NATIONAL BUREAU OF STANDARDS REPORT

7330

PROJECTS and PUBLICATIONS

of the

APPLIED MATHEMATICS DIVISION

A Quarterly Report

April through June 1961

For Official Distribution

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

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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 25, D. C.

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

APPLIED MATHEMATICS DIVISION

April 1 through June 30, 1961

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Harry J. Weiss, Ph.D.°

*Guest Worker °Temporary appointment **Part time

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*Only unclassified projects are included in this report.

Status of Projects

June 30, 1961

1. NUMERICAL ANALYSIS

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

Origin: NBS Authorized 8/29/54
Manager: P. Davis
Full task description: July-Sept 1954 issue, p. 1

Status: CONTINUED. O. Shisha has worked in the following areas: (i) Tchebycheff approximation by rational functions and by polynomials, with stress on the computational aspect; (ii) C^{∞} functions related to the theory of absolutely monotonic functions; (iii) structure and geometry of the zeros of infrapolynomials with prescribed coefficients.

P. Davis and O. Shisha are continuing their preparation of a survey on the theory of the transfinite diameter.

M. Marcus assisted F. May and W. Gordon in completing and revising the manuscript on "Integral matrices" by M. Newman. It is currently being prepared for publication. In generalizing the results of H.J. Ryser, M. Marcus and W. Gordon have completed a manuscript on inequalities with combinatorial applications. M. Marcus and F. May have completed a manuscript entitled "On the maximum number of zeros in the powers of an indecomposable matrix", which was submitted to a technical journal for publication. Notes by H. Minc on Eigenvalue Inequalities have been received and edited for publication by Harriet Fell. This material was covered in five lectures recently presented at NBS by H. Minc; it also included an exhaustive bibliography. Currently, research investigations on matrix functions of combinatorial interest are being conducted by M. Marcus, W. Gordon, and H. Minc.

S. Haber investigated the propagation of error in numerical solutions of ordinary differential equations and the comparison of various Runge-Kutta procedures.

K. Kloss prepared a series of codes designed to find a prime p such that a given polynomial has an irreducible factor of given degree, modulo p.

Publications:

(1) On approximation by analytic functions whose Taylor coefficients lie in a sector. O. Shisha. Abstract: Notices, American Mathematical Society, 8, 3, 275 (June 1961).
(2) Split integration methods for simultaneous equations. J.R. Rice. Submitted to a technical journal.
(3) Tchebycheff approximations by functions unisolvent of variable degree. J.R. Rice. To appear in the Transactions of the American Mathematical Society.

Status of Projects

(4) Regions containing the characteristic roots of a matrix. E. Haynsworth. Submitted to a technical journal.
(5) Best approximations and interpolating functions. J.R. Rice. To appear in the Transactions of the American Mathematical Society.
(6) Criteria for the reality of matrix eigenvalues. M.P. Drazin (RIAS) and E.V. Haynsworth. Submitted to a technical journal.
(7) Another extension of Heinz's inequality. M. Marcus. Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), 129-130 (1961).
(8) A note on normal matrices. M. Marcus and N. Khan (Muslim University, India). To appear in the Canadian Mathematical Bulletin.
(9) The invariance of symmetric functions of singular values. M. Marcus and H. Minc (The University of Florida). Submitted to a technical journal.
(10) Comparison theorems for symmetric functions of characteristic roots. M. Marcus. Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), 113-115 (1961).
(11) Symmetric means and matrix inequalities. M. Marcus and P. Bullen (University of British Columbia). Proceedings of the American Mathematical Society, 12, 2, 285-290 (April 1961).
(12) On the relation between the permanent and the determinant. M. Marcus and H. Minc (The University of Florida). To appear in the Illinois Journal of Mathematics.
(13) Linear operations on matrices. M. Marcus. In manuscript.
(14) Lower bounds for eigenvalues of Schroedinger's equation. N.W. Bazley and D.W. Fox (Applied Physics Laboratory, JHU). To appear in the Physical Review.
(15) Truncations in the method of intermediate problems for lower bounds to eigenvalues. N.W. Bazley and D.W. Fox (Applied Physics Laboratory, JHU). Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), 105-111 (1961).
(16) Optimal approximation for functions prescribed at equally spaced points. H.F. Weinberger. Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), 99-104 (1961).

OPERATIONS RESEARCH
Task 1101-12-11115/61-546

Origin: NBS Authorized 12/30/60
Manager: A.J. Goldman
Full Task Description: Oct.-Dec. 1960 issue, p. 3

Status: CONTINUED. B.K. Bender continued work on the IBM 704 Boolean simplification program, and on the derivation of additional simplification rules. B.K. Bender and A.J. Goldman continued preparation of papers on related theoretical questions; an 8-variable function with an absolutely superfluous prime implicant but no essential prime implicants was constructed.

Status of Projects

J. Edmonds defined a Hungarian set of a graph to be an isolated set of vertices whose cardinality exceeds that of its neighbor-set, and proved that a graph has no Hungarian set, if and only if it has a subgraph containing all the graph's vertices, with only single edges and odd circuits as components. The proof involves an algorithm which produces either a Hungarian set (if one exists) or a subgraph of the type just described. This algorithm can be used to generalize the Egervary-Kuhn "Hungarian method" for the assignment problem, to the problem of minimizing $x_1 + \ldots + x_n$ subject to constraints $x_i + x_j \geq r_{ij}$ for a specified set of unordered pairs (i, j). Namely, regard each variable as a vertex; for any particular set of values obeying the constraint, regard (x_i, x_j) as an edge if and only if $x_i + x_j = r_{ij}$ for those values. Theorem: a set of values solves the problem if and only if the corresponding graph has no Hungarian set. (If a Hungarian set does exist, it can be used in a straightforward way to find a new set of values yielding a lower value for the objective function.)

C.T. Zahn, Jr. investigated some cases of the problem of approximating a symmetric reflexive binary relation R by an equivalence relation E so as to minimize the cardinality of the symmetric difference of R and E; as noted by J. Edmonds, this problem arises in finding a "good" way of partitioning an interconnected system into disjoint subsystems. Zahn considered the situation in which R's graph consisted of complete graphs $G_1, \ldots, G_n$, unrelated except for a distinguished element a_i in G_i such that $a_1, \ldots, a_n$ also form a complete graph G. For the case in which each G_i has the same cardinality m, he showed that the graph of an optimizing E consists of (i) the union of G, $G_1-a_1, \ldots, G_n-a_n$ if $n \geq 2m-1$, and (ii) the union of $G_1, \ldots, G_n$ if $n \leq 2m-1$.

Publications:

(1) Some results on Boolean functions. B.K. Bender (11.2) and A.J. Goldman. In manuscript.
(2) On the range of a fleet of aircraft. A.J. Goldman. To appear in the Journal of Research NBS, Sec. B (Mathematics and Mathematical Physics)

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: M. Newman
Full task description: July-Sept. 1954 issue, p. 5

Status: CONTINUED. K. Goldberg continued his investigations of equalities which imply inequalities with the emphasis on those involving normal matrices and linear recursions.

K. Goldberg and J. Gager prepared further tests of the baseball model for the computer.

Status of Projects

Publications:

(1) Congruence properties of the partition function to composite moduli. M. Newman. To appear in the Illinois Journal of Mathematics.

(2) Some geometrical theorems for abscissas and weights of Gauss type. P. Davis and P. Rabinowitz. To appear in the Journal of Mathematical Analysis and Applications.

(3) A comment on Ryser's "Normal and Integral Implies Incidence" theorem. K. Goldberg. To appear in the American Mathematical Monthly.

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: I.A. Stegun
Full task description: Oct.-Dec. 1956 issue, p. 10

Status: CONTINUED. The text for chapter 8 (Legendre functions), chapter 18 (Weierstrass elliptic functions), and chapter 24 (Combinatorial analysis) are undergoing revision. Preliminary tables for the respective chapters are being prepared. Review of remaining chapters continues for consistency of notation, updating of references, cross-references, etc.

AUTOMATIC CODING
Task 1102-12-11120/55-65

Origin: NBS Authorized 9/29/54
Manager: J. Wegstein
Full task description: July-Sept. 1954 issue, p. 11

Status: CONTINUED. The preliminary design of a string manipulating language based on the ALGOL 60 language was completed. The utility of this language was tested by programming various data processing problems such as formula translations, English-sentence generation, report generating, file maintenance, and output editing. Work was begun on the design of IBM 704 subroutines for implementing the string language on the IBM 704 computer.

Status of Projects

MATHEMATICAL SUBROUTINES
Task 3911-61-39952/56-160

Origin: NBS Authorized 9/30/55
Managers: Staff
Full task description: July-Sept. 1955 issue, p. 13

Status: TERMINATED.

3. PROBABILITY AND MATHEMATICAL STATISTICS

MISCELLANEOUS STUDIES IN PROBABILITY AND STATISTICS
Task 1103-12-11131/51-2

Origin: NBS Authorized 7/1/50
Manager: C. Eisenhart
Full task description: July-Sept. 1950 issue, p. 58

Status: CONTINUED. Mary C. Dannemiller Croarkin has completed computations for the table of the non-centrality parameter of the non-central χ^2-distribution as a function of the degrees of freedom and the Type I and II errors. This essentially completes the computations of tables of the power function for analysis-of-variance procedures which NBS has been computing for the past decade.

J. Van Dyke prepared a working paper entitled "Numerical Investigation of the Random Variable $y = C(u^\lambda - (1-u)^\lambda)$", summarizing computations which determine values of C and λ for which the random variable y (where u is uniformly distributed on the unit interval) provides a "good" approximation to the distribution of Student's t. A memorandum by J.W. Tukey (Princeton University), describes the purpose of these calculations, and is incorporated in the working paper.

J. Cameron and M. Zelen are preparing an expository paper on the Theory of Least Squares with particular attention to restraints. This paper contains a proof of the fundamental Gauss-Markoff theorem which relies only on the use of the pseudo-inverse of a matrix.

A. Smith and J. Van Dyke completed evaluation of the α-Probability points, $P_\alpha(p_o,n)$, of the coverage distributions corresponding to Wilks' unbiased tolerance intervals $(\bar{x} - ks, \bar{x} + ks)$, where $k = k(p_o,n)$, in samples of size n = 5(1) 10, 12, 15, 20, 30, 60, from a normal distribution, for mean coverages p_o = 0.50, 0.95, and α = .005, .01, .025, .05, .10, .20, .25, .50, .75, .80, .90, .95, .975, .99, .995. Their results are given to 2S in P_α or $1-P_\alpha$ according as P_α is less or greater than one-half.

A joint paper on this work, entitled "Probability Points of the Coverage of Wilks' Unbiased Tolerance Intervals in Random Samples of Size n From a Normal Distribution", was presented by Dr. Eisenhart at a meeting of the Virginia Academy of Science, Lexington, Virginia, May 13, 1961.

H.H. Ku is collaborating with S. Kullback and M. Kupperman in the preparation of an expository paper on the application of information theory to the analyses of contingency tables and Markov chains.

G.H. Weiss began collaboration with Kurt Shuler, Consultant to the Director, on various problems in the stochastic theory of chemical kinetics, with particular attention to calculation of (i) first-passage times in certain chemical kinetic problems and (ii) Poincaré recurrence times in multidimensional random walks.

Publication:

(1) Probability inequalities of the Tchebycheff type. I.R. Savage. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

Status of Projects

STUDIES IN THE MATHEMATICS OF EXPERIMENT DESIGN
Task 1103-12-11131/53-1

Origin: NBS Authorized 10/15/52
Manager: J.M. Cameron
Full task description: Oct.-Dec. 1952 issue, p. 60

Status: CONTINUED. W.J. Youden has begun work on a particular class of experiment designs applicable in certain chemical investigations when we wish to establish quantitatively a relationship between the amounts that interact with several chemicals. Suppose materials A and C do not react with each other but both react with materials B and D. Further suppose that materials B and C are available in very limited quantities while very ample supplies of A and D are available. Initial studies were concerned with the apportionment of available material among the possible reactions in order to make the most effective use of available supplies.

Publications:

(1) Fractional factorial designs for experiments with factors at two and three levels. W.S. Connor and Shirley Young. To appear as NBS Applied Mathematics Series 58.
(2) Partial confounding in fractional replication. W.J. Youden. Submitted to a technical journal.
(3) Randomization and experimentation. W.J. Youden. To appear in Annals of Mathematical Statistics.
(4) A calculus for factorial arrangements. Badrig Kurkjian (DOFL) and M. Zelen. Submitted to a technical journal.
(5) Factorial designs and the direct product. Badrig Kurkjian (DOFL) and M. Zelen. Submitted to a technical journal.

STUDY OF NON-PARAMETRIC STATISTICAL TECHNIQUES
Task 1103-12-11131/56-170

Origin: NBS Authorized 12/15/55
Manager: J.R. Rosenblatt
Full task description: Oct.-Dec. 1955 issue, p. 14

Status: INACTIVE

Publication:

(1) Exact and approximate distributions for the Wilcoxon statistic with ties. Shirley Young Lehman. Journal of the American Statistical Association 56, 293-298 (June 1961).

Status of Projects

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

Origin: NBS Authorized 3/23/56
Managers: M. Zelen, J.R. Rosenblatt
Full task description: Jan.-Mar. 1956 issue, p. 13

Status: CONTINUED. Joan R. Rosenblatt and Anna M. Glinski prepared the first draft of a paper on "Confidence Intervals for Reliability: Some Illustrative Examples in Cases for which Exact Small Sample Methods are Available". This paper constitutes a formal write-up of a portion of the material discussed by Dr. Rosenblatt in a talk, "Confidence intervals for reliability: a survey of techniques and their limitations", presented in a Probability and Statistics Seminar at the University of Maryland, on May 16, 1961.

Dr. Rosenblatt also prepared a survey of statistical methods available for estimating confidence limits for system reliability using data on performance of subsystems or components.

M. Zelen has initiated work on procedures for estimating quantiles of distributions used in accelerated life tests. The experimental situation calls for conducting life tests both at normal operating conditions and at extreme environmental conditions in order to estimate small tail probabilities at the normal operating conditions. Preliminary results indicate that the greater the acceleration factor, the more tests one must run at normal operating conditions.

Joan R. Rosenblatt and D.D. Prill are preparing an annotated bibliography of USSR publications on reliability theory.

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-Sept. 1954 issue, p. 27

Status: CONTINUED. A. Ghaffari has completed a manuscript entitled "Analyticity and probability properties of one-dimensional Brownian motion". This paper gives the most general one-dimensional solutions of the Chapman-Kolmogoroff functional equation on the interval $(0,\infty)$ for the transition probability of such a motion in the form of a series of products of two Laguerre polynomials. It is shown that the limiting behavior of the probability function is non-oscillatory, and a derivation of the corresponding partial differential equation is obtained.

A. Ghaffari presented a paper entitled "Some applications of Hardy's formula in Brownian motion" at the American Mathematical Society Meeting in New York, April 5-8, 1961.

L.E. Payne and J.H. Bramble are continuing their investigation of methods for obtaining pointwise bounds in elastic plate problems.

Publications:

(1) On some partial differential equations of Brownian motion of a free partical. A. Ghaffari. Proceedings of the International Conference on Partial Differential Equations and Continuum Mechanics, University of Wisconsin Press, p. 348, 1961.
(2) Pointwise bounds in the Cauchy problem of elastic plates. L.E. Payne. Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), 157-163 (1961).
(3) Some applications of Hardy's formula in Brownian motion. A. Ghaffari. Abstract: Notices of the American Mathematical Society 8, 238 (June 1961).
(4) Some higher order integral identities with application to bounding techniques. J.H. Bramble and B.E. Hubbard. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).
(5) Analyticity and probability properties of one-dimensional Brownian motion. A. Ghaffari. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

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 prepared a manuscript for publication on "Kinetic Equation for Plasmas with Collective and Collisional

Correlations". This gives the formulation of the long range collective force, the collision force of shorter range, the mixing force between the two ranges, and the shielding mechanism. It contains the self-consistent field of the Vlasov equation, the collision terms of the kinetic equation of the Fokker-Planck type, and a mixing term. An interesting special case arises when the collective force is disregarded, for then the kinetic equation contains the effects of shielding and memory. If the Maxwellian distribution is used to compute the shielding, we reproduce the kinetic equation with memory, as proposed earlier by Tchen, Phys. Rev. 114, 394 (1959). On the other hand, if the memory is omitted, the well-known result in the form of the Fokker-Planck equation is reproduced. The kinetic equation proposed in the paper is suitable for the study of plasma oscillations with correlations.

C.M. Tchen gave the following addresses: (i) "A kinetic equation for plasmas", Howard University Physics Seminar, February 21, 1961; (ii) "Plasma oscillations", General Electric Company, Philadelphia, May 22, 1961.

Publication:

(1) Kinetic equation for plasmas with collective and collisional correlations. C.M. Tchen. Accepted for publication in the Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, Munich, Germany, August 28-September 1, 1961.

RESEARCH ON SATELLITE ORBITS
Task 1104-12-11440/59-420

Origin: NBS Authorized 12/19/58
Sponsor: Office of Scientific Research, ARDC, USAF
Manager: J.P. Vinti
Full task description: Oct.-Dec. 1958 issue, p. 15

Status: CONTINUED. A manuscript is now ready for typing as an NBS report and as a paper for the Journal of Research of the National Bureau of Standards (Mathematics and Mathematical Physics) on the "Theory of an Accurate Intermediary Orbit for Satellite Astronomy". The orbit corresponds to the gravitational potential proposed in Journal of Research NBS, 63 B (Mathematics and Mathematical Physics), 105-116 (1959). The solution gives the results in terms of certain uniformising variables, the periodic parts of which are correct through the second order in the oblateness parameter and the secular parts of which are exact, for the intermediary orbit. These exact results for the secular terms are expressed without the use of elliptic integrals of the third kind and involve only certain rapidly converging series.

An eleven page paper entitled "The Spheroidal Method in Satellite Astronomy" was prepared by J.P. Vinti for the First International Symposium on Analytical Astrodynamics, U.C.L.A., June 27-29, 1961, Los Angeles, California. The paper was not presented in person because of other commitments, but photostats were distributed at the symposium.

Status of Projects

J.P. Vinti was a participant in two seminars entitled "Cosmic Rays, Solar Particles, and Space Research" and "Evidence of Gravitational Theories" which were held at the Enrico Fermi International School of Physics, Varenna, Italy, May 22 - July 1, 1961.

Publications:

(1) Mean motion in conditionally periodic separable systems. J.P. Vinti. Journal of Research NBS, Section B (Mathematics and Mathematical Physics), 131-135 (1961).

(2) Theory of an accurate intermediary orbit for satellite astronomy. J.P. Vinti. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

(3) Formulaefor an accurate intermediary orbit of an artificial satellite. J.P. Vinti. Submitted to a technical journal.

FOURIER TRANSFORMS OF PROBABILITY DISTRIBUTION FUNCTIONS
Task 1104-12-11626/56-154

Origin: NBS Authorized 9/30/55
Sponsor: Office of Naval Research
Manager: F. Oberhettinger
Full task description: July-Sept. 1955 issue, p. 20

Status: CONTINUED. E. Lukas and M. Zelen reviewed the manuscript; also it was decided to extend the preface.

5. MATHEMATICAL AND COMPUTATIONAL SERVICES

3911-61-39952/54-30 SPECTRUM ANALYSIS
Origin: NBS, Division 4
Manager: W. Bozman (13.1)
Full task description: Jan.-Mar. 1954 issue, p. 46
Status: Terminated. The intensity table expressed as a function of the wavelength has been completed; the intensity table expressed as a function of the elements is approximately complete. A code was written for constructing a "square array" of energy levels; another code is being written by K.G. Kessler to average wavelengths and intensities from a number of spectrum plates. The computation of wavelengths and wavenumbers is continuing and a code has been written to compute interferometer patterns. Production runs are to be continued under the direction of the sponsor, and any future machine time will be reported in the Section, "Current Applications of Automatic Computer".

3911-61-39952/55-68 CRYSTAL STRUCTURE CALCULATIONS
Origin: NBS, Division 9
Managers: P.J. O'Hara, S. Block (9.7)
Full task description: Jan.-Mar. 1955 issue, p. 18
Status: Completed. Production runs were made and the results were transmitted to the sponsor.

3911-61-39952/55-82 THERMOMETER CALIBRATIONS
Origin: NBS, Section 3.1
Manager: B.S. Prusch
Full task description: Jan.-Mar. 1955 issue, p. 20
Status: Terminated. ITS constants were calculated for 67 thermometers, and LTS constants for 22 thermometers. Production runs are to be continued under the direction of the sponsor, and machine time will be reported henceforth in the Section, "Current Applications of Automatic Computer".

1102-40-11645/56-166 SCF-LCAO SOLUTION OF SOME HYDRIDES
Origin and Sponsor: NBS, Section 5.9
Manager: P.J. Walsh
Full task description: Jan.-Mar. 1956 issue, p. 27
Status: Continued. The coding and assembly of integral programs for the pentatomic tetrahedral molecules has been completed. These programs will be inserted into the basic SCF-control program for calculations on this type of molecule.

Status of Projects

1102-40-11645/56-186 MECHANICAL MEASUREMENTS OF GAGE BLOCKS
Origin and Sponsor: NBS, Section 2.5
Manager: B.S. Prusch
Full task description: July-Sept. 1956 issue, p. 33
Status: Continued. Computations were performed to check 23 laboratory sets of gage blocks.

1102-40-11645/57-236 SELF CONSISTENT FIELD--EIGENVALUES
Origin and Sponsor: NBS, Section 3.6
Manager: P. Walsh
Full task description: April-June 1957 issue, p. 30
Status: Continued. The testing of a program to perform transformations on the matrices of integrals occurring in molecular structure computations has been completed and checked out. They are of the form: $X^t(X^tAX)X$. Molecular SCF calculations were performed on three-center systems, and also for the N_3 and HO_2 molecules.

3911-61-39952/56-266 DEPOLYMERIZATION, II
Origin: NBS, Section 7.6
Manager: L.S. Joel
Full task description: July-Sept. 1957 issue, p. 36
Status: Terminated.

1102-40-11645/58-269 MOLECULAR STRUCTURE, IV
Origin and Sponsor: Naval Research Laboratory, USN
Manager: P.J. O'Hara
Full task description: July-Sept. 1957 issue, p. 38
Status: Terminated. Production runs are to be continued under the direction of the sponsor, and the machine time will be reported in the Section, "Current Applications of Automatic Computer".

1102-40-11645/58-270 MATHEMATICAL PROBLEMS RELATED TO POSTAL OPERATIONS
Origin: NBS
Sponsor: Post Office Department, Office of Research and Engineering
Managers: Bernice K. Bender, A. J. Goldman
Full task description: Oct.-Dec. 1958 issue, p. 22
Status: Terminated. Brief studies were made of queueing and coding problems arising in connection with mail-sorting automation. A preliminary report on the second network model was completed.

Status of Projects

1102-40-11645/58-272 THERMODYNAMIC PROPERTIES OF REAL GASES
Origin and Sponsor: NBS, Section 3.2
Manager: Karen A. Bedeau
Full task description: Oct.-Dec. 1957 issue, p. 32
Status: Terminated. Production runs are to be continued under the direction of the sponsor, and the machine time will be reported in the Section, "Current Applications of Automatic Computer".

1102-40-11645/58-339 COMPUTATION OF VISCOELASTICITY PROPERTIES OF MATERIALS
Origin and Sponsor: NBS, Section 3.4
Manager: H. Oser
Full task description: Jan.-Mar. 1958 issue, p. 38
Status: Continued. Theoretical studies of the network model were completed. Some production runs with different data were made to study the influence of parameters on the problem.

1102-12-11513/59-348 RUSSIAN-TO-ENGLISH MACHINE TRANSLATION
Origin: NBS
Sponsor: Office of Ordnance Research, U.S. Army
Manager: I. Rhodes (11.0)
Full task description: Oct.-Dec. 1958 issue, p. 26
Status: Continued. Research on "profiling", i.e. the determination of clause and phrase boundaries, continues. In the portion of the machine code dealing with the generation of morphological information, the mainline routine and a few subroutines have been finished; in the portion dealing with syntactic integration, a number of subroutines have been added. Compilation of inflectional forms of Russian nouns, verbs, and adjectives is progressing; this is a first step in the preparation of a pilot dictionary of a few thousand stems, to be used for trial translations.

Publications: (1) Recognition of clauses and phrases in machine translation of languages. F.L. Alt and I. Rhodes. To appear in the Proceedings of the International Conference on Machine Translation of Languages and (2) A new approach to the mechanical syntactic analysis of Russian. I. Rhodes. To appear in Mechanical Translation.

1102-40-11645/58-358 REDUCED CROSS-SECTIONS
Origin and Sponsor: NBS, Section 3.2
Manager: S. Peavy
Full task description: Apr.-June 1958 issue, p. 30
Status: Completed. Results have been transmitted to the sponsor.

Status of Projects

1102-40-11645/58-361 CALCULATIONS FOR SPECTRUM OF DIPOLE RADIATION
Origin and Sponsor: Naval Research Laboratory
Manager: R.J. Arms
Full task description: Apr.-June 1958 issue, p. 33
Status: Terminated. There has been relatively little activity on this project. Financial limitations have eliminated production runs. Code checking of revised imput techniques was completed.

1102-40-11645/58-366 RADIATION PATTERNS OF ANTENNAS
Origin and Sponsor: U.S. Information Agency, Department of State
Manager: P.J. Walsh
Full task description: Apr.-June 1958 issue, p. 35
Status: Continued. The analysis program was used to compute the characteristics of many antennas. The scanning program, which prints detailed information over a specified range of the vertical or horizontal field for a fixed horizontal or vertical angle, was also used for several antennas. Results have been transmitted to the sponsor.

1102-40-11645/58-368 INTENSITY FUNCTIONS AND CROSS SECTIONS OF LIGHT SCATTERED BY SPHERICAL PARTICLES
Origin and Sponsor: U.S. Army Signal Research and Development Laboratories, Atmospheric Physics Branch, Belmar, N.J.
Manager: H. Oser
Full task description: July-Sept. 1958 issue, p. 32
Status: Reactivated. A new code has been written by A.E. Beam. With this program it is possible to compute scattering functions for size parameters $\beta = 2\pi b/\lambda$ up to 400, where b is the radius of the outer shell. The angular increment $\Delta\,\theta$ can be varied to achieve sufficiently fine subdivisions. Preparations are nearly complete for a publication of the computed functions in tabular form.

1102-40-11645/59-389 FREQUENCY ALLOCATION
Origin and Sponsor: Civil Aeronautics Administration
Manager: L.S. Joel
Full task description: Oct.-Dec. 1958 issue, p. 29
Status: Terminated. A final report has been prepared for the sponsor.

1102-40-11645/59-394 VARIATIONAL CALCULATION OF SLOW ELECTRON SCATTERING BY HYDROGEN ATOMS, II
Origin and Sponsor: NBS, Section 4.6
Manager: A.E. Beam
Full task description: Oct.-Dec. 1958 issue, p. 30
Status: Continued. The code for calculation of the energy eigenvalues of H^- was completed and checked, and several production runs were made. Checking of the new p and d code was completed and some production runs were obtained.

Status of Projects

1102-40-11645/59-435 ELECTROCARDIOGRAPHIC ANALYSIS
Origin: NBS, Division 12.5
Sponsor: Veterans Administration
Manager: R.J. Arms
Full task description: April-June 1959 issue, p. 29
Status: Terminated. This project is nearly complete. The sponsor has been developing a technical staff capable of handling future problems. Dr. Stallman (VA) has completed an excellent method, utilizing smoothing transformations, for wave recognition procedures.

1102-40-11645/59-445 OIL SUPPLY
Origin and Sponsor: Military Petroleum Supply Agency, Department of the Navy
Manager: L.S. Joel
Full task description: Apr.-June 1959 issue, p. 30
Status: Terminated.

1102-40-11645/60-458 DOMESTIC AIRLINE TRAFFIC SURVEY
Origin and Sponsor: Civil Aeronautics Board
Managers: J.M. Beiman, W.G. Hall
Full task description: July-Sept. 1959 issue, p. 31
Status: Terminated. Production runs are to be continued under the direction of the sponsors and machine time will be reported in the Section, "Current Applications of Automatic Computer."

1102-40-11645/60-465 CALCULATIONS IN MOLECULAR QUANTUM MECHANICS
Origin and Sponsor: NBS, Section 3.2
Managers: P.J. Walsh, J.D. Waggoner
Full task description: Oct.-Dec. 1959 issue, p. 26
Status: Continued. The code for computing the eigenvalues and eigenvectors of real symmetric matrices was used on a large number of matrices submitted by the sponsor.

1102-40-11645/60-466 ELECTRONIC PROPERTIES OF SIMPLE MOLECULAR SYSTEMS
Origin and Sponsor: NBS, Section 3.2
Manager: P.J. Walsh
Full task description: Oct.-Dec. 1959 issue, p. 27
Status: Continued. Additional production runs were completed and a tentative potential curve was obtained for the interaction between two Ne atoms over the range of internuclear distance $3.0 \leq R \leq 8.0$ atomic length units.

Status of Projects

1102-40-11645/60-467 TRANSISTOR SIMULATION
Origin and Sponsor: NBS, Section 12.1
Manager: G.W. Reitwiesner
Full task description: Oct.-Dec. 1959 issue, p. 27
Status: Terminated.

1102-40-11645/60-476 GAS TUBE CHARACTERISTICS, II
Origin and sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Managers: H. Oser, W. Börsch-Supan
Full task description: Oct.-Dec. 1959 issue, p. 30
Status: Continued. A code was written to compute the characteristic quantities for gas tube phenomena assuming a constant electric field across the gap between the electrodes. The problem of finding the solutions can be reduced to finding the roots of certain transcendental equations. Three cases were considered: (i) solution of the differential equations with constant electric field; (ii) solution of the difference equations, assuming the electrons to be in the equilibrium state at all times; (iii) solution of the difference equations in the general case. Production runs are now being conducted by the sponsor.

1102-12-11122/60-479 PROCESSING OF DIAGRAMS
Origin and Sponsor: NBS, Section 11.0
Managers: F.L. Alt (11.0), S.T. Peavy, R.J. Herbold
Full task description: Oct.-Dec. 1959 issue, p. 30
Status: Continued. A manuscript has been prepared describing the results obtained so far. Consideration has been given to the problem of finding algorithms which classify patterns on the basis of moments.

1102-40-11645/60-486 MORSE WAVE FUNCTIONS AND FRANCK-CONDON FACTORS
Origin and Sponsor: NBS, Section 3.0
Manager: R. Zucker
Full task description: Jan.-Mar. 1960 issue, p. 28
Status: Continued. Additional results of continued production runs were forwarded to the sponsor.

1102-40-11645/60-501 KANSAS RIVER SYSTEM
Origin and Sponsor: Corps of Engineers, U.S. Army, Office of District Engineers, Kansas City District
Manager: S. Peavy
Full task description: Apr.-June 1960 issue, p. 24
Status: Terminated.

Status of Projects

1102-40-11645/60-504 ELECTROSTATIC-FOCUSING PROBLEM
Origin and Sponsor: Diamond Ordnance Fuze Laboratories, Department of the Army
Manager: A. Beam
Full task description: Jan.-Mar. 1960 issue, p. 30
Status: Completed. Several additional production runs were obtained and transmitted to the sponsor.

1102-40-11645/60-506 COMMODITY PRICE INDICES
Origin and Sponsor: U.S. World Bank, Statistics Division
Manager: J.C. Lamkin, Jr.
Full task description: Oct.-Dec 1960 issue, p. 19
Status: Continued. Production runs were made and the results were transmitted to the sponsor.

3911-61-39952/60-508 MODEL ADSORPTION ISOTHERMS
Origin and Sponsor: NBS, Section 5.2
Manager: H. Oser
Full task description: Apr.-June 1960 issue, p. 25
Status: Terminated.

1102-40-11645/60-513 RADIATIVE ENVELOPES OF MODEL STARS
Origin and Sponsor: National Aeronautics and Space Administration
Managers: S. Haber (11.1) and P.J. Walsh
Full task description: July-Sept. 1960 issue, p. 23
Status: Continued. Production runs were made and the results were submitted to the sponsor. Upon analysis of these results, some modifications were suggested in the formulae, and code checking of the latest version is now in progress.

1102-40-11645/61-516 RADIATION FIELD FROM A CIRCULAR DISK SOURCE
Origin and Sponsor: NBS, Section 4.8
Manager: R.J. Herbold
Full task description: July-Sept. 1960 issue, p. 24
Status: Completed.

1102-40-11645/61-530 SPECIMEN WAVELENGTH
Origin and Sponsor: NBS, Section 9.4
Manager: L. Joseph
Full task description: July-Sept. 1960 issue, p. 28
Status: Continued. Methods of solving for the four parameters using the results of four sets of measurements are currently being investigated.

Status of Projects

1102-40-11645/61-531 HEAT TRANSFER IN CRYSTALS
Origin and Sponsor: NBS Section 3.1
Manager: H. Oser
Full task description: July-Sept. 1960 issue, p. 29
Status: Continued. Various improvements in the Fortran program became necessary to reduce machine time. Experience showed that double indices are handled very uneconomically by the Fortran compiler. Therefore, it was necessary to reprogram all the subroutines using one dimensional arrays; timing was improved by a factor of more that two. Several lattice models with regular and irregular mass distributions were also computed.

1102-40-11645/61-532 CALCULATION OF VIBRATIONAL ENERGY LEVELS FOR IONIC MOLECULES
Origin and Sponsor: Georgetown University
Manager: P.J. Walsh
Full task description: Oct.-Dec. 1960 issue, p. 21
Status: Continued. The coding of another phase of the problem was completed and checked out. The results of the code checks were submitted to the sponsor for further analysis.

1102-40-11645/61-536 SECULAR EQUATIONS
Origin and Sponsor: NBS, Section 13.2
Manager: Ruth Zucker
Full task description: Oct.-Dec. 1960 issue, p. 22
Status: Terminated.

1102-40-11645/61-537 MASS ACTION LAW
Origin and Sponsor: NBS, Section 5.2
Manager: H. Oser, J.C. Lamkin, Jr.
Full task description: Oct.-Dec. 1960 issue, p. 23
Status: Completed. All relevant material for this project has been transmitted to the sponsor, who is preparing a final report.

1102-40-11645/61-538 SPECTRAL REFLECTANCE
Origin and Sponsor: NBS, Section 9.4
Managers: W. Börsch-Supan, S. Haber (11.1)
Full task description: Oct.-Dec. 1960 issue, p. 23
Status: Continued. Code checking was done on least-squares fit programs. Exploratory work was performed on an alternative theoretical method of determination of some of the parameters as suggested by the sponsor.

Status of Projects

1102-40-11645/61-540 DIFFUSION CALCULATIONS
Origin and Sponsor: Army Chemical Center
Manager: L. Joseph
Full Task Description: Jan.-Mar. 1961, p. 21
Status: Continued. A change was made in the equations, and hence in the codes, in order to give more realistic results for certain values of the parameters. Production runs were made with the revised codes and results were sent to the sponsor.

1102-40-11645/61-542 STUDENT LOAN DATA
Origin and Sponsor: Department of Health, Education, and Welfare
Manager: R. Zucker
Full task description: Oct.-Dec. 1960 issue, p. 24
Status: Inactive.

1102-40-11645/61-551 PARTICLE SIZE CALCULATIONS
Origin and Sponsor: NBS, Section 10.7
Manager: R. Zucker
Full task description: Jan.-Mar. 1961 issue, p. 22
Status: Terminated.

1102-40-11645/61-555 MONTE CARLO NEUTRON STUDIES
Origin and Sponsor: NBS, Section 4.3
Manager: Sally T. Peavy
Objective: To develop a flexible Monte Carlo code in order to explore simple box-type configurations in neutron penetration problems.
Background: Protection engineering investigations concerning initial neutron penetration frequently require considerable knowledge of simple-structure shields. This program was designed to facilitate the analyses of various elementary shielding-structures.
The problem was transmitted by L.V. Spencer (4.3).
Status: Terminated (New).

1102-40-11645/61-556 TCHEBYCHEFF APPROXIMATION BY RATIONAL FUNCTIONS
Origin and Sponsor: NBS, Section 11.1
Manager: P.J. Walsh
Full task description: Jan.-Mar. 1961 issue, p. 22
Status: Continued. The coding has been completed and code checking is now in progress. Several systems of equations, involving more unknowns than equations, will be tested before main-program production runs are attempted.

Status of Projects

1102-40-11645/61-557 STRUCTURE DETERMINATION
Origin and Sponsor: NBS, Section 13.5
Manager: Karen A. Bedeau
Full task description: Jan.-Mar. 1961 issue, p. 23
Status: Continued. The code has been revised to include a more general function. Differences in the results of the new and old codes are being investigated.

1102-40-11645/61-559 THERMOCOUPLE CALIBRATION
Origin and Sponsor: NBS, Section 3.1
Manager: Karen A. Bedeau
Full task description: Jan.-Mar. 1961 issue, p. 23
Status: Continued. Work on the first phase of the problem has been temporarily suspended at the request of the sponsor. A Fortran code has been written for the other phases and is being checked out.

1102-40-11645/61-560 MUSCLE FLEXING
Origin and Sponsor: National Naval Medical Center
Manager: H. Oser
Objective: To compute and plot the characteristic functions of muscular contraction according to a model of A.F. Huxley (Progress in Biophysics, Vol. VII., 1957). The purpose of these computations is to obtain information concerning the rates of the chemical reactions and the quantities involved.
Background: Huxley describes the interaction between the myosin and actin fibres when tension is applied to the muscle. The formulation of this phenomenon involves chemical reactions and heat balances expressed in differential form. A discrete analogue has been developed at the National Naval Medical Center, Bethesda, Md., which was programmed for an IBM 650 computer. However, NBS was requested to render auxiliary services in order to expedite these investigations.
The problem was transmitted by R.J. Podolsky (NNMC).
Status: New. A FORTRAN program was written for the IBM 704 which has been checked out completely.

1102-40-11645/61-562 CUBIC LATTICES
Origin and Sponsor: NBS, Section 7.06
Manager: L. Joseph
Objective: To simulate configurations of polymer molecules by means of restricted random walks.
Background: One method of gaining information as to the structure of certain types of polymer molecules is simulation by the use of random walk models.

Status of Projects

An appropriate lattice (e.g., cubic or tetragonal) is chosen and rules for proceeding at each step and for terminating the walk are given. Exclusionary rules must be included to avoid impossible molecular configurations. By use of a high-speed computer it is possible to perform the walk many times and thus obtain statistical information as to properties of the molecules; e.g., mean square end to end distance.

Status: New. Random walks in a cubic and in a square lattice, using various rules for proceeding were programmed for the 704 computer. Production runs were made and the results were given to the sponsor.

1102-40-11645/61-563 PATTERN RECOGNITION

Origin and Sponsor: NBS, Section 12.03

Manager: J.C. Lamkin, Jr.

Objective: To develop a program which will locate conjugate images in two digitalized, overlapping aerial photographs, and to measure the parallax in the direction of flight.

Background: Numerous military and industrial organizations are vitally interested in possible methods that will reduce the time required between the taking of serial photographs and the production of an acceptable map. The possibility of digitalizing photographs by utilizing a photoelectric scanner which supplies information to a high-speed automatic digital computer has already been demonstrated. From the parallax measurements it should be possible to derive data from which a crude contour map of the terrain could be displayed on an oscilloscope screen. Initially the photographs will be laboratory produced, with sharply defined "terrain" features in order to reduce the time required for the initial, exploratory, programming research.

The problem was transmitted by H. Joseph (12.03).

Status: Terminated (New). The project was terminated while initial investigations were being conducted.

1102-40-11645/61-565 INFINITE TRIGONOMETRIC EQUATIONS

Origin and Sponsor: NBS, Section 3.01

Manager: R. Zucker

Objective: To solve the set of sumultaneous equations:

(i)

$$e^{-i\pi r(ac)^{\frac{1}{2}}} \sin v_o \pi r + \sum_{v=1}^{\infty} B_v e^{irD_v} \sin v\pi r = \sum_{v=1}^{\infty} A_v e^{irF_v} \sin v\pi r.$$

(ii)

$$e^{-i\pi r(ac)^{\frac{1}{2}}} v_o \cos v_o \pi r + \sum_{v=1}^{\infty} B_v e^{irD_v} v \cos v\pi r = \sum_{v=1}^{\infty} A_v e^{irF_v} (iF_v/\pi) \sin v\pi r.$$

where:

$D_v = \pi\, a^{\frac{1}{2}}\, (c + v_o^2 - v^2)^{\frac{1}{2}}$

$F_v = \pi\, (c + v_o^2 - v^2/a)^{\frac{1}{2}}$

$r = \frac{1}{n+1}\left(\frac{1}{n+1}\right)\frac{n}{n+1}$, where 2n equals the number of equations.

Sets of values of A_v and B_v are desired as a function of a, c, and v_o^2. Also, to evaluate for each solution the normalization condition:

$$1 = \sum_{v=1}^{v^2 \leq a(c + v_o^2)} |A_v|^2 \sqrt{\frac{1 + (v_o^2 - v^2/a)/c}{a}} + \sum_{v=1}^{v^2 \leq c + v_o^2} |B_v|^2 \sqrt{1 + \frac{(v_o^2 - v^2)}{c}}$$

Background: The simple model of a chemical exchange reaction which is being studied has been considered in special cases by a number of investigators who have used different numerical techniques. In the model, an atom A is constrained to approach a molecule BC along the axis of the molecule. The quantum mechanical probability of the exchange reaction is calculated from Schrödinger's equation as a function of: (i) the relative momentum, k, of A and BC, and (ii) the vibrational state, v, of the molecule BC. For the particular choice of the vibrational potential energy function and the atom-molecule interaction energy, the Schrödinger equation is separable either in the reactant region or the product region. However, there is a nonseparable boundary condition which must be satisfied along the line separating these regions. Thus a solution of Schrödinger's equation describing a collision can be expressed in the reactant region as an infinite linear combination of reactant-state wave functions and in the product region as an infinite linear combination of product-state wave functions. These two representations, including unknown coefficients must satisfy certain continuity conditions along the line separating the reactant and product regions. From the continuity conditions, one can derive two infinite sets of linear relations which the two sets of coefficients must satisfy. If certain conditions are assumed, then the reaction probability is obtained directly from the magnitudes of the coefficients of the wave functions in the product region.

Status: Completed (New). A code was prepared and the results of several runs, evaluated for various sets of parameters, were transmitted to the sponsor.

1102-40-11645/61-566 ELECTRONIC DETECTION OF LAND-MINES

Origin and Sponsor: Fort Belvoir

Manager: L. Joseph, S. Haber

Objective: To review the mathematical theory developed to maximize the effectiveness of an electronic device employed in land-mine detection.

Background: Drexel Institute of Technology, under contract to Fort Belvoir, has developed a mathematical theory to explore the feasibility of utilizing microwave devices for land-mine detection. Since NBS acts as a consultant to Fort Belvoir, it was requested to evaluate this theory.

Status of Projects

The problem was transmitted by C. Stewart (Fort Belvoir).
Status: New. Preliminary analyses were instituted concerning the functions occurring in the mathematical theory of the land-mine detector.

1102-40-11645/61-567 RADIOACTIVITY ESTIMATIONS
Origin and Sponsor: National Institutes of Health
Manager: R.A. Arms
Objective: Development of the computer phase of estimating concentrations of various radioactive elements found in food products. The NBS computation laboratory presently limits its role to consultation on computer orientation.
Background: Food samples are collected on a nationwide basis and gammaspectrometrically analyzed for radioactivity and standard isotopes. This data can then be utilized by an automatic digital computer to determine a linear function involving concentrations of radioactive elements. The concentrations are subsequently given statistical summaries.
Status: New. The immediate objectives have been essentially completed. Considering linearity and analogue instrumentations, the classical weighted least-squares solution was recommended. If the orthonormal program by P. Walsh and E. Haynsworth is used, then very little new coding would be necessary.

1102-40-11645/61-568 TRANSIENT HEAT FLOW IN FLUID AMPLIFIERS
Origin and Sponsor: Diamond Ordnance Fuze Laboratories
Manager: H. Oser, M.L. Paulsen
Objective: Utilization of the finite difference method to obtain the solution of the three-dimensional heat transfer equation for a right parallelpiped. Specified boundary conditions will be assumed for the six surfaces and at the interfaces of the fluid streams with the parallelpiped.
Background: The Diamond Ordnance Fuze Laboratories have continually conducted extensive experimental investigations concerning the transient heat flow in fluid amplifiers. It was realized, however, that a comprehensive theoretical investigation utilizing a high-speed automatic digital computer would eventually be necessary. Recently, an analysis was begun which employed a finite difference scheme that was devised by C.E. Huckaba, University of Florida, and which included approximately 5000 points over a specified region.
This problem was transmitted by D.S. Marsh (DOFL).
Status: New. A code is now being written by Maxine Paulsen.

1102-40-11645/61-571 NMR SPECTRUM
Origin and Sponsor: NBS, Section 15.07
Manager: H. Oser
Objective: To compute nuclear magnetic resonance (NMR) spectra of nuclear spin systems.

Status of Projects

Background: Several relatively independent programs exist for calculating the line frequencies and intensities of nuclear spin systems, e.g., (i) the program developed at Livermore, California, and (ii) the program developed by the Mellon Institute, Pittsburgh, Pennsylvania. It appears as if the symmetric principle will be capable of providing the necessary means of analysis for the development of an acceptable generalized theory. A synthesis of these programs is anticipated after preliminary analysis has been concluded.

The problem was transmitted by E. Lustig (15.07).

Status: New.

6. 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. Cameron
Full task description: July-Sept. 1950 issue, p. 60

Status: CONTINUED. The first draft of a manuscript concerning measurement was completed by W.J. Youden. The manuscript is expected to be one of the books in the Vistas of Science book series under development by the National Science Teachers Association. This series of paper-back books undertakes to provide high school students and teachers with current, accurate science information that is not contained in textbooks. The book on Measurements provides an introduction to the statistical aspects of measurement. Numerous examples are included using, in most cases, measurements that the students themselves can easily make. The need for the books was identified through questionnaires sent by the National Education Association to 16,000 science teachers and 100 scientists and science educators, requesting suggestions for improvements in secondary school science education.

Members of the Section provided statistical assistance and advice to numerous Bureau personnel. The following are representative examples:

(i) Color scales. Joan R. Rosenblatt collaborated with G.L. Howett of the Photometry and Colorimetry Section in the development and interpretation of statistical techniques for the analysis of a paired comparison experiment which was conducted by members of the Committee on Uniform Color Scales of the Optical Society of America. The report of this experiment has been completed.

(ii) Calibration of angle standards. Methods for the analysis of data from the simultaneous calibration of two polygons were worked out by J.M. Cameron for C.E. Haven of the Engineering Metrology Section. A 704 program was prepared by Jeanne M. Beiman of the Computation Laboratory.

(iii)Standard voltage cells. Mary C. Dannemiller Croarkin completed a 704 computer code for automatic analysis of calibration data on standard voltage cells, for Catherine A. Law of the Electrochemistry Section.

(iv) Optical pyrometers. H.H. Ku advised H.J. Kostkowski of the Temperature Physics Section in the development of a statistical model for the calibration errors of optical pyrometer temperature measurements.

(v) Gage blocks. H.H. Ku is collaborating with J.S. Beers of the Length Section in the development of a scheme for the calibration of gage blocks by intercomparing simultaneously sets of blocks with two sets of master blocks.

Publications:

(1) How to evaluate accuracy. W.J. Youden. Materials Research and Standards, 1, 268-271 (April 1961)

(2) Statistical problems arising in the establishment of physical standards. W.J. Youden. To appear in the Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.
(3) Systematic errors in physical constants. W.J. Youden. Submitted to a technical journal.
(4) Variability of Spectral Tristimulus Values. I. Nimeroff (Photometry and Colorimetry), J.R. Rosenblatt, and M.C. Dannemiller. Submitted to a technical journal.
(5) The interpretation of preliminary measurement. W.J. Youden. Submitted to a technical journal.
(6) What is the best value? W.J. Youden. Submitted to a technical journal.
(7) Systematic errors in standards of measurement. W.J. Youden. To appear in Proceedings of Standards and Metrology Division of American Ordnance Association Meeting of February 1961.
(8) Experimental design and ASTM committees. W.J. Youden. Submitted to a technical journal.

STATISTICAL SERVICES FOR COMMITTEE ON SHIP STEEL, NRC
Task 1103-40-11430/52-1

Origin and Sponsor: Ship Structure Committee, NRC Authorized 12/1/51
Manager: W.J. Youden
Full task description: Oct.-Dec. 1951 issue, p. 58

Status: TERMINATED. This project has been inactive for the past two years. The objective of the project was to provide assistance on the statistical aspects of tests of ship steel. Dr. Youden will continue to serve on the Committee on Ship Steel of the National Research Council, but this and any other work, if of sufficient magnitude, will be reported under Task 1103-40-11625/58-346.

MANUAL ON EXPERIMENTAL STATISTICS FOR ORDNANCE ENGINEERS
Task 1103-40-11433/55-93

Origin and Sponsor: Office of Ordnance Research Authorized 12/29/54
Manager: C. Eisenhart
Full task description: Oct.-Dec. 1954 issue, p. 28

Status: COMPLETED. The Office of Ordnance Research contracted with this Laboratory for the preparation of a manual on experimental statistics for ordnance engineers, to include descriptions of, and criteria for the selection of statistical techniques useful in the planning and analysis of experiments.

Status of Projects

The Manual, now going to press, constitutes a part of the Ordnance Engineering Design Handbook, and is to be published as five consecutive Ordnance Corps Pamphlets, ORDP 20-110 through ORDP 20-114, under the inclusive title Experimental Statistics. The five sections and their contents are shown below.

ORDP 20-110 Section 1 BASIC CONCEPTS AND ANALYSIS OF MEASUREMENT DATA

- Chapter 1 Basic Statistical Concepts and Preliminary Considerations
- Chapter 2 Characterizing the Measured Performance of a Material, Product or Process
- Chapter 3 Comparing Materials or Products with Respect to Average Performance
- Chapter 4 Comparing Materials or Products with Respect to Variability of Performance
- Chapter 5 Characterizing Linear Relationships Between Two Variables
- Chapter 6 Analysis of Polynomial and Multivariable Relationships by the Method of Least Squares

ORDP 20-111 Section 2 STANDARD TECHNIQUES FOR THE ANALYSIS AND INTERPRETATION OF ENUMERATIVE AND CLASSIFICATORY DATA

- Chapter 7 Characterizing the Qualitative Performance of a Material, Product, or Process
- Chapter 8 Comparing Materials or Products with Respect to a Two-Fold Classification of Performance (Comparing Two Percentages)
- Chapter 9 Comparing Materials or Products with Respect to Several Categories of Performance (Chi-Square Tests)
- Chapter 10 Sensitivity Testing

ORDP 20-112 Section 3 THE PLANNING AND ANALYSIS OF COMPARATIVE EXPERIMENTS

- Chapter 11 General Considerations in Planning Experiments
- Chapter 12 Factorial Experiments
- Chapter 13 Randomized Blocks, Latin Squares, and Other Special Purpose Designs
- Chapter 14 Experiments to Determine Optimum Conditions or Levels

Status of Projects

ORDP 20-113 Section 4 SPECIAL TOPICS

Chapter 15 Some Short-Cut Tests for Small Samples from Normal Populations

Chapter 16 Some Tests That are Independent of the Form of the Distribution

Chapter 17 The Treatment of Outliers

Chapter 18 The Place of Control Charts in Experimental Work

Chapter 19 Statistical Techniques for Analyzing Extreme-Value Data

Chapter 20 The Use of Transformations

Chapter 21 The Relation Between Confidence Intervals and Tests of Significance

Chapter 22 Notes on Statistical Computations

Chapter 23 The Expression of Uncertainties

ORDP 20-114 Section 5 TABLES contains all the mathematical tables needed for application of the procedures given in Sections 1 through 4.

The principal author of the text is Mary G. Natrella, who also had overall responsibility for the completion of the final handbook. The original plans for coverage, a first draft of the text, and some original tables were prepared by P.N. Somerville. Chapter 6 is by J.M. Cameron; most of Chapter 1 and all of Chapter 23 are by C. Eisenhart; and Chapter 10 is based on a nearly-final draft by Mary L. Epling. Other members of the staff aided in various ways through the years; particular mention is made of N.C. Severo for assistance with Section 2 and of Shirley Young Lehman for help in the collection and computation of examples.

Publication:

(1) Experimental Statistics. Mary G. Natrella. To be published as ORDP 20-110, 111, 112, 113, 114 by the Army Research Office Durham, Box CM, Duke Station, Durham, N.C.

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

Origin and Sponsors: Various Agencies Authorized 3/31/58
Manager: J.M. Cameron
Full task description: Jan.-Mar. 1958 issue, p. 45

Status of Projects

Status: CONTINUED. Joan R. Rosenblatt completed the third of a series of reports to the Water Resources Division of the U.S. Geological Survey. These reports treat various aspects of statistical techniques which have been used to improve the estimates of stream flow in one stream by taking advantage of the correlation between discharges in geographically related streams. Earlier reports were based on the simplifying assumption that stream discharges are statistically independent from year to year. The new report introduces the (empirically established) autocorrelation in stream discharge time-series, represented by an autoregressive structure. An approximate formula is given for the variance of the estimated mean discharge in a stream for which direct measurements consist of a "short" time series, when the estimate of this mean is "improved" through use of the estimated regression of discharge in this stream on the discharge in another stream for which there is a "long" time series record. A report of this investigation is being prepared for publication jointly by N.C. Matalas (U.S.G.S.), and Dr. Rosenblatt.

Current Applications of Automatic Computer

The record of the use of the IBM 704 for the period April 1 through June 30, 1961, is as follows:

Task No.		Title	Assembly	Checking	Production
NBS SERVICES:			(M I N U T E S)		
11110/55-55	11.1	Research in numerical analysis	10	36	361
11411/55-56	11.1	Research in mathematical topics applicable to numerical analysis	0	12	0
11120/55-65	11.2	Automatic coding	29	71	284
39952/56-160	11.2	Mathematical subroutines	246	224	490
39951/51-1	11.3	Statistical engineering	38	195	294
39952/54-30	13.1	Spectrum analysis	152	362	1139
39952/55-68	9.7	Crystal structure calculations	42	1	790
39952/55-82	3.1	Thermometer calibrations	0	0	304
39952/56-131	2.2	Calculations in optics*	26	0	60
11645/56-166	5.9	SCF-LCAO solution of some hydrides*	81	68	72
11645/56-171	3.2	Collision integrals used in transport theory**	23	139	49
11645/57-219	3.2	Thermal properties*	31	19	21
11645/57-223	3.2	Self-consistent fields	0	0	274
11645/57-236	3.6	Eigenvalues for self-consistent fields	1	66	13
11645/57-246	4.8	Radiation diffusion**	285	431	1561
39952/57-250	2.3	Automatic reduction in spectrophotometric data*	0	0	58
11645/57-252	4.4	Detecting efficiency in a neutral meson experiment**	49	101	0
39952/58-254	2.3	Reproduction of color- and spectral-energy distribution of daylight*	0	0	10
11645/58-255	4.8	Chi functions**	917	234	682
11645/58-256	10.6	Composite walls**	159	34	50
11645/58-260	12.5	Prototype accounting**	36	159	199
11645/58-270	12.5	Mathematical analysis of postal operations	13	19	0
11645/58-272	3.2	Thermodynamic properties of real gases	77	120	526
11645/58-274	9.7	Calculations for d-spacings II*	0	0	74
11645/58-275	7.8	Crystallography**	0	0	64
11645/58-294	4.8	Nuclear scattering of photons*	0	0	25
11645/58-295	11.3	Measurement theory	18	4	142
11645/58-308	3.4	Oscillating sphere*	9	5	36
11645/58-314	3.7	Approximations for gas mixtures*	99	218	99
11645/58-333	9.0	Calcium hydroxide*	66	0	273
11645/58-356	3.0	Tabulation	5	0	70
11645/58-357	3.3	Eigenvalues**	93	14	194

Current Applications of Automatic Computer

Task No.		Title	Assembly	Checking	Production
NBS SERVICES:			(M I N U T E S)		
11645/58-358	3.2	Reduced cross sections	17	12	17
/59-372	11.3	Statistical analysis**	57	8	0
/59-382	4.6	Phase shift**	0	9	0
/59-387	30.4	Nuclear reactor design**	0	0	245
/59-394	4.6	Slow electron scattering by hydrogen atoms	122	671	211
/59-395	7.7	Adsorption study**	51	31	63
/59-403	2.1	Computation of color fadings*	0	0	28
/59-409	12.5	Bank Board**	166	556	2851
/59-412	3.7	Differential equations	26	24	6
/59-414	3.0	Infinite systems	8	29	233
/59-417	2.4	Spectrum analysis of ruthenium**	0	0	87
/59-418	4.8	p-wave equation*	154	127	372
/59-421	12.5	Traffic simulation**	3	653	7
/59-428	12.5	Radio intensities**	137	60	369
/59-430	3.2	Rotating body problem	0	0	16
/59-433	2.3	Color of signals**	30	28	41
/59-440	82.1	Mapping**	143	377	1157
/59-446	85.1	Ionospheric data**	0	0	13
/60-457	12.5	Public Housing problem**	0	218	405
/60-463	8.5	Black box computer service**	0	0	7
/60-474	2.5	Gage block stability*	0	0	8
/60-484	7.6	Polymer crystallization	0	0	20
/60-486	3.6	Morse wave function	0	0	329
/60-489	3.1	Inversion of line probe data	0	0	26
/60-493	3.7	Poisson distribution function**	305	125	824
/60-507	1.6	Transistor aging studies	59	0	36
/60-514	3.9	Flame spectra**	0	0	5
/60-515	13.5	Convolution integral**	0	0	8
/69-520	2.4	Heat expansion	0	0	12
/61-523	4.0	Neutron cross section computations**	201	72	550
/61-525	3.8	Curve fitting of wave functions**	0	0	42
/61-526	3.0	Crystal field calculations	53	3	0
/61-528	14.1	Transistor aging	92	20	101
/61-530	9.4	Specimen wave lengths	9	16	1
/61-531	3.1	Heat transfer in crystals	136	38	1025
/61-536	13.2	Secular equations	0	0	12
/61-537	15.2	Mass action law	6	72	157
/61-538	9.2	Curve fitting for spectra reflectance data	12	6	6
/61-546	11.1	Operations research in optimization techniques	0	27	557
/61-555	4.3	Monte Carlo neutron studies	7	15	0
/61-556	11.1	Tchebycheff approximation by rational functions	165	84	6
/61-557	13.5	Structure determination	15	20	46

Current Applications of Automatic Computer

Task No.		Title	Assembly	Checking	Production
NBS SERVICES:			(M I N U T E S)		
11645/61-559	3.1	Thermocouple calibration	75	35	0
/61-562	7.6	Simulation of molecular structure	23	6	208
/61-564	5.0	Calculation of complex constants	0	0	8
/61-565	3.0	Infinite trigonometric equations	55	16	19
/61-567	12.0	Radioactivity estimations	0	22	15
/61-571	15.7	NMR Spectrum	0	7	15
/61-574	4.4	Cross sections	9	25	0
		Miscellaneous	1	0	0
		Totals (NBS Services)	4,642	5,944	18,378
NON-NBS SERVICES:					
11645/57-200	DTMB	(DTMB)**	0	0	409
/58-269	NRL	Molecular structure, IV	55	7	354
/58-270	PO	Post Office problem	0	0	36
/58-276	NOL	General kinetics, I**	0	0	4256
/58-340	DOFL	Fuse data analysis	1	4	3
/58-348	OOR	Russian-to-English machine translation	16	16	0
/58-361	NRL	Spectrum of dipole radiation	60	52	21
/58-366	USIA	Radiation patterns of antennas	0	0	289
/58-368	SC	Intensity functions of light scattered by spherical particles	41	278	2107
/59-371	NRL	ASWAP°	572	8	1674
/59-373	DOFL	Rhinitis**	46	13	58
/59-389	CAA	Frequency allocation	0	10	480
/59-407	DOFL	Fourier coefficients*	178	90	100
/59-408	NASA	NASA**	0	0	563
/59-411	HEW	Fitting of exponential curves**	486	207	946
/59-415	DOFL	Complex Legendre functions*	442	7	191
/59-416	DOFL	Analysis of power supply experiments**	13	0	26
/59-419	DOFL	Neutrons°	0	32	2544
/59-423	WB	Weather Bureau**	0	0	229
/59-425	CU	Molecular orbitals*	0	0	62
/59-434	CIW	Petrological computations*	0	0	14
/59-435	VA	Electrocardiographic analysis	146	249	901
/59-441	GK	Systems engineering**	21	7	2330
/59-445	NPSA	Oil supply	0	0	36
/59-447	BPRO	Public Roads study**	347	893	9342
/60-450	ACC	Chemical warfare	40	62	12
/60-458	CAB	Domestic airline traffic survey	18	117	2965
/60-476	DOFL	Gas tube characteristic II	20	0	770
/60-481	SC	Radar study°	102	60	1158
/60-492	IMF	Monetary research reports**	159	22	99
/61-499	DOFL	Equilibrium calibration	135	193	32

Current Applications of Automatic Computer

Task No.		Title	Assembly	Checking	Production
NON-NBS SERVICES:			(M I N U T E S)		
11645/60-502	USA	Quartermaster mathematics programming**	370	36	1165
/60-504	DOFL	Electrostatic focusing	0	0	544
/60-506	WB	World Bank**	4	8	113
/60-512	DOFL	Data transformation**	265	58	904
/60-517	DOFL	Shock tube**	155	16	61
/61-532	GU	Vibrational energy levels for ionic molecules**	0	17	241
/61-540	EDARS	Edgewood Arsenal°	10	13	586
/61-545	WEST	Nuclear reactor design**	0	0	9890
/61-548	GE	Atomic power**	0	0	6
/61-550	GWU	Logistics research**	71	27	25
/61-552	DOFL	Transistor data**	34	3	23
/61-558	FDIC	Federal deposit**	0	0	417
/61-560	NNMC	Muscle flexing	32	25	0
/61-561	OSR	Zone refinements for quartz**	5	0	173
/61-569	AGO	Human factors research**	123	69	156
/61-570	TFMON	War games**	131	25	15
/61-572	NIH	Heart studies	79	85	0
		Totals (Non-NBS Services)	4,177	2,709	46,326
		Total time for the quarter (MINUTES)	8,819	8,653	64,704
		Total time for the quarter (HOURS)	147	144	1078

* Problem programmed in the Computation Laboratory; production runs continued under direction of sponsor.

** Problem programmed by sponsor and run under his direction.

° 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

CORBATO, F.J. (Massachusetts Institute of Technology) Integrals for diatomic molecule calculations. June 6.

McCARTHY, J. (Massachusetts Institute of Technology) Computing with symbolic expressions. April 20.

MINC, H. (University of Florida) Survey of eigenvalues inequalities for finite matrices. Presented as a series of five lectures. June 12-16.

MORDELL, L.J. (University of Notre Dame, St. John's College, Cambridge) The minimum of an inhomogeneous quadratic form. May 19.

REINER, I. (University of Illinois) Group representations. June 7.

Theory of Errors Colloquium

EISENHART, C. This series, open to members of the Bureau staff, aims to provide a thorough consideration of selected topics in the Theory of Errors that are especially pertinent to the calibration and basic measurements programs of the Bureau. The following subjects have been treated: (1) The postulate of direct measurement and the strong law of large numbers. January 12; (2) Some mathematical models of measurement processes. January 26; (3) The measurement of unprecision. February 23; (4) The probable error--never was what it used to be. March 9; (5) More on intervals of the form $(x-\bar{k}S, x+\bar{k}S)$. March 23; (6) Asymptotic normality and the central limit theorem. April 13; (7) On the law of propagation of error. May 11.

Lectures and Technical Meetings

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

BAZLEY, N. (1) A procedure for obtaining lower bounds to eigenvalues. Presented at the meeting of the American Mathematical Society, New York City, April 8. (2) Lower bounds for eigenvalues of the Schrödinger equation, II. Presented at the meeting of the American Physical Society, Washington, D.C., April 24-27.

DAVIS P. Weak * Convergence and its application to approximation theory. (1) Presented at the Bell Telephone Laboratories, Murray Hill, New Jersey, June 5. (2) Presented at the U.S. Naval Ordnance Laboratory, Silver Spring, Maryland. April.

EDMONDS, J. On minimum element-covering for a finite class of weighted sets. Presented at the meeting of the American Mathematical Society, New York, N.Y., April 5-8.

EISENHART, C. (1) Some examples of the recent work of the Statistical Engineering Laboratory, National Bureau of Standards. Presented at Wells College, Aurora, New York, May 5. (2) To fit or not to fit; that is the question---. Presented at Cornell University, Ithaca, New York, May 8. (3) Probability points of the coverage of Wilks' unbiased tolerance intervals of random samples from a normal distribution (with Ann D. Smith and John Van Dyke). Presented before the Virginia Academy of Science, Virginia Military Institute, Lexington, May 13.

GHAFFARI, A. Some applications of Hardy's formula in Brownian motion. Presented at the meeting of the American Mathematical Society, New York City, April 5-8.

ROSENBLATT, J.R. Confidence intervals for reliability: A survey of techniques and their limitations. Presented at the University of Maryland, May 16.

SHISHA, O. (1) Different types of convexity. Presented at the University of Maryland, April 21. (2) Some properties of Tchebycheff approximation. Presented at the Mathematics Department Colloquium, U.S. Naval Ordnance Laboratory, Silver Spring, Maryland, March 27.

VINTI, J.P. The spheroidal approach to satellite astronomy. Presented by title at the First International Symposium of Analytical Astrodynamics, U.C.L.A., June 27-29.

WEGSTEIN, J.H. Automatic data processing artificial languages. Presented at the meeting of the Interagency Committee on Automatic Data Processing, Washington, D.C., June 23.

Lectures and Technical Meetings

YOUDEN, W. Precision and accuracy in spectrochemical analysis. Presented at the General Motors Technical Center, Warren, Michigan, April 24.

ZELEN, M. Theory of reliability: Robustness of statistical life testing procedures. Presented at the University of Maryland, April 13.

Publication Activities

1. PUBLICATIONS THAT APPEARED DURING THE QUARTER

1.3 Technical Papers

The following papers appeared in the Journal of Research NBS, 65 B (Mathematics and Mathematical Physics), April-June 1961:

(1) Truncations in the method of intermediate problems for lower bounds to eigenvalues. N.W. Bazley and D.W. Fox (Applied Physics Laboratory, JHU). Pp. 105-111.

(2) A new decomposition formula in the theory of elasticity. J.H. Bramble and L.E. Payne. Pp. 151-156.

(3) Another extension of Heinz's inequality. M. Marcus. Pp. 129-130.

(4) Comparison theorems for symmetric functions of characteristic roots. M. Marcus. Pp. 113-115.

(5) Pointwise bounds in the Cauchy problem of elastic plates. L.E. Payne. Pp. 157-163.

(6) Mean motion in conditionally periodic separable systems. J. Vinti. Pp. 131-135.

(7) Optimal approximation for functions prescribed at equally spaced points. H.F. Weinberger. Pp. 99-104.

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(8) Automatic screening of normal and abnormal electrocardiograms by means of a digital electronic computer. R.J. Arms with H.V. Pipinger and F.W. Stallman (Veterans Administration, Mt. Alto, and Georgetown University School of Medicine). Proceedings of the Society for Experimental Biology and Medicine 106, 130-132 (1961).

(9) On some partial differential equations of Brownian motion of a free particle. A. Ghaffari. Proceedings of the International Conference on Partial Differential Equations and Continuum Mechanics, University of Wisconsin Press, p. 348, 1961.

Publication Activities

(10) How to evaluate accuracy. W.J. Youden. Materials Research and Standards (formerly ASTM Bulletin) 1, 268-277 (April 1961).

(11) Exact and approximate distributions for the Wilcoxon statistic with ties. Shirley Young Lehman. Journal of the American Statistical Association 56, 293-298 (June 1961).

2. MANUSCRIPTS IN THE PROCESS OF PUBLICATION

2.2 Technical Notes, Manuals, and Bibliographies

(1) Handbook of Mathematical Functions. To appear in the NBS Applied Mathematics Series.

(2) Fractional factorial designs for experiments with factors at two and three levels. To appear as Applied Mathematics Series 58.

(3) Experimental Statistics. Mary G. Natrella. To appear as a part of Ordnance Engineering Design Handbook. Army Research Office Durham, Durham, North Carolina.

2.3 Technical Papers

(1) Digital pattern recognition by moments. F.L. Alt. Submitted to a technical journal.

(2) Safety levels in military inventory management. F.L. Alt. Submitted to a technical journal.

(3) Recognition of clauses and phrases in machine translation of languages. F.L. Alt and I. Rhodes. To appear in the Proceedings of the International Conference on Machine Translation of Languages and Applied Language Analysis, Teddington, England, Sept. 6-8, 1961.

(4) Lower bounds for eignevalues of Schroedinger's equation. N.W. Bazley and D.W. Fox (Applied Physics Laboratory, JHU). Submitted to a technical journal.

(5) Some higher order integral identities with application to bounding techniques. J.H. Bramble and B.E. Hubbard (University of Maryland). Submitted to a technical journal.

(6) A priori bounds in the first boundary value problem in elasticity. J.H. Bramble and L.E. Payne. Submitted to a technical journal.

Publication Activities

(7) The reflection of logistics in electronic computer development. E.W. Cannon. To appear in the Proceedings of the Logistics Research Conference, held at the George Washington University, Washington, D.C., 1960.

(8) Distribution of total service time for a fixed observation interval. W.S. Connor and N.C. Severo. Submitted to a technical journal.

(9) Advances in orthonormalizing computation. P.J. Davis and P. Rabinowitz. Submitted to a technical journal.

(10) Some geometrical theorems for abscissas and weights of Gauss type. P. Davis and P. Rabinowitz. To appear in the Journal of Mathematical Analysis and Applications.

(11) Criteria for the reality of matrix eigenvalues. M.P. Drazin (RIAS) and E.V. Haynsworth. Submitted to a technical journal.

(12) Boscovich and the combination of observations. To appear as Chapter 9 in "Boscovich--Studies of His Life and Work", edited by Lancelot Law Whyte.

(13) Precision and accuracy--experiment design aspects. C. Eisenhart. To appear in "Proceedings of a Symposium on Statistical Methods in the Chemistry Industry", to be held by the ASQC, Spring, 1961.

(14) Analyticity and probability properties of one-dimensional Brownian motion. A. Ghaffari. Submitted to a technical journal.

(15) A comment on Ryser's "Normal and Integral Implies Incidence" theorem. K. Goldberg. To appear in the American Mathematical Monthly.

(16) The range of a fleet of aircraft. A.J. Goldman. Submitted to a technical journal.

(17) Regions containing the characteristic roots of a matrix. E.V. Haynsworth. Submitted to a technical journal.

(18) On the determination of the eigenvalues and eigenvectors of certain matrices. A.N. Lowan. Submitted to a technical journal.

(19) Stability criteria for problems involving cylindrical and spherical symmetry. A.N. Lowan. Submitted to a technical journal.

(20) Stability criteria for various difference schemes associated with the problem of the vibrating bar. A.N. Lowan. Submitted to a technical journal.

(21) A note on normal matrices. M. Marcus and N. Khan (Muslim University, India). To appear in the Canadian Mathematical Bulletin.

Publication Activities

(22) On the maximum number of zeros in the powers of an indecomposable matrix. M. Marcus and F. May. Submitted to a technical journal.

(23) The invariance of symmetric functions of singular values. M. Marcus and H. Minc (The University of Florida). Submitted to a technical journal.

(24) Inequalities for the permanent function. M. Marcus and M. Newman. Submitted to a technical journal.

(25) The sum of the elements of the powers of a matrix. M. Marcus and M. Newman. Submitted to a technical journal.

(26) Some results on non-negative matrices. M. Marcus, H. Minc, and B. Moyles. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

(27) Congruence properties of the partition function to composite moduli. M. Newman. To appear in the Illinois Journal of Mathematics.

(28) Modular forms whose coefficients possess multiplicative properties (II). M. Newman. Submitted to a technical journal.

(29) Note on the partition function. M. Newman. Submitted to a technical journal.

(30) A new approach to the mechanical syntactic analysis of Russian. I. Rhodes. To appear in Mechanical Translation.

(31) Best approximations and interpolating functions. J.R. Rice. To appear in the Transactions of the American Mathematical Society.

(32) Split integration methods for simultaneous equations. J.R. Rice. Submitted to a technical journal.

(33) Tchebycheff approximation by exponentials. J.R. Rice. Submitted to a technical journal.

(34) Tchebycheff approximations by functions unisolvent of variable degree. J.R. Rice. To appear in the Transactions of the American Mathematical Society.

(35) Variability of spectral tristimulus values. I. Nimeroff, J.R. Rosenblatt, and M.C. Dannemiller. Submitted to a technical journal.

(36) Probability inequalities of the Tchbycheff type. I. Richard Savage. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

Publication Activities

(37) Convergence to normality of powers of a normal random variable. N.C. Severo and L.J. Montzingo. Submitted to a technical journal.

(38) On approximation by analytic functions whose Taylor coefficients lie in a sector. O. Shisha. Abstract submitted to a technical journal.

(39) Kinetic equation for plasmas with collective and collisional correlations. C.M. Tchen. Accepted for publication in the Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, Munich, Germany, August 28-September 1, 1961.

(40) Formulae for an accurate intermediary orbit of an artificial satellite. J.P. Vinti. Submitted to a technical journal.

(41) Theory of an accurate intermediary orbit for satellite astronomy. J.P. Vinti. To appear in the Journal of Research NBS, Section B (Mathematics and Mathematical Physics).

(42) A status report on ALGOL 60. J.H. Wegstein. Submitted to a technical journal.

(43) On the pedestrian queueing problem. G.H. Weiss. Submitted to a technical journal.

(44) Experimental design and ASTM committees. W.J. Youden. Submitted to a technical journal.

(45) The interpretation of preliminary measurements. W.J. Youden. Submitted to a technical journal.

(46) Partial confounding in fractional replication. W.J. Youden. To appear in Technometrics.

(47) Physical measurements and experiment design. W.J. Youden. Submitted to a technical journal.

(48) Randomization and experimentation. W.J. Youden. To appear in Annals of Mathematical Statistics.

(49) Statistical problems arising in the establishment of physical standards. W.J. Youden. To appear in the Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability, 1960.

(50) Systematic errors in physical constants. W.J. Youden. To appear in Physics Today.

(51) Systematic errors in standards of measurement. W.J. Youden. To appear in "Proceedings of the Standards and Metrology Division of the American Ordnance Association".

Publication Activities

(52) What is the best value? W.J. Youden. Submitted to a technical journal.

(53) A calculus for factorial arrangements. B. Kurkjian (Diamond Ordnance Fuze Laboratories) and M. Zelen. Submitted to a technical journal.

(54) Factorial designs and the direct product. B. Kurkjian (Diamond Ordnance Fuze Laboratories) and M. Zelen. Submitted to a technical journal.

USCOMM-NBS-DC

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

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.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

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.

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

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics. Electrolysis and Metal Deposition.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Crystal Growth. Physical Properties. Constitution and Microstructure.

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

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

Data Processing Systems. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

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

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

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

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Interval Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

Radio Systems. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

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


NBS