description: July - September 1956 issue, p. 33
Status: CONTINUED. Computations were performed for the checking of 36 laboratory sets of gage blocks.

1102-40-11647/58-0266 DEPOLYMERIZATION PROCESSES
Origin and Sponsor: NBS, Section 7.6
Manager: Maxine L. Rockoff
Full task description: July - September 1957 issue, p. 36
Status: CONTINUED. Results are being analyzed by sponsor.

1102-40-11645/58-0339 COMPUTATION OF VISCOELASTICITY PROPERTIES OF MATERIALS
Origin and Sponsor: NBS, Section 3.4
Manager: H. Oser
Full task description: January - March 1958 issue, p. 38
Status: CONTINUED. A paper entitled "Effect of molecular weight on visco-elasticity properties of polymers as predicted by a molecular theory", written together with R. S. Marvin (6.05), appeared in the April - June issue of the Journal of Research NBS, 67B, pp. 87 - 90.

1102-40-11645/58-0366 RADIATION PATTERNS OF ANTENNAS
Origin and Sponsor: U. S. Information Agency, Department of State
Manager: P. J. Walsh
Full task description: April - June 1958 issue, p. 35
Status: REACTIVATED. Runs will be continued under sponsors' direction.

Status of Projects

1102-40-11645/60-0476 GAS TUBE CHARACTERISTICS, II
Origin and Sponsor: Diamond Ordnance Fuze Laboratories
Manager: H. Oser
Full task description: October - December 1959 issue, p. 30
Status: CONTINUED. Program is run by sponsor.

1102-40-11645/60-0486 MORSE WAVE FUNCTIONS AND FRANCK-CONDON FACTORS
Origin and Sponsor: NBS, Section 3.0
Manager: Ruth Zucker
Full task description: January - March 1960 issue, p. 28
Status: CONTINUED. Production runs were made and results submitted to the sponsor.

1102-40-11645/60-0513 RADIATIVE ENVELOPES OF MODEL STARS
Origin and Sponsor: National Aeronautics and Space Administration
Managers: P. J. Walsh and S. Haber (11.1)
Full task description: July - September 1960 issue, p. 23
Status: INACTIVE

1102-40-11645/61-0532 CALCULATION OF VIBRATIONAL ENERGY LEVELS FOR IONIC MOLECULES
Origin and Sponsor: Georgetown University
Managers: H. Oser and P. Walsh
Full task description: Oct.-Dec. 1960 issue, p. 21
New Objective: To determine with a precision of at least six decimals, the eigenvalues of the Schrödinger equation $y'' + \lambda(E - V)y = 0$, where λ is a constant, E the unknown eigenvalue and V(x) the Heitler-London potential. Both the ground state J=2 and the first rotational level J=4 are to be considered.
Status: REACTIVATED. Due to the properties of the H-L potential, the solution with $y(0) = y(\infty) = 0$ shows enormous exponential rise on the left of the first turning point and to a lesser degree an exponential decay on the right of the second turning point. The changes in the order of magnitude are so great that they cannot be accommodated by conventional computers.

The following procedure was therefore used: Starting at $x = x_o$, which lies between zero and the first turning point, with $y(x_o) = 0$, $y'(x_o) = 1$, we integrate numerically to a point x_1 near the minimum of V(x). Then, starting at x_2 on the right of the second turning point, with the values $y(x_2) = 0$, $y'(x_2) = -1$, we integrate again to x_1. The quantity

$$Q = \frac{y(x_1 - 0)}{y'(x_1 - 0)} - \frac{y(x_1 + 0)}{y'(x_1 + 0)}$$

is then computed for two different approximate values of E close to the expected eigenvalue. With the secant method, the eigenvalue is successively improved until the desired precision is reached.

The computations are then repeated with x_1 moved further left, and x_2 further right until there is no influence on the value E any more.
Literature: H. Harrison and R. B. Bernstein: Iterative method for the one-dimensional wave equation... J. Chem. Phys. 38, No. 9, 1963, pp. 2135-2143.

1102-40-11645/61-0538 SPECTRAL REFLECTANCE
Origin and Sponsor: NBS, Section 9.4
Managers: S. Haber (11.1) and P. J. Walsh
Full task description: October - December 1960 issue, p. 23
Status: CONTINUED.

1102-40-11645/62-1009 MONTE CARLO NEUTRON STUDIES
Origin and Sponsor: NBS, Section 4.3
Manager: Sally T. Peavy
Full task description: April - June 1961 issue, p. 21
Status: COMPLETED.

1102-40-11647/62-1022 CALCULATIONS FOR SPECTRUM OF DIPOLE RADIATION
Origin and Sponsor: Naval Research Laboratory
Manager: R. J. Arms
Full task description: April - June 1958 issue, p. 33
Status: CONTINUED. There has been some activity in this project. Code checking of a new program is under way.

1102-40-11645/62-1027 NEW SYSTEM
Origin and Sponsor: NBS, Section 11.2
Manager: R. J. Herbold
Full task description: July - September 1961 issue, p. 22
Status: CONTINUED. The IBM system (IBSYS) was obtained and several experimental runs were made. IBSYS consists of one supervisory system which handles one or more subsystems. The subsystems are Fortran II monitor, IBJOB and SORT, to mention three.

IBJOB, a new system developed by IBM, consists of Fortran IV, COBOL, Loader and MAP systems. Since IBJOB uses blocking technique when writing out the output, the 1410 tape-to-printer program has been modified to accommodate this.

Simple COBOL and Fortran IV programs were assembled and executed.

Studies are being made on how IBSYS should be used at the NBS computer facilities. Literature on various systems operating under IBSYS are being obtained and distributed. An accounting program has been incorporated into the IBSYS system.

Status of Projects

Coding has been started on a supervisory program to handle OMNITAB runs, i.e., put OMNITAB program on the IBSYS tape.

Studies are being made on how the Bell system produced object decks can be run under IBSYS.

1102-40-11645/62-1030 ELECTROCARIOGRAPHIC ANALYSIS
Origin: NBS, Section 12.5
Sponsor: Veterans Administration
Full task description: April - June 1959, p. 29
Status: CONTINUED. Production runs, coding of new programs and modifications of old programs are being done as directed by the sponsor.

1101-12-11416/62-1091 BOUNDS FOR EIGENVALUES
Origin: Wright Patterson AFB
Manager: H. Oser
Full task description: October - December 1961 issue, p. 4
Status: CONTINUED. Work on Legendre's differential equation continued. The applicability of Bazley and Fox's method to other differential operators is currently under study.

1102-40-11647/62-1130 FALLOUT SHELTER COMPUTATIONS
Origin and Sponsor: Office of Civil Defense
Manager: D. I. Mittleman
Full task description: October - December 1961 issue, p. 25
Status: CONTINUED. A few special summaries were run.

1102-40-11647/62-1155 MORTGAGE LOAN SURVEY
Origin and Sponsor: Federal Home Loan Bank Board
Manager: Ruth Zucker
Full task description: January - March 1962 issue, p. 24
Status: CONTINUED. Production runs continued under direction of sponsor.

1102-40-11647/62-1178 LOGARITHMIC COEFFICIENTS
Origin and Sponsor: NBS, Section 5.3
Manager: R. J. Arms
Full task description: January - March 1962 issue, p. 27
Status: INACTIVE.

1102-40-11647/62-1179 CATALOGUE INFORMATION
Origin and Sponsor: Diamond Ordnance Fuze Laboratories
Manager: Ruth Varner
Full task description: January - March 1962 issue, p. 27
Status: CONTINUED. Additional work on the problem is being carried out by the sponsor.

Status of Projects

1102-40-11647/62-1182 FOURIER INTEGRAL
Origin and Sponsor: Diamond Ordnance Fuze Laboratories
Manager: H. Oser
Full task description: April - June 1962 issue, p. 25
Status: CONTINUED. Program is being run by sponsor.

1102-40-11647/62-1189 SEQUENTIAL METHODS TABLES
Origin and Sponsor: Quartermaster Research and Engineering Field Evaluation Agency, U. S. Army
Manager: R. J. Arms
Full task description: April - June 1962 issue, p. 26
Status: Continued. It is expected that the project will be completed before the end of June 1963.

1102-40-11647/62-1193 SOLUTION TO SECOND ORDER PARTIAL DIFFERENTIAL ELLIPTIC EQUATION
Origin and Sponsor: NBS, Section 3.08
Manager: P. J. Walsh
Full task description: April - June 1962 issue, p. 28
Status: CONTINUED. Production runs were made for different values of C and K, using the third version of the problem. The results have been submitted to the sponsor.

1102-40-11647/62-1196 HEAT OF ADSORPTION
Origin and Sponsor: NBS, Section 15.2
Manager: Ruth Varner
Full task description: April - June 1962 issue, p. 29
Status: CONTINUED. All results have been transmitted to the sponsor who will carry out any further calculations needed.

1102-40-11647/62-1201 UHF-TV
Origin and Sponsor: Federal Communications Commission
Manager: W. Hall
Full task description: April - June 1962 issue, p. 29
Status: COMPLETED.

1102-40-11647/62-1203 CYLINDRICAL SHOCK WAVE
Origin and Sponsor: NBS, Section 3.7
Managers: Sally Peavy and S. Haber
Full task description: April - June 1962 issue, p. 30
Status: CONTINUED. All the subroutines are checked except the one which computes the inner boundary condition.

Status of Projects

1102-40-11647/62-1212 COLOR DIFFERENCES
Origin and Sponsor: NBS, Section 10.9
Manager: J. D. Waggoner
Full task description: April - June 1962 issue, p. 33
Status: INACTIVE. Some revisions were made in the original program, and are being checked out.

1102-40-11647/63-1219 SHOCK TUBE DATA
Origin and Sponsor: Diamond Ordnance Fuze Laboratories
Manager: L. Joseph
Full task description: July - December 1962 issue, p. 32
Status: INACTIVE.

1102-40-11647/63-1223 CARDIOVASCULAR DYNAMICS
Origin and Sponsor: Univ. of Pennsylvania, Bockus Research Institute
Manager: M. Rockoff
Full task description: July - December 1962 issue, p. 32
Status: INACTIVE.

1102-40-11647/63-1240 SECRET SERVICE FORGERY PROJECT
Origin and Sponsor: Treasury Department, U. S. Secret Service
Manager: M. Paulsen
Full task description: July - December 1962 issue, p. 33
Status: CONTINUED. A production run was made in January which yielded so much output that the S.S. decided they would have to made certain changes in their classification rules, and this may necessitate changes in the computer program. This run gave the S.S. information that identified a multiple-check case where there were sacks of mail stolen in Cincinnati. Some of the Government checks were forged there and others in St. Louis, which is something they had not suspected.

1102-40-11647/63-1258 SPECTRAL ANALYSIS
Origin and Sponsor: NBS, Section 15.03
Manager: H. Oser
Full task description: July - December 1962 issue, p. 33
Status: INACTIVE

1102-40-11647/63-1260 DENTAL RESEARCH
Origin and Sponsor: NBS, Section 7.8
Manager: H. Oser
Full task description: July - December 1962 issue, p. 34
Status: COMPLETED. Project proved to be not feasible in its present formulation.

Status of Projects

1102-40-11647/63-1273 CRYSTAL GROWTH
Origin and Sponsor: NBS, Section 8.5
Manager: J. Quinones
Full task description: July - December 1962 issue, p. 34
Status: COMPLETED. Further results will be reported under task 63-1319.

1102-40-11647/63-1275 SECURITIES MARKET STUDY
Origin and Sponsor: Securities and Exchange Commission
Managers: I. A. Stegun and Ruth Zucker
Full task description: July - December 1962 issue, p. 35
Status: COMPLETED. Results transmitted to sponsor.

Status of Projects

1102-40-11647/63-1319 SOLUTION OF BIQUADRATIC AND BICUBIC EQUATIONS
Origin and Sponsor: NBS, Section 6.1 Authorized 1/24/63
Manager: Louis Joseph
Objective: To find the roots of the following two equations:
(1) $Ez^4 + Fz^2 + G = 0$, (2) $Ay^6 + By^4 + Cy^2 + D = 0$ for various values of the complex coefficients A, B, C, D, E, F, and G.
Background: Equation (1) is a quadratic in z^2 while Equation (2) is a cubic in y^2. Thus the equations can be solved using standard formulas for solution of quadratic and cubic equations, respectively, and then taking the square root.
Status: NEW. COMPLETED. A FORTRAN program was written to solve the equations. Production runs were made and results given to the sponsor.

1102-40-11647/63-1335 MATRIX OF POLYNOMIALS Authorized 3/29/63
Origin and Sponsor: NBS, Section 13.1
Manager: Ruth Zucker
Objective: A program was written to evaluate

$$\alpha_{ij} = \frac{2}{N\pi} \sum_{n=o}^{M} (2n + 1)\, H_n(x_i)\, \Phi_n(r_j) \qquad i \neq 0$$

$$\alpha_{oj} + \frac{1}{N\pi} \sum_{n=o}^{M} (-1)^n (2n + 1)\, \Phi_n(r_j) \qquad M = 2, 6$$

where $x_i = \frac{i}{N}$ $r_j = \frac{j}{N}$ $i, j = 0, \cdots\cdots N-1$

$\Phi_n(r) = P_n(2r^2 - 1)$, $P_n(t)$ is the Legendre Polynomial

$$H_n(x) = \frac{\sin\left[(2n + 1) \arccos x \right]}{\sqrt{1-x^2}}$$

for given values of N and M.

Background: The above was written as a subroutine so the sponsor could use it readily as part of his larger program which dealt with the solution of Abel's Integral equation. The solution is necessary for reduction in plasma - arc spectroscopic data.
The problem was transmitted by John R. Solarski. (13.01)
Status: NEW.

Status of Projects

1102-40-11647/63-1341 LINE WIDTHS Authorized 6/7/63
Origin and Sponsor: NBS, Section 13.2
Manager: Maxine Paulsen
Objective: The most tedious and most time consuming stage in the calculation involves finding a particular root of a somewhat complicated expression. This can be done with existing tabulated functions and trial and error procedures. Since in a typical calculation one may have several hundred of these equations to solve the calculations are hardly worth the time involved.

The objective was to have the computer solve these equations. Since several hundred equations can be solved in a few minutes on the computer, the major drawback to making these rather detailed calculations would be removed. With such a program it is feasible to investigate the detailed predictions of the theory for a wide choice of molecular constants and, if desired, over a range of temperatures.
Background: Anderson has developed a theory for pressure broadening of gases in the infrared region of the spectrum. The theory is applicable to both self broadening and foreign gas broadening. Detailed comparisons between the theory and experiment have not been too frequent, however, as the theoretical predictions involve a large amount of rather tedious numerical computation.
Status: NEW. The code was written, checked out, and the sponsor is now using it for production runs.

1102-40-11647/63-1352 NEAR NATIONAL EMERGENCY ALARM REPEATER
Origin and Sponsor: OCD Authorized 4/29/63
Manager: Louis Joseph
Objective: Computation Laboratory is serving as a consultant to the Office of Civil Defense in helping to evaluate work previously done at Midwest Research Institute.
Background: The NEAR (National Emergency Alarm Repeater) system is an emergency warning system that utilizes electrical power networks to transmit the alarm signal. Midwest Research Institute has been investigating methods of determining requirements for NEAR signal generators.
Status: NEW.

1102-40-11647/63-1355 STUDY OF ELECTRONIC ENERGY BANDS IN THE RUTILE CRYSTAL Authorized 4/2/63
Origin and Sponsor: NBS, Section 13.4
Managers: P. Walsh and A. Gregg
Objective: To compute the energy matrices of rutile crystals and to diagonalize them.
Background: This is a theoretical study of the electronic energy bands in the rutile crystal (TiO_2). The Bloch functions are represented by linear combinations of atomic orbitals (LCAO). The energy matrices are then formed from the LCAO functions.

Status of Projects

Status: The program for generating energy matrices is written and code checking has been started. A standard subroutine for diagonalizing the symmetric energy matrices will be used.

1102-40-11647/63-1364 BaF ELEMENT RESPONSE TIME BARIUM FLORIDE
Origin and Sponsor: NBS, Section 14.4 Authorized 5/17/63
Manager: Maxine Paulsen
Objective: The objective of the computer program was to provide an analysis of the paper tape data. An empirical equation was to be used to determine the first, second, and third differences (ratios of these differences were to be calculated) of indicated relative humidity with respect to time from which the response time of the hygrometer element could be inferred.
Background: As part of a program of research and development on electric hygrometer elements, ten thin film hygrometer elements were mounted on radiosondes and sent aloft on balloons to make measurements of relative humidity in the atmosphere. The radiosonde transmitted a signal of audio frequency which varied with the electrical resistance of the hygrometer element and, therefore, with the ambient relative humidity. The transmitted signal was recorded by a pen recorder and by a magnetic tape recorder. The magnetic tape recorder data had been analyzed and a frequency "count" for each half second of time during each balloon flight was printed out on paper tape.
Status: NEW. The code was written, checked out, and the results of the production run were given to the sponsor.

1102-40-11647/63-1368 HEART DISEASE CONTROL Authorized 4/11/63
Origin and Sponsor: Public Health Service
Manager: Sally Peavy
Objective: Nutrients are needed for tabulating nutrient contents of food in every day diets. Although tables may exist itemizing the nutrient content of each food, it is a laborious task to tabulate consumption of individuals. To help solve the problem, a computer program can be formulated to do a table retrieval and compute the consumption of each nutrient for individuals.
Background: In epidemiologic studies nutrients are used as a factor to differentiate between normal and diseased cardiac subjects.
Status: NEW. A program is in the process of being written.

Status of Projects

1102-40-11647/63-1377 WHISKER GROWTH IN A VAPOR ATMOSPHERE
Origin and Sponsor: NBS, Section 8.5 Authorized 6/27/63
Managers: H. Oser and J. A. Simmons (8.5)
Objective: To find the solution of the following partial differential equation:

$$D \frac{\partial^2 u}{\partial x^2} + N = \frac{\partial u}{\partial t} + \frac{u}{T} \qquad 0 \leq x \leq x(t)$$

under the boundary conditions:

$$u \equiv 0 \quad \text{for} \quad x > x(t) \quad \text{(moving boundary)}$$

$$\frac{\partial u}{\partial x} = 0 \quad \text{at} \quad x = 0,$$

the initial condition:

$$u(x,0) = 0 \quad \text{for all } x,$$

and the conditions for the boundary x(t):

$$\frac{dx(t)}{dt} = -\frac{D}{\alpha} \frac{\partial u}{\partial x}\Bigg|_{x=x(t)} \qquad t > 0$$

$$x(0) = \ell \qquad \dot{x}(t) > 0 \qquad t > 0$$

Background: The equations above describe the temporal growth of a one-dimensional crystal whisker, where D is the linear diffusion coefficient for the transport of material to the end of the whisker, T is a characteristic time which governs the evaporation of deposited material back into the vapor atmosphere and α relates the rate of deposition at the end of the whisker to the rate of growth of the whisker tip. N is the deposition rate of atoms which are captured on the surface where they begin to diffuse towards the tip.

Status: NEW. The problem has been analyzed and transformed into a system of two non-linear integral equations. Using asymptotic relations, which can be derived easily from the integral form, starting values are found which lead to a stable iterative algorithm. Preliminary runs turned out to be rather promising. Currently a machine program is being written with an aim for six-place accuracy in the boundary-function x(t).

7. STATISTICAL ENGINEERING SERVICES

COLLABORATION ON STATISTICAL ASPECTS OF NBS RESEARCH AND TESTING
Task 3911-61-39951/51-1

Origin: NBS Authorized 7/1/50
Managers: W. J. Youden, J. M. Cameron
Full task description: July - September 1950 issue, p. 60

Status: CONTINUED. During this period members of the section provided statistical assistance to a number of Bureau personnel. The following are examples:

(1) Churchill Eisenhart is preparing for publication an article entitled "Expression of the uncertainties of calibrations". In this article, the terms used to describe the precision and accuracy of measurements are defined and discussed. Specific rules are recommended for expressing the uncertainty of a reported value for four cases distinguished according to the relative magnitudes of the imprecision and the likely systematic error of the measurement process employed. Examples of recommended uncertainty statements are given.

(2) The section participated in a number of studies aimed at evaluating the precision and accuracy of measurement processes. Notable among these were the work on proving rings, voltage cells, and mass calibration.

Collaboration with the Mass and Scale Section provides an excellent example of the use of statistical methods in calibration work. New weighing designs in which a standard is incorporated as an "unknown" have been worked out; techniques for surveillance as to whether the measurement process is in a state of statistical control have been put into operation, and a computer program has been worked out for the analysis and record keeping features of these procedures.

(3) George Weiss is preparing a paper jointly with B. D. Coleman (Mellon Institute) and F. Gornick (NBS Macromolecules: Synthesis and Structure Section) on the statistics of irreversible termination in anionic polymerization.

Publications:

(1) Uncertainties in calibration. W. J. Youden. IRE Transactions on Instrumentation I-11, Nos. 3 and 4, 133 - 138, December 1962.
(2) The collaborative test. W. J. Youden. Journal of the Association of Official Agricultural Chemists, 46, 55 - 62, February 1963.
(3) Mean first passage times and the dissociation of diatomic molecules. Kurt Shuler (Institute for Defense Analysis) and George Weiss. Journal of Chemical Physics, 38, 505 - 509, January 1963.
(4) Statistics in chemical analysis. W. J. Youden. Handbook of Analytical Chemistry, pp. 14-1 to 14-9 (edited by Louis Meites, McGraw-Hill Book Co., Inc., New York), 1963.
(5) Statistical interpretations. W. J. Youden. Standard Methods for Chemical Analysis, pp. 318 - 325 (6th ed., D. Van Nostrand Co., Inc., New York), 1963.

Status of Projects

(6) Long term distribution of received power. M. M. Siddiqui (Boulder Laboratories) and George Weiss. To appear in Journal of Research NBS, Section D (Radio Propagation).
(7) Mathematical models for personnel promotion. E. L. Crow (Boulder Laboratories) and George Weiss. Submitted to a technical journal.
(8) An editorial for "The Physics Teacher". W. J. Youden. Submitted to The Physics Teacher.
(9) Simplified statistical quantity control. W. J. Youden. To appear in Proceedings 48th National Conference on Weights and Measures.
(10) Mathematics and experimental science. W. J. Youden. Submitted to The Science Teacher.
(11) Measurement agreement comparisons. W. J. Youden. To be published by NBS in Proceedings, National Conference of Standards Laboratories.

STATISTICAL SERVICES
Task 1103-40-11625/58-346

Origin and Sponsors: Various Agencies Authorized 3/31/58
Manager: J. M. Cameron
Full Task Description: January - March 1958 issue, p. 45

Status: INACTIVE.

Current Applications of Automatic Computer

This is a record of the use of the IBM 7090 for the period of January 1 through June 30, 1963.

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NBS SERVICES			(M I N U T E S)			
51-0002	11.3	STATISTICAL ENGINEERING	25.2	80.1	376.1	481.4
54-0030	13.1	SPECTRUM ANALYSIS++	8.2	5.9	1066.6	1080.7
54-0031	13.1	SPECTRUM ANALYSIS++	.0	.0	30.5	30.5
54-0033	13.1	SPECTRUM ANALYSIS++	134.4	1.2	1456.9	1592.5
54-0034	13.1	SPECTRUM ANALYSIS++	11.5	24.0	144.0	179.5
55-0055	11.1	RESEARCH IN NUMERICAL ANALYSIS	24.7	27.6	154.2	206.5
55-0065	11.2	AUTOMATIC CODING	4.5	76.0	56.7	137.2
55-0082	3.1	THERMOMETER CALIBRATION+	.0	3.2	167.9	171.1
56-0166	15.0	SCF-LCAO SOLUTION OF HYDRIDES+	11.1	335.1	698.1	1044.3
57-0219	3.2	THERMAL PROPERTIES+	10.7	23.1	23.7	57.5
57-0236	3.8	SCF EIGENVALUES+	2.2	1.5	140.5	144.2
57-0250	2.1	SPECTROPHOTOMETRIC DATA+	2.0	44.7	30.2	76.9
57-0252	4.4	NEUTRAL MESON EXPERIMENTS++	131.4	333.8	508.2	973.4
58-0256	10.6	COMPOSITE WALL STUDIES++	16.9	155.0	239.6	411.5
58-0272	3.7	EQUATION OF STATE++	42.2	157.8	1058.4	1258.4
58-0298	5.2	CODE REVISION+	3.0	5.0	3.3	11.3
58-0314	3.7	APPROXIMATIONS FOR GAS MIXTURES+	22.6	204.0	340.0	566.6
58-0339	6.5	VISCOELASTICITY PROPERTIES	.0	2.5	18.7	21.2
59-0403	2.1	COMPUTATION OF COLOR FADINGS+	.0	.0	3.7	3.7
59-0433	2.1	COLOR OF SIGNALS++	.0	5.8	14.8	20.6
59-0440	87.1	NUMERICAL MAPPING++	.0	9.0	.0	9.0
60-0489	3.1	INVERSION OF LINE PROBE DATA+	.0	92.1	1.2	93.3
60-0493	3.8	POISSON DISTRIBUTION FUNCTION++	.0	30.9	180.8	211.7
61-0523	4.7	NEUTRON CROSS SECTION STUDIES++	59.6	134.1	17.6	211.3
61-0538	9.4	SPECTRAL REFLECTANCE DATA	8.8	.0	58.8	67.6
61-0559	3.1	THERMOCOUPLE CALIBRATION+	2.9	18.7	14.5	36.1
61-0856	11.2	IBM 7090 FORTRAN INSTRUCTION+++	.0	1.9	.0	1.9
61-0995	11.2	ERROR DETECTION+++	1.3	.3	68.0	69.6
62-1000	12.5	POST OFFICE OPERATIONS STUDY++	172.0	356.1	154.1	682.2
62-1003	15.4	MOLECULAR SPECTROSCOPY+	10.1	75.3	67.7	153.1
62-1005	4.3	RADIATION INTERACTION++	106.1	224.3	611.0	941.4
62-1007	4.3	RADIATION SHIELDING++	.0	53.1	10.1	63.2
62-1009	4.3	MONTE CARLO NEUTRON STUDIES	1.9	12.9	.0	14.8
62-1011	13.5	DISPERSION INTEGRALS++	.0	5.4	2.7	8.1
62-1013	7.0	STATISTICAL METHODS++	3.3	16.5	.8	20.6

Current Applications of Automatic Computer

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
			(M I N U T E S)			
NBS SERVICES						
62-1015	15.1	THERMAL FUNCTIONS++	25.0	16.7	5.1	46.8
62-1019	41.0	NBS PERSONNEL REPORT++	4.4	35.9	117.4	157.7
62-1020	3.3	EIGENVALUES+	.0	.0	331.2	331.2
62-1027	11.2	NEW SYSTEM	8.0	33.3	42.2	83.5
62-1029	9.7	D-SPACING CALCULATIONS+	.0	.0	35.5	35.5
62-1033	9.7	CRYSTAL STRUCTURE CALIBRATION++	5.7	8.1	667.9	681.7
62-1034	30.0	PHOTOIONIZATION CROSS SECTION++	156.5	12.9	34.3	203.7
62-1035	7.7	CREEP DATA ANALYSIS++	13.5	19.7	33.5	66.7
62-1036	7.7	FILM THICKNESS++	.0	.0	25.2	25.2
62-1038	7.5	STANDARDIZATION ANALYSES++	22.4	36.7	10.8	69.9
62-1055	8.4	ELLIPSOIDAL COMPUTATION++	.0	.0	1.3	1.3
62-1060	15.0	BLACK BOX COMPUTER SERVICE+	.0	.0	1.0	1.0
62-1064	2.4	GAGE BLOCK STUDIES++	.0	.4	17.7	18.1
62-1066	1.2	STANDARD CELLS++	.0	.0	15.1	15.1
62-1080	9.2	BLACK BOX COMPUTER SERVICE+	.0	.0	80.6	80.6
62-1089	9.6	ELASTIC CONSTANTS++	.0	5.1	9.8	14.9
62-1102	6.8	BLACK BOX COMPUTER SERVICE+	.0	3.4	30.2	33.6
62-1123	10.3	BLACK BOX COMPUTER SERVICE+	.0	1.1	1.4	2.5
62-1125	9.5	MATRIX COMPUTATIONS	156.7	112.5	79.2	348.4
62-1133	5.0	CHEMISTRY CALCULATIONS++	.0	.0	.4	.4
62-1157	11.4	PLASMA RESEARCH++	.4	.0	.0	.4
62-1162	10.7	CEMENT AGING STUDIES++	53.6	80.6	5.3	139.5
62-1163	14.1	TRANSISTOR AGING BEHAVIOR++	14.3	27.4	17.0	58.7
62-1165	15.2	NMR SPECTRA ANALYSES+	.0	2.8	7.6	10.4
62-1181	12.4	NTDC++	8.6	15.3	.0	23.9
62-1185	10.3	HEAT TRANSFER CALCULATIONS+	50.7	131.0	92.9	274.6
62-1193	3.8	ELLIPTIC DIFFERENTIAL EQUATIONS	.0	.0	30.5	30.5
62-1194	15.1	MEMBRANE TRANSPORT++	20.9	34.7	.0	55.6
62-1195	7.2	LIGHT SCATTERING++	.0	38.7	.0	38.7
62-1203	3.7	CYLINDRICAL SHOCK WAVE	7.8	51.3	22.9	82.0
62-1211	12.5	TECHNICAL INFO RETRIEVAL++	3.0	7.7	.0	10.7
62-1212	10.9	COLOR DIFFERENCES	.0	12.5	.0	12.5
63-1224	9.7	ATOM PACK++	21.1	.0	19.5	40.6
63-1226	12.0	OTS - KWIC++	25.7	123.1	40.0	188.8
63-1228	3.7	SHOCK DISSOCIATION	17.2	66.9	46.1	130.2
63-1229	10.0	MORTAR BOND INVESTIG++	5.3	1.3	38.2	44.8
63-1230	15.2	LEAST SQUARES+	.0	.0	.4	.4
63-1231	13.0	BLACK BOX COMPUTER SERVICE+	3.4	18.8	4.8	27.0
63-1233	9.7	BLACK BOX COMPUTER SERVICE+	.0	1.1	.0	1.1
63-1234	10.3	VAPOR TRANSMISSION++	5.2	42.5	6.5	54.2
63-1237	3.1	PYROMETRY++	.0	2.6	.0	2.6
63-1238	10.3	CT TRUCK DATA ANALYSIS++	.0	12.1	15.4	27.5

Current Applications of Automatic Computer

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NBS SERVICES			(M I N U T E S)			
63-1241	12.5	IICASP++	3.7	37.6	18.9	60.2
63-1245	10.2	FIRE RESEARCH++	.0	.0	.3	.3
63-1248	15.4	CALCULATION OF FORCE CONSTANTS+	.0	1.5	.0	1.5
63-1250	12.0	KWIC++	1.9	35.8	7.5	45.2
63-1252	11.5	ARMY ORDNANCE++	.0	15.8	.0	15.8
63-1257	7.8	CALC OF CALCIUM PHOSPHATE++	.0	.0	12.6	12.6
63-1258	15.5	SPECTRUM ANALYSIS	.0	15.8	43.4	59.2
63-1259	11.3	RESEARCH IN PROBABILITY++	.0	2.8	20.7	23.5
63-1260	7.8	DENTAL RESEARCH	10.3	53.1	.0	63.4
63-1263	15.5	LINEAR CLASSICAL SYSTEM++	66.5	3.4	227.9	297.8
63-1276	14.2	INSTRUMENTATION++	3.7	26.1	.0	29.8
63-1277	1.2	BLACK BOX COMPUTER SERVICE++	.0	6.2	5.4	11.6
63-1278	4.7	TIME OF FLIGHT SPECTRUM++	25.0	111.0	73.1	209.1
63-1281	2.4	CORRECTION-SMEARING	.0	5.9	.0	5.9
63-1285	11.5	RTS FUNDS++	41.5	255.9	101.9	399.3
63-1287	3.7	DATA ANALYSES OF GASES++	.0	2.9	158.0	160.9
63-1288	10.3	TRUCK INFILTRATION++	3.1	15.4	1.2	19.7
63-1289	3.8	IONIZED GASES++	88.4	105.4	26.4	220.2
63-1290	3.0	MOLECULAR ENERGY LEVELS++	.0	20.3	.0	20.3
63-1291	7.1	JOB CALCULATIONS++	.0	44.9	13.4	58.3
63-1300	4.1	MAXIMUM SIGMA++	15.0	128.8	127.1	270.9
63-1302	7.3	COMPUTER CALCULATIONS++	.0	3.9	1.8	5.7
63-1308	2.5	BUTTRESS THREADS++	.0	4.1	.0	4.1
63-1309	4.2	LINEAR REGRESSION ANALYSIS++	.0	.0	15.3	15.3
63-1311	3.1	OMNITAB+	.0	.9	.0	.9
63-1312	3.7	CRO TRACE++	.0	1.8	2.3	4.1
63-1315	3.3	VIRIAL COEFFICIENTS++	.0	9.4	.0	9.4
63-1316	13.7	RECOMBINATION++	14.4	3.2	50.8	68.4
63-1318	10.3	THERMISTOR PROGRAM++	1.1	1.0	2.7	4.8
63-1319	6.1	BIQUADRATIC-BICUBIC EQUATION	.0	6.2	.0	6.2
63-1320	9.7	CRYSTAL STRUCTURE	.0	22.2	23.1	45.3
63-1321	13.6	OMNITAB+	.0	.0	7.4	7.4
63-1322	7.1	CHEMIST GENERAL++	.0	13.1	.0	13.1
63-1323	3.0	PLASMA TRANSPORT++	2.6	.0	115.9	118.5
63-1325	4.7	THERMOFLUX++	18.6	69.0	32.5	120.1
63-1326	3.2	HEAT MEASUREMENT++	.5	21.8	52.0	74.3
63-1328	10.7	LONG-TIME CEMENT STUDY 2++	15.6	.3	115.5	131.4
63-1329	10.7	LONG-TIME CEMENT STUDY 1++	75.5	6.4	126.3	208.2
63-1331	6.1	BLACK BOX COMPUTER SERVICE+	.0	1.2	.0	1.2
63-1332	3.1	TEMPERATURE PHYSICS++	.0	7.3	4.1	11.4
63-1333	2.2	BLACK BOX COMPUTER SERVICE+	24.1	19.1	5.8	49.0
63-1334	15.0	PHASE TRANSITION++	.0	53.8	2.7	56.5

Current Applications of Automatic Computer

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NBS SERVICES			(M I N U T E S)			
63-1335	13.7	MATRIX OF POLYNOMIALS	.0	15.6	.0	15.6
63-1337	12.0	RICASIP PT1++	1.6	.5	29.7	31.8
63-1338	15.4	SECTION COMPUTATIONS++	28.4	11.8	21.7	61.9
63-1340	3.3	FUNCTION OF TEMPERATURE++	.0	8.7	31.5	40.2
63-1341	13.2	LINE WIDTH	5.9	9.8	3.6	19.3
63-1342	6.1	OMNITAB+	.0	.4	.5	.9
63-1343	3.1	OMNITAB+	.0	12.8	.0	12.8
63-1348	5.2	SPECTROMETER	.0	5.2	.0	5.2
63-1349	12.5	COAST AND GEODETIC SURVEY++	51.6	20.5	.0	72.1
63-1351	1.2	TEST DATA++	.0	.0	48.8	48.8
63-1353	6.3	WAVES IN STRATIFIED FLUID	.0	2.6	1.6	4.2
63-1355	13.4	RUTILE BAND STRUCTURE	.0	.0	2.4	2.4
63-1359	13.5	OMNITAB+	.0	5.1	10.9	16.0
63-1364	14.4	BAF ELEMENT RESPONSE TIME	3.6	.4	1.1	5.1
63-1375	3.7	THERMAL PROPERTIES+	31.0	37.9	563.3	632.2
63-1376	15.0	OMNITAB+	.0	1.5	.0	1.5
63-1377	13.5	WHISKER GROWTH EQUATION	7.5	21.0	.0	28.5
63-1378	12.5	DCA++	12.4	6.0	2.0	20.4
63-1381	3.8	POLY-ELECTROLYTES	10.6	34.0	7.6	52.2
63-1382	2.3	SIGMA COMPUTATIONS	1.5	2.2	1.9	5.6
63-1383	9.0	KEY WORD INDEX++	.0	4.6	.0	4.6
63-1389	6.4	PROVING RINGS++	.0	11.1	2.8	13.9
63-1390	30.0	FOKKER-PLANCK	1.5	37.0	29.4	67.9
63-1392	2.4	INSTRUMENTAL SMEARING++	.0	2.4	3.4	5.8
63-3003	11.2	MACHINE TIME ONLY+++	25.5	69.8	.8	96.1
63-3005	11.2	FREE MACHINE TIME+++	.0	10.0	.0	10.0
63-3008	11.2	SECRETARYS MACHINE TIME+++	149.6	396.3	306.8	852.7
63-3010	11.2	NEW SYSTEMS+++	.0	1.8	34.1	35.9
Totals (NBS Services)			2188.2	5335.4	12106.2	19629.8

Current Applications of Automatic Computer

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NON-NBS SERVICES			(M I N U T E S)			
57-0216	NSF	HANDBOOK OF MATHEMATICAL TABLES	.4	1.7	.0	2.1
58-0348	OOR	MACHINE TRANSLATION OF RUSSIAN	22.5	38.1	1.7	62.3
58-0366	USIA	RADIATION PATTERNS OF ANTENNAS	.0	.0	2.0	2.0
59-0407	DOFL	FOURIER COEFFICIENTS+	18.4	9.3	13.1	40.8
59-0409	FSLIC	BANK BOARD REPORTS++	13.6	262.1	2281.3	2557.0
59-0425	CU	MOLECULAR ORBITALS+	159.4	81.9	174.5	415.8
59-0434	GC	PETROLOGICAL COMPUTATIONS+	.0	116.2	26.4	142.6
59-0441	USRED	SYSTEMS ENGINEERING++	8.4	225.9	57.6	291.9
60-0457	PHA	PUBLIC HOUSING PROBLEM++	4.9	30.7	181.9	217.5
60-0476	DOFL	GAS TUBE CHARACTERISTIC II	.0	.0	538.1	538.1
60-0486	U ONT	MORSE WAVE FUNCTION++	.0	.0	24.7	24.7
60-0492	IMF	MONETARY RESEARCH REPORTS++	10.0	107.1	94.3	211.4
60-0506	WBANK	WORLD BANK REPORTS++	.0	.0	52.0	52.0
61-0513	NASA	ORBITING STUDIES	9.9	.0	25.1	35.0
61-0532	GU	VIBRATIONAL ENERGY LEVELS+	12.6	49.1	54.2	115.9
61-0540	ACC	DIFFUSION CALCULATIONS+	3.7	.0	25.9	29.6
61-0550	GWU	LOGISTICS RESEARCH++	.0	24.0	.0	24.0
61-0569	AGO	HUMAN FACTORS RESEARCH++	65.8	405.7	191.1	662.6
61-0830	BPR	HIGHWAY TRAFFIC STUDIES++	4.6	4.2	722.1	730.9
61-0849	BPR	HIGHWAY TRAFFIC STUDIES++	.0	.0	540.0	540.0
61-0902	BPR	HIGHWAY TRAFFIC STUDIES++	.0	.0	385.9	385.9
61-0903	BPR	HIGHWAY TRAFFIC STUDIES++	39.9	65.3	1489.3	1594.5
61-0945	WB	FORECASTING++	.0	1.9	3943.0	3944.9
62-1004	BUSHP	RHOMBIC ANTENNAS+	.0	18.7	124.8	143.5
62-1014	NIH	METABOLIC DISEASES++	257.5	427.2	814.8	1499.5
62-1018	NRL	HYDROMAGNETIC PROBLEMS+	100.9	292.7	1541.7	1935.3
62-1021	DCH	HIGHWAY STUDIES++	195.4	401.9	3382.4	3979.7
62-1022	NRL	SPECTRUM OF DIPOLE RADIATION	.0	.0	30.5	30.5
62-1023	NSF	IMAGE PROCESSING++	.0	17.9	41.9	59.8
62-1030	VA	ELECTROCARDIOGRAPHIC ANALYSIS	438.7	1634.4	739.9	2813.0
62-1044	FCC	RADIO INTENSITIES++	.0	.0	10.7	10.7
62-1030	VA	ELECTROCARDIOGRAPHIC ANALYSIS	1.0	.0	.0	1.0
62-1044	FCC	RADIO INTENSITIES++	11.8	20.8	35.6	68.2
62-1046	BPR	TRAFFIC PREDICTION++	329.8	977.1	846.5	2153.4
62-1056	DOFL	PD ENGINEERING++++	.0	.0	295.5	295.5
62-1071	DOFL	RHINITIS STUDIES++	4.0	9.2	6.3	19.5
62-1076	NAS	EVALUATION OF APPLICATIONS+	43.0	71.0	58.2	172.2
62-1096	DOFL	VULNERABILITY STUDY++++	30.6	359.6	275.9	666.1
62-1110	ICC	ICC SYSTEMS STUDY++	34.8	60.0	21.3	116.1
62-1113	DOFL	TRANSPORT ANALYSES++++	25.9	26.4	177.4	229.7
62-1119	BPR	HIGHWAY TRAFFIC STUDIES++	.0	.0	310.1	310.1
62-1121	CARIN	CARNEGIE INSTITUTE STUDIES++	13.1	73.3	.0	86.4

Current Applications of Automatic Computer

TASK NUMBER		TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NON-NBS SERVICES			(M	I N	U T E	S)
62-1130	COENG	FALLOUT SHELTER COMPUTATIONS	1.8	74.8	382.8	459.4
62-1131	USIA	CANTILEVER RETAINING WALL++	3.0	15.5	3.0	21.5
62-1134	HARVU	STATISTICAL DECISION THEORY++	.0	16.8	1.8	18.6
62-1140	VA	VA MEDICAL++	3.4	.0	839.7	843.1
62-1141	COENG	FALLOUT SHELTER COMPUTATIONS	.0	.0	92.5	92.5
62-1144	UOFMD	THERMAL BOUNDARY LAYERS	.0	.0	28.8	28.8
62-1146	BPR	GRAVITY MODEL STUDIES++	1.4	8.8	449.9	460.1
62-1158	GC	MINERALOGY STUDIES++	1.2	33.3	219.9	254.4
62-1169	U ONT	ATOMIC COLLISIONS++	23.6	.0	37.7	61.3
62-1171	VA	HOSPITAL PROGRAM PLANNING+	152.9	247.6	108.3	508.8
62-1172	PEACE	PEACE CORPS EVALUATIONS++	3.8	3.6	8.4	15.8
62-1175	DOFL	ION DISTRIBUTIONS+	.0	3.8	68.2	72.0
62-1177	DOFL	ANALYSIS OF VARIANTS+	.0	.0	3.5	3.5
62-1179	DOFL	CATALOG INFORMATION+	.0	.0	11.3	11.3
62-1188	FTBEL	STEPWISE REGRESSION+	.0	21.5	192.5	214.0
62-1189	QM	TABLES FOR SEQUENTIAL METHODS	3.4	44.6	1051.2	1099.2
62-1197	UOFMD	HIGH ENERGY PHYSICS++	.0	.0	510.0	510.0
62-1201	FCC	UHF TV	2.1	33.2	112.2	147.5
62-1215	NASA	MISSILE SATELLITE++	15.8	3.5	403.8	423.1
62-1216	BPR	ARIZONA++	.0	3.0	12.4	15.4
63-1218	DOFL	INTEGRAL EVALUATION	.0	.0	1.5	1.5
63-1221	BPR	RHODE ISLAND++	.0	2.7	38.8	41.5
63-1225	OQMG	LINEAR AND NON LINEAR ESTIM++	1.0	.0	.0	1.0
63-1227	FTBEL	ARMY GENERATOR NOISE++	34.9	14.5	25.7	75.1
63-1232	NORAD	MISSILES++	129.2	363.4	81.9	574.5
63-1236	COMM	DATATROL++	94.3	14.9	31.6	140.8
63-1239	PHS	PUBLIC HEALTH SERVICE++	.0	.0	21.2	21.2
63-1240	TREAS	SECRET SERVICE FORGERY	.0	.0	14.5	14.5
63-1243	WSMAS	HIGHWAY STUDIES++	.0	5.5	37.5	43.0
63-1246	PHS	SCREENING EVALUATION+	16.4	63.9	.4	80.7
63-1249	RC	ISOTOPE TRACER ANALYSIS++	.0	.0	3.8	3.8
63-1253	GU	BLACK BOX COMPUTER SERVICE++	12.4	88.1	39.7	140.2
63-1254	DEFCO	HIGH FREQUENCY PROPAGATION++	43.3	227.3	313.4	584.0
63-1256	NCTA	TRANSIT STUDY++	5.7	9.2	754.6	769.5
63-1262	NRL	NUCLEONICS++	227.4	142.9	427.9	798.2
63-1264	NRL	NUCLEONICS++	.0	.0	1029.4	1029.4
63-1270	BPR	MODAL SPLIT PROCEDURE++	.0	85.6	917.3	1002.9
63-1271	COMM	ECONOMICS STUDY++	11.3	23.4	153.0	187.7
63-1272	BPR	ROADS STUDY++	4.6	5.4	474.6	484.6
63-1274	FTBEL	NUCLEAR UTILITY SERVICES++	64.2	.0	13.8	78.0
63-1275	SEC	SECURITIES MARKET STUDY++	8.0	210.2	313.4	531.6
63-1280	UARIZ	NIH++	23.2	23.8	8.8	55.8

Current Applications of Automatic Computer

TASK NUMBER	TITLE	ASSEMBLY TIME	CODE CHECKING	PRODUCTION TIME	TOTAL TIME ON COMPUTER
NON-NBS SERVICES		(M I N U T E S)			
63-1284 DOFL	STATISTICAL ANALYSIS++	.0	.0	2.4	2.4
63-1286 UOFMD	OPTIMAL EXAMINATION	.0	34.0	.0	34.0
63-1293 COMM	BODDY CALCULATION++	.0	38.6	.4	39.0
63-1296 DOFL	OPTIMUM LIFE++	74.2	374.7	1.5	450.4
63-1298 DOFL	LITTLE JOHN SPARE PARTS++	.0	.0	82.8	82.8
63-1301 DOFL	SERGEANT SPARE PARTS++	.0	.0	85.1	85.1
63-1303 UCLA	LOS ANGELES HEART STUDY++	.0	16.7	6.5	23.2
63-1305 DSA	ARMY++	100.6	1019.3	1582.5	2702.4
63-1307 DOFL	MISCELLANEOUS PROGRAMMING++	.8	9.7	.0	10.5
63-1310 DOFL	SHOCK WAVE TEST++	.7	43.7	3.2	47.6
63-1313 IDA	OMNITAB+	.0	.5	95.7	96.2
63-1314 BPR	FLORIDA HIGHWAYS++	.0	.0	42.7	42.7
63-1317 AID	SORTING AND TABULATING	2.8	2.7	8.9	14.4
63-1324 HEW	GENERAL KINETICS++	89.6	547.1	42.0	678.7
63-1330 BROOK	INVESTMENT++	.0	.0	61.9	61.9
63-1336 NAVWE	ARC++	70.6	1.8	5551.5	5623.9
63-1339 DOFL	TRAPEZOIDAL PLATE++	10.1	23.6	.0	33.7
63-1345 DOFL	ROCKET TRAJECTORIES++	56.7	71.6	22.5	150.8
63-1352 OCDM	NEAR	.0	1.2	524.3	525.5
63-1356 NIH	COMPUTER CONSULTING	195.9	14.9	55.3	266.1
63-1357 BPR	HIGHWAY STUDIES++	3.4	19.6	252.8	275.8
63-1358 PHS	TRAINING GRANTS	128.2	171.1	224.8	524.1
63-1360 FPC	FEDERAL POWER COMMISSION++	.0	.0	35.2	35.2
63-1361 DOFL	ANTENNA CALCULATION++	4.7	8.0	21.7	34.4
63-1362 VA	RESEARCH++	.0	.0	107.5	107.5
63-1367 BPR	PUBLIC ROADS++	1.1	.0	28.4	29.5
63-1368 PHS	HEART DISEASE	5.0	.0	.0	5.0
63-1371 TREAS	ALTERNATE TAX PLANS++	18.0	3.5	30.4	51.9
63-1374 OCDM	FEDERAL RESEARCH++	46.1	67.6	138.7	252.4
63-1379 BPR	PUBLIC ROADS++	.0	.0	12.4	12.4
63-1386 BPR	PUBLIC ROADS++	.0	.0	10.3	10.3
63-1387 DOFL	MAGNETOSTATIC MODES++	.0	.0	1.9	1.9
	Totals ((NON-NBS Services)	3557.4	10074.1	37811.7	51443.2
	TOTAL TIME FOR THE QUARTER (MINUTES)	5745.6	15409.5	49917.9	71073.0

Current Applications of Automatic Computer

\+ Problem programmed in the Computation Laboratory, production runs continued under direction of sponsor.

++ Problem programmed by the sponsor and run under his direction.

+++ Functions pertain to the internal operations of the Computation Laboratory.

++++ Classified task.

Lectures and Technical Meetings

Note: In general, copies of papers or talks listed in this section are not available from the National Bureau of Standards. If and when a paper is to be published, it will be listed in the section of this report on Publication Activities.

Applied Mathematics Division Lectures

MARCUS, M. (University of California, Santa Barbara, California) Series five lectures on selected topics in linear algebra. April 8, 1963 to April 12, 1963.

OSTROWSKI, A.M. (Graduate Institute for Mathematics and Mechanics, Indiana) (i) Positive Matrices. April 22, 1963. (ii) Runge's Rule of Signs in the Theory of Algebraic Equations. April 23, 1963.

GOODWIN, E.T. (National Physical Laboratory, Great Britain) On Richardson's Deferred Approach to the Limit. May 7, 1963.

HELLER, I. (Stanford University) Representation and Classification of Unimodular Sets. May 20, 1963.

MORDELL, L.J. (University of Arizona, Arizona) On a Certain Diophantine Equation. May 27, 1963.

GUPTA, H. (Panjab University, India) Recent Results in the Theory of Partitions. June 12, 1963.

Seminar in Mathematics

A series of weekly seminars led by Dr. Seymour Haber with the cooperation of Dr. B. Bernstein, was conducted to cover the Princeton lecture notes, "Advanced Calculus" by H. K. Nickerson, D.C. Spencer, and N. E. Steenrod (D. Van Nostrand Co., 1959). January to April, 1963.

Lectures and Technical Meetings

Papers and Invited Talks Presented by Members of the Staff at Meetings of Outside Organizations

ARMS, R. J. On the Limit Behavior of Steepest Descent, Preliminary Report. Presented before the American Mathematical Society.
Berkeley, California January 21, 1963

DAVIS, P. J. The Computation of Highly Multiple Integrals. Presented at NBS Boulder.
Boulder, Colorado January 30, 1963
Of Men and Mathematics. Presented at the Maryland, Delaware, Virginia section of the MAA.
Annapolis, Maryland April 1963

EDMONDS, J. Maximum Degree-Constrained Subgraphs. Presented at the Graph and Combinatorics Conference, Princeton University.
Princeton, New Jersey May 18, 1963

GOLDMAN, A. J. Examples of OR Applications in the Federal Government. Presented at the Operations Research Orientation. General Accounting Office.
Washington, D.C. April 2, 1963
Examples of OR Applications in the Federal Government. Presented at the Management Sciences Orientation. General Accounting Office.
Washington, D.C. April 24, 1963
A Theorem on Convex Programming. Presented at the Mathematical Association of America. U.S. Naval Academy.
Annapolis, Maryland April 27, 1963

MATHER, J. The Planar Immersions of a Graph. Presented at the Graph and Combinatorics Conference, Princeton University.
Princeton, New Jersey May 16, 1963

MEYERS, P. A Comparison of One and Two Stage Coding for Mail. Presented at the 23rd National Meeting of Operations Research Society of America.
Cleveland, Ohio May 28, 1963

NEWMAN, M. Normal Congruence Subgroups of the Modular Group. Presented at Combinatorial Seminar.
Princeton, New Jersey March 25, 1963

RHODES, I. Mechanical Translation by Means of Computers. (Westinghouse Science Talent Search, Statler Hilton Hotel.)
Washington, D.C. February 28, 1963

Lectures and Technical Meetings

ROCKOFF, M. L. On the Numerical Solution of Finite Difference Approximations which are not of Positive Type. Presented before the Am. Math. Society. Berkeley, California. January 24, 1963

ROMANO, Albert, Distributions in Reliability Studies. Presented in the 1963 Reliability Training Program of the Washington Section, American Society for Quality Control at Georgetown Univ.
Washington, D.C. April 16, 1963

ROSENBLATT, Joan R., Moderator on "Ask the Scientists" panel discussion. Sponsored by Joint Board on Science Education, Georgetown Visitation School.
Washington, D.C. March 30, 1963
Panel discussion on activities of the Committee on Women in Science, of the Joint Board on Science Education. This discussion was taped and broadcast by the Georgetown Univ. Forum over Radio Station WTTG and TV Channel 5.
Washington, D.C. April 7, 1963
Applications of Statistics in Colorimetry. Presented at the Department of Statistics, Harvard University.
Cambridge, Massachusetts April 10, 1963

TCHEN, C. T. Participated in the 4th International Space Science Symposium.
Warsaw, Poland June 3-11, 1963
Kinetic Problems in Plasmas. Presented at Plasma Physics Institute.
Garching, Germany June 18, 1963
Kinetic Equation and Landau Demping. Presented at the Institute for High Temperature Research, Technical Univ.
Stuttgart, Germany June 19, 1963
Kinetic Equations of Plasmas. Presented at the Institute for the Structure of Materials, Philipps University.
Marburg, Germany June 21, 1963
Interaction of Plasma Flows with Magnetic Fields. Presented at the Laboratorium voor Massascheiding.
Amsterdam, Netherlands June 24, 1963
Kinetic Theories of Plasmas. Presented at the Institute Battelle, Centre de Recherche de Geneve.
Geneva, Switzerland June 28, 1963
Plasma Oscillations with Collective Correlations, and Interaction of a Plasma Source with a Uniform Magnetic Field. Presented at the 6th International Symposium on Ionization Phenomena in Gases.
Paris, France July 8-13, 1963

Lectures and Technical Meetings

WEISS, George, The Theory of Pedestrian Queueing. Presented at the Operations Research Society Meeting.
Cleveland, Ohio May 27, 1963

WITZGALL, C. On Edmond's Algorithm for Maximum Matchings of Graphs. Presented for the Department of Mathematics, The Institute for Fluid Dynamics and Applied Mathematics, University of Maryland.
College Park, Maryland March 8, 1963
On Convex Metrics. Presented at the Mathematical Association of America, U. S. Naval Academy.
Annapolis, Maryland April 27, 1963

YOUDEN, W. J., Measurement and Science. Presented at the Maryland-D.C. Conference on Junior High School Science, Nicholas Orem Junior High School.
Hyattsville, Maryland February 16, 1963
Measurement and Science. Presented at the Science Seminar, Immaculata High School.
Washington, D.C. February 18, 1963
Checking Calibrations. Presented at the Cleveland Electronics Conference.
Cleveland, Ohio April 17, 1963
Interpretation and Evaluation of Analytical Data. Presented at a meeting of the American Chemical Society.
Philadelphia, Pennsylvania April 18, 1963
Precision and Accuracy in Spectrochemical Analysis. Presented at a meeting of Baltimore-Washington Chapter of the Spectroscopy Society.
Washington, D.C. April 23, 1963
Precision and Accuracy in Spectrochemical Analysis. Presented before the Society for Applied Spectroscopy.
Cleveland, Ohio May 15, 1963
Picking Winners and Losers. Symposium at Virginia Polytechnic Institute.
Blacksburg, Virginia April 25, 1963
Picking Winners and Losers. Presented before the American Society for Quality Control.
Detroit, Michigan May 1, 1963
Analytical Procedures. Seminar presented to the Statistical Group of the Food and Drug Administration.
Washington, D.C. June 4, 1963
Simplified Statistical Quantity Control. Presented at the 48th National Conference on Weights and Measures.
Washington, D.C. June 13, 1963

Publication Activities

1. PUBLICATIONS THAT APPEARED DURING THIS PERIOD

1.1 Mathematical Tables

Tables Describing Small-Sample Properties of the Mean, Median, Standard Deviation, and Other Statistics in Sampling from Various Distributions. Churchill Eisenhart, Lola S. Deming and Celia S. Martin. NBS Technical Note 191. June 1963.

1.2 Manuals, Bibliographies, Indices

Selected Bibliography of Statistical Literature: supplement, 1958-1960. Lola S. Deming. Journal of Research NBS, Section B (Mathematics and Mathematical Physics). 67B, pp. 91-133, April-June 1963.

Statistical Interpretations. W. J. Youden. Standard Methods for Chemical Analysis, 6, pp. 318-325, D. Van Nostrand Co., Inc., New York, 1963.

Statistics in Chemical Analysis. W. J. Youden. Handbook of Analytica Chemistry, pp. 14-1 to 14-9, McGraw-Hill Book Co. Inc., New York,1963

1.3 Technical Papers

An Algorithm for Obtaining an Orthogonal Set of Individual Degrees of Freedom for Error. J. M. Cameron. Journal of Research NBS, Section B (Mathematics and Mathematical Physics) 67B, 19-22, January - March 1963.

The Segmental Variation of Blaschke Products. G. T. Cargo. Duke Mathematical Journal, 30, No. 1, pp. 143-150, March 1963.

Packing Inequalities for Circles. P. Davis. Michigan Math. J. 10, pp. 25-31, March 1963.

Uniqueness Classes for Difference Functionals. R. F. DeMar. Notices, American Mathematical Society, Vol. 10, No. 1, p. 91, January 1963.

Publication Activities

Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems. Churchill Eisenhart. Journal of Research NBS, Section C (Engineering and Instrumentation) 67C, No. 2, pp. 161-187, 1963.

Tables of Genera of Groups of Linear Fractional Transformations. H. Fell, M. Newman and E. Ordman. Journal of Research NBS, 67B, pp. 61-68, 1963.

Recognition of Completely Mixed Games. A. J. Goldman. Journal of Research NBS, 67B, pp. 23-29, 1963.

Maximal Cellular Boolean Functions. A. J. Goldman and B. K. Bender. Journal of Research NBS, 67B, pp. 77-84, 1963.

Copositive and Completely Positive Quadratic Forms. M. Hall and M. Newman. Proceedings of the Cambridge Philosophical Society, 59, pp. 329-339, 1963.

Factorial Designs and the Direct Product. Badrig Kurkjian. (Harry Diamond Laboratories) and Marvin Zelen. Bulletin International Statistical Institute, XXXIX, Part 2, pp. 509-519, 1962.

A Note on Modular Groups. M. Newman. Proceedings of the American Mathematical Society, 14, pp. 124-125, 1963.

Bounds for Cofactors and Arithmetic Minima of Quadratic Forms. M. Newman. Journal of the London Mathematical Society, 38, pp. 215-217, 1963.

Modulary Groups of t x t Matrices. M. Newman and J. R. Smart. Duke Journal of Mathematics, 30, pp. 253-257, 1963.

Confidence Limits for the Reliability of Complex Systems. Joan Raup Rosenblatt. Statistical Theory of Reliability, (edited by Marvin Zelen, The University of Wisconsin Press, Madison) pp. 115-148, 1963.

Mean First Passage Times and the Dissociation of Diatomic Molecules. Kurt Shuler (Institute for Defense Analyses) and George Weiss. Journal of Chemical Physics, 38, pp. 505-509, January 1963.

Precision of Simultaneous Measurement Procedures. W. A. Thompson, Jr., Journal of the American Statistical Association, 58, No. 302, pp. 474-479, June 1963.

Publication Activities

A survey of Some Mathematical Models in the Theory of Reliability. George Weiss. Statistical Theory of Reliability, (edited by Marvin Zelen, The University of Wisconsin Press, Madison) pp. 3-15, 1963.

On the Pedestrian Queueing Problem. George Weiss. Bulletin International Statistical Institute, XXXIX, Part 4, pp. 163-168, 1962.

The Collaborative Test. W. J. Youden. Journal of the Association of Official Agricultural Chemists, 46, pp. 55-62, February 1963.

Uncertainties in Calibration. W. J. Youden. IRE Transactions on Instrumentation I-11, Nos. 3 and 4, pp. 133-138, December 1962.

1.4 Reviews and Notes

Review of "Systems: Research and Design." A. J. Goldman. Technometrics 5, pp. 130-131, 1963.

2. MANUSCRIPTS IN THE PROCESS OF PUBLICATION

2.2 Manuals, Bibliographies and Indices

"Experimental Statistics". Mary G. Natrella. To appear August 1, 1963 as NBS Handbook 91. In press.

2.3 Technical Papers

A Study of Stress Relaxation with Finite Strain. B. Bernstein (with E. A. Kearsley and L. Zapas). To appear in the Transactions of the Society of Rheology.

Mathematical Models for Personnel Promotion. E. L. Crow (Boulder Laboratories) and George Weiss. Submitted to a technical journal.

A Uniqueness Theorem. R. F. DeMar. To be published in Proceedings of the American Mathematical Society.

On a Theorem Concerning Existence of Interpolating Functions. R. F. DeMar. Submitted to the Transactions of the American Mathematical Society.

Higher Approximations with the Stroboscopic Method. A. Ghaffari. To appear in the Proceedings of the Second International Conference on Non-linear Vibrations, Warsaw, Poland, September 18-21, 1962.

Publication Activities

A Recurrance on Integral Vectors. K. Goldberg. In manuscript.

Hadamard Matrices of Order Cube Plus One. K. Goldberg. In manuscript.

Random Notes on Combinalysis. K. Goldberg. In manuscript.

The Powers of the Iterates of a Formal Power Series. K. Goldberg. In manuscript.

Incidence Spaces and Algebras. K. Goldberg and E. C. Dade. In Manuscript.

Group Generated Incidence Spaces and Applications. K. Goldberg and E. C. Dade. In manuscript.

A Proposed Computer Based Model. K. Goldberg and J. G. Reed. In manuscript.

A Note on Contingency Tables Involving Zero Frequencies and the $2\hat{I}$ Test. H. H. Ku. To appear in Technometrics.

Weierstrass' Points of $\Gamma_o(n)$. J. Lehner and M. Newman. To appear in Annals of Mathematical Statistics.

Syntactic Integration Carried out Mechanically. Ida Rhodes. Proceedings of the Nato Advanced Study Institute of Languages, Journal of Information Storage and Retreval, Pergamon Press Ltd. Venice, 1962.

The Method for Mechanical Translation Used by the NBS Group and the Structure of its Machine Glossary. Ida Rhodes. To appear in the Proceedings of the American Documentation Institute, Chicago, 1963.

Sympletic Modulary Groups. M. Newman and J. R. Smart. To appear in Acta Arithmetica.

Long Term Distribution of Received Power. M. M. Siddiqui (Boulder Laboratories) and George Weiss. To appear in Journal of Research NBS, Section D (Radio Propagation).

On a Rank Sum Test for Outliers. W. A. Thompson, Jr., and T. A. Willke. To appear in Biometrika.

Zonal Harmonic Perturbations of an Accurate Reference Orbit of an Artificial Satellite. J. P. Vinti. Submitted to a technical journal.

An Editorial for "The Physics Teacher". W. J. Youden. Submitted to The Physics Teacher.

Publication Activities

Mathematics and Experimental Science. W. J. Youden. Submitted to The Science Teacher.

Measurement Agreement Comparisons. W. J. Youden. To be published by NBS in Proceedings, National Conference of Standards Laboratories.

Simplified Statistical Quantity Control. W. J. Youden. To appear in Proceedings, 48th National Conference on Weights and Measures.

Approximating Symmetric Relations by Equivalence Relations. C.T. Zahn, Jr. To be submitted to a technical journal.

USCOMM-NBS-DC-18,603

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Tropospheric and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics - NBS Group (Univ. of Colo.).


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