NASA CR-163,728

NASA-CR-163728
19810003162

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COSMIC

A Catalog of Selected Computer Programs

NASA
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Availability of Programs described in this Catalog

Programs described in this catalog may be obtained from the Computer Software Management and Information Center (COSMIC), 112 Barrow Hall, University of Georgia, Athens, Georgia, 30602, Telephone (404) 542-3265.

Additional Programs

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PUBLISHED BY:

National Aeronautics &
Space Administration
Technology Utilization Office

Foreword

The Computer Software Management and Information Center (COSMIC) is operated for NASA by the University of Georgia for the purpose of making computer programs developed in the space program available to the public. Many programs from the Department of Defense and selected software from other government agencies are also offered. At present, over 1500 programs in almost every technical or managerial discipline are available. This catalog describes about 300 of the programs for which most requests have been received.

Before offering a program for sale, COSMIC ascertains that it will compile and that the documentation describing it is adequate. Then a brief description is written for inclusion in *Computer Program Abstracts*, which is the complete catalog of software that is available (for ordering details, contact COSMIC). Especially useful programs are also described in *NASA Tech Briefs*, a free quarterly publication containing about 150 articles on NASA innovations of all types thought to have commercial application. To get on the mailing list for Tech Briefs, write NASA, Code KT, Washington, DC 20546.

Another important, and free, service offered by COSMIC is the identification of potentially useful software for customers who are unable to find what they need in the catalog. Simply call or write COSMIC to obtain assistance. Also, in some cases NASA engineers can offer guidance to users in installing or running a program when difficulties are encountered.

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COSMIC is eager to help you save money by using software for which the development expenses have already been paid. For more information about services or software available from COSMIC, call or write:

COSMIC
112 Barrow Hall
The University of Georgia
Athens, Georgia, 30602
Telephone: (404) 542-3265

TABLE OF CONTENTS

AERODYNAMICS

(Includes Aerodynamics of Bodies, Wings, Rotors, and Control Surfaces; Internal Flow in Ducts and Turbomachinery)

AIRCRAFT

(Includes Aircraft Design, Testing, and Performance; Aircraft Communication and Navigation; Aircraft Instrumentation, Aircraft Propulsion Systems; Aircraft Stability and Control)

AUXILIARY SYSTEMS

(Includes Auxiliary Power Sources Such as Chemical Power Units, Fission Electric Cells, Nuclear Power Units, Electric Batteries, Electric Generators, and Solar Power Units; Auxiliary Gas Turbines; Hydraulic, Pneumatic and Electrical Systems)

BIOTECHNOLOGY

(Includes Life Support Systems; Bioengineering (Bioinstrumentation, Biometrics, Biotelemetry, Cardiography, Electroencephalography); Personnel Training, Evaluation, and Maintenance (Medical))

CHEMISTRY

(Includes Chemical Analysis and Identification, Chemical Engineering, Electrochemistry, Inorganic and Physical Chemistry)

COMPUTERS

(Includes Programs and Systems Designed to Manage, Evaluate, and Effect Control of the Operations of Hardware Resources; Systems for the Design, Implementation, Processing, and Monitoring of Software Resources; General Systems for the Management of User Data Including Information Searches and Retrieval and Graphics Support Packages)

ELECTRONICS

(Includes Electronic Circuit Design and Analysis; Design and Development of Basic Electrical and Electronic Components; Feedback and Control Theory)

FACILITIES, RESEARCH AND SUPPORT

(Includes Simulators and Simulation Methods; Test Facility and Test Equipment Design and Operation; Cost Effectiveness, Examination and Selection of Equipment, Materials, Personnel, and Methods for Optimum Performance of Tasks; Support Facility Administration, Management and Inventory Control)

FLUID MECHANICS

(Includes Boundary Layer Flow; Compressible Flow; Gas Dynamics; Hydrodynamics and Turbulence)

GEOPHYSICS

(Includes Aeronomy; Upper and Lower Atmosphere Studies; Oceanography; Cartography; Geodesy; Hydrology and Limnology; Geochemistry and Geomagnetism)

INSTRUMENTATION AND PHOTOGRAPHY

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MACHINE ELEMENTS AND PROCESSES

(Includes Bearings and Gears, Seals, Pumps, Vacuum Technology; Lubrication and Lubricants; Friction and Wear; Materials Fabrication; Numerically Controlled Machining; Manufacturing Processes and Quality Control; Structures and Component Reliability Analysis)

MATHEMATICS

(Includes Numerical Analysis Techniques Such as Error Analysis, Function Evaluation, Numerical Integration and Differentiation, Differential and Integral Equation Solution; Combinatorial and Discrete Mathematics; Mathematical Programming; Mathematical Statistics and Probability)

STRUCTURAL MECHANICS

(Includes Structural Element Design and Weight Analysis; Fatigue Studies for Structures and Components; Stress Including Thermal) Calculation and Analysis of Structures; Analysis of Vibration and Damping in Structures; Analysis of Shell Structures Including Stresses, Loads, Buckling and Vibration)

THERMODYNAMICS AND COMBUSTION

(Includes Thermodynamic and Transport Properties; Combustion Processes and Analysis; Thermal Protection Systems; Heat Transfer; and Heat Exchangers)

AERODYNAMICS

Includes aerodynamics of bodies, wings, rotors, and control surfaces; internal flow in ducts and turbomachinery.

Vortex-Lattice FORTRAN Program for Estimating Subsonic Aerodynamic Characteristics of Complex Planforms

In recent years, some wings have become very complex because of the varied speed regimes in which they are required to operate. In order to solve the problems of preliminary designs or parametric evaluations, a computer program has been developed for estimating the subsonic aerodynamic characteristics of complex planforms. The program represents the lifting planforms with a vortex-lattice. These complex planforms include wings with variable-sweep outer panels, wings with several changes in dihedral angle across the span, wings with twist and/or camber, and a wing in conjunction with either tail or a canard. The aerodynamic characteristics of interest are lift and pitching moment for both the flat and/or twisted wing, drag-due-to-lift parameter, leading edge thrust, leading-edge suction, distributions of leading-edge thrust and suction coefficients, distributions of several span loading coefficients, distribution of lifting pressure coefficient, damping-in-pitch parameter, damping-in-roll parameter, and lift coefficient due to pitch rate. The program uses a minimum of input data to describe relatively complex planforms. These planforms may be described by up to 24 line segments on a semispan. They may have an outboard variable-sweep panel or they may have several dihedral angles across the span. In addition, two planforms may be used together to represent a combination of wings and tails or wings, bodies, and tails. The analysis has been extended to handle planforms in a sidewash field. The documentation provides examples and typical running times of various types of configurations which can be used. In addition, the results of parametric applications of the program are presented to provide guidance in specifying vortex-lattice arrangements which can be expected to give acceptable results.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Aproximately 1,572 source statements
PRICE: Program $680.00 Documentation $15 50
PROGRAM NUMBER: LAR-11047

Computer Program to Determine Pressure Distribution and Forces on Blunt Bodies of Revolution

The process described in the NASA Technical Note, NASA TN D-4865, for obtaining the surface pressures along meridian lines of blunt bodies of revolution has been programmed for high-speed digital computation. The computer program has been written to include the integration of the surface pressures in order to obtain the axial-force, normal-force, and pitching-moment coefficients. The program reads in the body geometry in terms of a spherical nosecap radius and x, y coordinates starting at the point of tangency to the nose cap. The program then generates for the desired radial angles θ the equivalent bodies which represent the shape of the meridian lines of the body at the input angle of attack. The program represents the longitudinal shape of these bodies by straight-line elements between the transformed input coordinates. The spherical cap from the stagnation point to the tangency point is represented by 20 straight-line segments. After the equivalent bodies are obtained, the pressure distributions are computed and integrated along the respective meridian lines of the input body to obtain the forces and moments. By selecting output options, the pressure and Mach number variations for each meridian line can be obtained with the forces and moments or just the forces and moments can be output.

LANGUAGE: CDC FORTRAN Extended
MACHINE REQUIREMENTS: CDC 3000 Series
PROGRAM SIZE: Approximately 879 source statements
PRICE: Program $330 00 Documentation $13 00
PROGRAM NUMBER: LAR-11197

An Improved Method for the Aerodynamic Analysis of Wing-Body-Tail Configurations in Subsonic and Supersonic Flow

A new method has been developed for calculating the pressure distribution and aerodynamic characteristics of wing-body tail combinations in subsonic and supersonic potential flow. A computer program has been developed to perform the numerical calculations. The configuration surface is subdivided into a large number of panels, each of which contains an aerodynamic singularity distribution. A constant source distribution is used on the body panels, and a vortex distribution having a linear variation in the streamwise direction is used on the wing and tail panels. The normal components of velocity induced at specified control points by each singularity distribution are calculated and make up the coefficients of a system of linear equations relating the strengths of the singularities to the magnitude of the normal velocities. The singularity strengths which satisfy the boundary condition of tangential flow at the control points for a given Mach number and

angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and moments acting on the configuration determined by numerical integration. The new method contains a number of unique features which are considered improvements over the former methods available for solving this problem. The u, v, and w components of velocity induced by surface distributions of sources and vortices at arbitrary points in the flow field are derived by an extended version of a current theory. The new method includes panels inclined to the free stream direction in both subsonic and supersonic flow, which allows a complete surface panel representation of the configuration and a corresponding improvement in the aerodynamic solution. In particular, it permits the analysis of non-circular bodies and the calculation of wing-body interference effects in the presence of body closure, two features not available in the original method. In addition, the use of a vortex distribution having a linear variation in the streamwise direction results in improved chordwise pressure distributions on wing and tail surfaces. The computer program is written in FORTRAN IV for the CDC-6600 computer, occupies 70,000 (octal) words and operates in overlay mode. The program requires five peripheral storage disc-files in addition to the input and output files.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 6,594 source statements
PRICE: Program $960.00 Documentation $27.50
PROGRAM NUMBER: LAR-11305

Modified Multhopp Lifting Surface Method of Aero Characteristics

This program determines the longitudinal subsonic aerodyanmic characteristics of wings, which may be composite, by an extension of the approach used by Multhopp. The solution is based on linearized potential flow with compressibility being accounted for by use of the Prandtl-Glauret factor. The characteristics determined include the overall lift-curve slope, the overall pitching-moment-curve slope, the aerodynamic center, the ratio of the induced drag based on the spanwise distribution of circulation to the lift coefficient, and many of the section features. The loadings for wings with twist and camber can also be computed. Since a large portion of this program is concerned with computation of required geometric representation, two additional routines are included to aid in obtaining this geometric input data for the program. One routine determines the aspect ratio of a wing which can have a broken leading and trailing edge and skewed tip. In addition, the program can iterate on the trailing edge sweep to determine the required angle to give a particular aspect ratio. The other routine determines the X and Y location of the pivot that an arrow wing with a skewed tip in its high sweep position must have in order for: (1) the pivot to occur at a certain fraction of the high sweep normal chord, and (2) the outer panel in the low sweep position to have a certain specified span increase over that of the high sweep wing.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,023 source statements
PRICE: Program $440.00 Documentation $12.50
PROGRAM NUMBER: LAR-11573

A Computer Program for Calculating Inviscid, Adiabatic Flow About Blunt Bodies Traveling at Supersonic and Hypersonic Speeds at Angle of Attack

This is a computer program which calculates inviscid plane, axisymmetric, and three dimensional flow about blunt bodies traveling at supersonic and hypersonic speeds in a uniform free stream. An exact time-dependent finite-difference method of second order accuracy is used. The bodies which can be treated include plane and axisymmetric bodies with sharp shoulders and smooth nonaxisymmetric bodies. Equilibrium air and perfect-gas thermodynamic models can be used and a procedure for approximating equilibrium gases with the perfect gas model is also described. The results of the program include the shock-wave location and the flow properties at a number of grid points on the body surface, on the shock wave, and in the region between the body and shock.

LANGUAGE: FORTRAN IV
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PRICE: Program $340.00 Documentation $9.00
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Subsonic Annular Wing Theory With Application to Flow About Nacelles

This program was written to assist in the design of high-bypass-ratio fan engine nacelles. These nacelles can be treated as annular wings on which the circulation developed determines both the external and internal flow. The program was developed for calculating the flow over a nacelle at zero angle of attack and at subsonic Mach numbers. The method uses the annular wing theory and boundary-layer theory and has shown good correlation to experimental data. The method permits variation of the mass flow by changing the size of a center body.

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This computer program provides a flow analysis of a radial inflow gas turbine. The program obtains a meridional solution on the mean surface between the blades, followed by solutions on hub, mean, and shroud blade-to-blade surfaces, in a single computer run. Suggestions for modifying the program for use with other types of turbomachines are given. Techniques for overcoming convergence problems are discussed. The method used is based on an equation for the velocity gradient along an arbitrary quasi orthogonal between blades and is similar to a method using quasi-orthogonals in a meridional plane. With this method, a streamline analysis can be made for any blade-to-blade stream surface. This surface, if desired, may be assumed to be a surface of revolution generated by a meridional streamline obtained from a meridional streamline analysis. On this stream surface a two-dimensional solution for the velocity and pressure distributions is obtained. With several such blade-to-blade solutions, the velocity distribution throughout the rotor passage can be calculated. Simplifying assumptions for upstream and downstream conditions are made for the purpose of readily obtaining a reasonable approximation near the inlet and outlet.

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LANGUAGE: FORTRAN IV (89%), MAP (11%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 1,415 source statements
PRICE:Program $460.00 Documentation $14.00
PROGRAM NUMBER: LEW-00226

Computer Program for Analysis of Geometry and Design Point Performance of Axial Flow Turbines

This program was developed to solve the basic equations which govern the design-point performance of an axial flow turbine, avoiding lengthy and time-consuming numerical methods. The program is capable of analyzing both single and multispool units (a maximum of three spools is allowed). The program will determine the standard turbine design parameters at a pre-selected number of streamlines. These parameters will be consistent with the requirement of radial equilibrium, the definition of blade element performance being used for the analysis, and the input specifications of design requirements and analysis variables when a valid solution of the design problem exists. When used for the analysis of a single spool, designs for any number of sets of analysis variables may be computed consecutively.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,214 source statements
PRICE: Program $460.00 Documentation $28.00
PROGRAM NUMBER: LEW-10471

FORTRAN Program For Calculating Velocities and Streamlines on a Blade to Blade Stream Surface of a Tandem Blade Turbomachine

This computer program gives the blade-to-blade solution of the two-dimensional, subsonic, compressible (or incompressible), nonviscous flow problem for a circular or straight infinite cascade of tandem or slotted turbomachine blades. The blades may be fixed or rotating. The flow may be axial, radial, or mixed. The method of solution is based on the stream function using an iterative solution of nonlinear finite-difference equations. These equations are solved using two major levels of iteration. The inner iteration consists of the solution of simultaneous linear equations by successive overrelaxation, using an estimated optimum overrelaxation factor. The outer iteration then changes the coefficients of the simultaneous equations to correct for compressibility. The program input consists of the basic blade geometry, the meridional stream channel coordinates, fluid stagnation conditions, weight flow and flow split through the slot, and inlet and outlet flow angles. The output includes blade surface velocities, velocity magnitude and direction throughout the passage, and the streamline coordinates.

LANGUAGE: FORTRAN IV (99%), MAP (1%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,583 source statements
PRICE: Program $460.00 Documentation $14.50
PROGRAM NUMBER: LEW-10743

Fortran IV Program to Estimate the Off Design Performance of Radial Inflow Turbines

This program is designed to calculate the off-design performance of radial inflow turbines. The analysis consists of a one-dimensional solution of flow conditions along the mean streamline, using perfect gas relations and is written for subsonic flow only, since stator choking is not expected. The program uses the thermodynamic equations of rotor incidence loss and the calculation of additional performance parameters. Use of the program requires as input information the turbine flow areas, diameters, and blade angles. An estimate of design point performance is also necessary. The output consists of conventional performance parameters at specified flow conditions and speeds.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/7044 DCS
PROGRAM SIZE: Approximately 407 source statements
PRICE: Program $280.00 Documentation $8.50
PROGRAM NUMBER: LEW-10764

Computer Programs for Axial Flow Compressor Design

Four FORTRAN IV computer programs for the design of axial flow compressors have been developed. (1) The first of these programs was based on the assumption of simple radial equilibrium of static pressure and constant efficiency radially. In this program, limits on hub and tip ramp angles, axial velocity ratio across blade rows, rotor hub and stator tip loadings, rotor exit relative flow angle, and stator hub Mach number are specified; the velocity diagram and stage-by-stage performance are calculated. (2) The second program accounts for complete radial equilibrium of flow. Losses are evaluated on the basis of blade element loss prediction methods. Radial distribution of energy is specified as a polynomial variation of whirl velocities at the exit of each blade row; rotor tip loadings, limiting values of rotor hub relative exit angles, stator hub Mach numbers, stator hub loadings, and the compressor flow path are also specified. (3) Program 3 differs from Program 2 in that the radial distribution of total pressure is specified for each rotor blade row rather than the whirl velocity distribution, and there is the option of specifying the flow path or specifying the axial velocity ratios and calculating the resulting flow path. (4) The fourth program developed is an off-design performance calculation. The calculation accounts for variable specific heat and full radial equilibrium and determines energy addition and adiabatic efficiencies on the basis of data for blade element turning and loss. The program user has available as options either double-circular-arc or NACA 65-series blade performance data, plus the capability of specifying reference incidence angle through tabular input for any individual blade row or through the criterion of suction surface tangency for any double-circular-arc blade row. The off-reference increment in deviation angle is furnished in the form of a correlation of selected NASA data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approxmately 14,251 source statements
PRICE: Program $1,070.00 Documentation $50.50
PROGRAM NUMBER: LEW-10765

Turbo-Fortran Program for Calculating Velocities and Streamlines on a Blade-to-Blade Stream Surface of a Turbomachine

This program is a revision of an existing program for blade-to-blade aerodynamic analysis of turbomachine blades and it is a simpler program while consistent with related programs. The analysis is for two-dimensional, subsonic, compressible (or incompressible), nonviscous flow in a circular or straight infinite cascade of blades, which may be fixed or rotating. The flow may be axial, radial, or mixed, and the stream channel thickness may

change in the through-flow direction. The program input consists of blade and stream channel geometry, total flow conditions, inlet and outlet flow angles, and blade-to-blade stream channel weight flow. The output includes blade surface velocities, velocity magnitutde and direction at all interior mesh points in the blade-to-blade passage, and streamline coordinates throughout the passage.

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,171 source statements
PRICE: Program $480.00 Documentation $5.50
PROGRAM NUMBER: LEW-10768

Magnify— Fortran Program for Calculating Velocities in a Magnified Region on a Blade to Blade Surface of a Turbomachine

This program obtains a local detailed solution around a leading or trailing edge or in a slot region for compressible, subsonic, nonviscous flow on a blade-to-blade surface between turbomachine blades. Using this program, a coarse mesh solution for an entire blade-to-blade region can be magnified by a chosen magnification factor in a small rectangular region. The program input requires information obtained from a less detailed solution from one of three programs: TURBLE, TANDEM, and 2DCP. These programs are available from COSMIC. The output includes detailed surface velocities, velocity magnitude and direction, and stream function values throughout the magnified region. The method is based on the stream function with the solution of the simultaneous, nonlinear finite-difference equations being obtained by two major levels of iteration. The inner iteration consists of the solution of simultaneous linear equations by successive overrelaxation, using an estimated optimum overrelaxation factor. The outer iteration then changes the coefficient of the simultaneous equations to compensate for compressibility.

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE REQUIREMENTS: IBM-7094
gprogram size: approximately 2,516 source statements
PRICE: Program $480.00 Documentation $9.50
PROGRAM NUMBER: LEW-10769

Tsonic—Fortran Program For Calculating Transonic Velocities on a Blade Stream Surface of a Turbomachine

This program obtains a transonic flow solution on a blade-to-blade surface between blades of a turbomachine. The flow must be essentially subsonic, but there may be locally supersonic flow. The solution is two-dimensional, isentropic, and shock-free. The baldes may be fixed or rotating. The flow may be axial, radial, or mixed, and there may be a change in stream channel thickness in the through-flow direction. A loss in relative stagnation pressure may be accounted for. The program input consists of blade and stream-channel geometry, stagnation flow conditions, inlet and outlet flow angles, and blade-to-blade stream-channel weight flow. The output includes blade surface velocities, velocity magnitude and direction at all interior mesh points in the blade-to-blade passage, and streamline coordinates throughout the passage. The transonic solution is obtained by a combination of a finite-difference, stream function solution and a velocity-gradient solution. The finite-difference solution at a reduced weight flow provides information needed to obtain a velocity gradient solution.

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,602 source statements
PRICE: Program $480.00 Documentation $10.50
PROGRAM NUMBER: LEW-10977

Analysis of Geometry and Design Point Performance of Axial Flow Turbines Using Specified Meridional Velocity Gradients

This computer program uses a non-restrictive method for determining the alternative geometries and associated design point performance of axial-flow turbines capable of satisfying specified design requirements; it solves the flow field within the turbine without making the simplifying assumptions that result in restrictive designs. The program is capable of analyizing both single and multispool units (a maximum of three spools is allowed), and each spool may have up to eight stages. The absolute and relative flow fields are computed at the first stator inlet, at each interblade row plane, and at the final rotor exit. The effects of the radial variation of the following quantities are taken into account: inlet conditions, streamline angle of inclination and curvature, loss coefficient or efficiency, meridional velocity, or angle. Further, the effects of coolant flows, interfilament mixing, and a station-to-station variation of specific heat can be included. As additional features, the program allows for: (1) the internal calculation of losses based on a correlation which has been developed for pressure-loss coefficient, and (2) either subsonic or supersonic solutions for the absolute velocity. The program will determine the standard turbine design parameters at a preselected number of streamlines. These parameters will be consistent with the requirement of radical equilibrium, the specified or calculated blade element performance, and the input specifications of design requirements. When used for the analysis of a single spool, designs for any number of sets of analysis variables may be computed consecutively. This program is a modification of LEW-10471 (M69-10338). It complements the original rather than replaces it in that not all of the originally selected optimal specifications of a design are made available in this new version. However, the new version can be used independently of the original for designs in which blade-element performance is directly specified by total-pressure-loss coefficients or indirectly by the coefficients of a correlation of the total-pressure-loss coefficient chosen for fully consistent analysis

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,038 source statements
PRICE: Program $490.00 Documentation $21.00
PROGRAM NUMBER: LEW-11029

Fortran Program for Quasi-Three Dimensional Calculation of Surface Velocities and Choking Flow for Turbomachine Blade Rows

A computer program, CHANEL, has been developed to obtain a quasi-three dimensional solutions of surface velocities and choking flow for turbomachinery blade rows. The aerodynamic design of turbomachinery blades requires the determination of blade surface velocity distribution. Also, it is necessary to know the choking flow. In many designs, there are significant velocity gradients both from blade-to-blade and from hub-to-tip. This condition necessitates consideration of the three-dimensional effects. One of the useful techniques for calculating surface velocities where three-dimensional

effects are of importance is the velocity gradient (stream filament) method. The general velocity gradient equation determines the velocity variation in any direction. In particulatr, the velocity gradient equation can be reduced to special cases to determine both the blade-to-blade and hub to tip variation in velocity. A combination of the velocity variation in two directions with a specified mass flow will determine the velocities at a passage cross section. This method works well in a well-guided passage. Some of the coinditions that can be handled by the CHANEL program could not be handled previously are: (1) Nonuniform inlet temperature, pressure, and prewhirl; (2) Nonaxial flow where meridional flow angle; (3) Meridional streamline curvature; (4) Radius can vary as desired from the hub to the tip.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 433 source statements
PRICE: Program $370.00 Documentation $6.50
PROGRAM NUMBER: LEW-11635

FORTRAN Program for Calculating Velocities in the Meridional Plane of a Turbomachine

A computer program has been developed which calculates the velocities in the meridional plane of a centrifugal compressor. This program will determine the velocities in the meridional plane of a backward-swept impeller, a radial impeller, and a vaned diffuser. The velocity gradient equation with the assumption of a hub-to-shroud mean stream surface is solved along arbitrary quasi-orthogonals in the meridional plane. These quasi-orthogonals are fixed straight lines that remain fixed, regardless of any streamline change. If the streamlines are not smooth, a smoothing routine can be used. Increased interest has been shown in high pressure-ratio backward-swept centrifugal impellar blades because centrifugal compressors with such blades have the potential of achieving higher efficiencies than those with radial impeller blades. Several methods are available for designing radial bladed compressors, but only limited work has been done on backward swept impeller blades. The input quantities consist essentially of mass flow, rotational speed, number of blades, specific-heat ratio, inlet total temperature and density, gas constant, loss in total relative pressure, hub-to shroud profile, mean blade shape, and a normal thickness table. In the input, each item has units specified in both the SI and US customary systems. Since the program does not use any constants which depend on the system of units being used, any consistent set of units may be employed.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,264 source statements
PRICE: Program $590.00 Documentation $6.50
PROGRAM NUMBER: LEW-11796

Computer Program for Preliminary Design Analysis of Axial Flow Turbines

A computer program has been developed for the preliminary design analysis of axial flow turbines. The computations are based on mean-diameter flow properties and do not consider any radial gradients. Specific heat ratio is assumed constant throughout the turbine. For any given turbine, all stages, except the first, are specified to have the same shape velocity diagram. The first stage differs only in that the inlet flow is axial. The velocity diagram shape depends upon the speed-work parameter value and the specified type of velocity diagram. Any of three types of velocity diagrams can be specified: symmetrical, zero exit swirl, or impulse. Exit turning vanes can be included in the design. Input design requirements include power or pressure ratio, mass flow rate, inlet temperature and pressure, and rotative speed. The design variables include inlet and exit diameters, stator angle or exit radius ratio, and number of stages. Gas properties are input as gas constant, specified heat ratio, and viscosity.The program output includes inlet and exit annulus dimensions, exit temperature and pressure, total and static efficiencies, blading angles, and last-stage critical velocity ratios.Program verification by COSMIC was limited to compilation and link-edit on an IBM-7094

LANGUAGE: FOPRTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 598 source statements
PRICE: Program $370.00 Documentation $6.50
PROGRAM NUMBER: LEW-11815

Computer Program for Calculating Potential Flow in Propulsion System Inlets

In the process of designing inlets, particularly for Vertical Takeoff and Landing and Short Takeoff and Landing propulsion systems, a system of three computer programs evolved. The chief program is an axisymmetric potential flow program which calculates the incompressible potential flow about arbitrary axisymmetric bodies. One generates input from various specified analytic shapes for the inlet components. The other program takes basic solutions of interest and applies a compressibility correction.

LANGUAGE: FORTRAN IV (94%), MAP (6%)
PROGRAM REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 7,083 source statements
PRICE: Program $630.00 Documentation $15.00
PROGRAM NUMBER: LEW-12152

Computer Program for Definition of Transonic Axial-Flow Compressor Blade Rows

A computer program for designing axial flow compressor blading from stacked blade elements has been developed. The particular type of blade element used has two segments which have centerlines and surfaces described by constant change of angle with path distance on a cone. The computer program begins with input from velocity diagrams for stations near the leading and trailing edges of the blade and parameters for blade-element description. The blade design steps are: (1) blade-element definition, (2) blade-element stacking, (3) interfacing the reference station velocity diagrams to the blade-element edges, and (4) terminal calculations. The first three parts are used in an iterative procedure to establish the blade for terminal calculations. Blade-element angles are obtained from the velocity diagrams by (1) correcting the velocity diagrams from fixed locations to the edges of the blades through continuity and conservation of angular momentum principles as stacking adjustments move the blade edges, (2) determining and applying incidence and deviation angles at the edges of the blade with one of several common methods chosen through control options, and (3) correcting the inlet and outlet blade edge angles on a streamline of revolution to the blade element layout cone with the use of appropriate direction derivatives. The iterative stacking adjustments are made by translating the

blade elements along the cone so that the center of area of the associated blade section is alined on the stacking axis. The stacking axis through input controls can be leaned in either the axial or tangential directions. The output of the computer program gives coordinates for fabrication and properties for aeroelastic analysis on planar blade section. These coordinates and properties are defined by interpolation across conical blade elements to planes perpendicular to radial line through the hub stacking point. The output blade-section properties are area, center-of-area location, stacking-point location, maximum and minimum moments of inertia along with their orientation, torsion constant, and twist stiffness.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 3,523 source statements
PRICE: Program $350.00 Documentation $19.00
PROGRAM NUMBER: LEW-12325

Stanton Number - Aerodynamic Heating

This desk-top procedure calculates the Stanton Numbers corresponding to specified flow conditions and configurations in the rarefaction regime. The solutions are valid for 3-D stagnation wedge/cylinder flows, cone/ogive flows, yawed-cylinder flows, flat plate flows and all combinations of the models (ogive for instance) dependent only upon selection of the proper option within the program provided. First and second order boundary conditions, where continuum and free molecular flow regimes are defined, are satisfied and accounted for in the program. The curve fits of experimental data reproduce the polynomials that generate the Stanton Number variations. In the non-continuum regime, the Stanton Number is given as a function of a newly developed rarefaction coefficient, W, that combines the Mach number, Reynolds Number, compressibility factor, and Knudsen number.

LANGUAGE: Instructions and data are entered at the time of processing.
MACHINE REQUIREMENTS: Hewlett Packard 9820A
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold seperately from the program listing.
PROGRAM NUMBER: MSC-19493

AIRCRAFT

Includes aircraft design, testing, and performance; aircraft communication and navigation; aircraft instrumentation, aircraft propulsion systems; aircraft stability and control.

Aircraft Noise Source and Contour Estimation Computer Program

This computer system was developed for 1/3 octave band noise estimates for quiet engines, lift fans, lift/cruise fans, propellars and helicopters in addition to conventional jet engines. It also has the capability of computing noise contours (footprints). The system was written as two programs, one for providing source noise estimates for an aircraft operating at a prescribed set of conditions and the second to compute noise contours for an aircraft during takeoff or landing operations.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 10,768 source statements
PRICE: Program $1,420.00 Documentation $32.00
PROGRAM NUMBER: ARC-10380

Prediction of Stall Characteristics of Straight Wing Aircraft

The objective of this computer program is to calculate the span-wise distributions of lift, drag, and pitching moment coefficients on a wing-fuselage combination up to the angle-of-attack at which stall occurs and to predict the spanwise position of initial stall. The program considers an unswept wing with a circular or elliptical fuselage. The wing may have part-or full-span deflected flaps, and the wing aspect ratio must be 6 or greater. For a wing without fuselage the lifting line method of Sivells (NACA TR 1090) is employed. When a fuselage is present the method of Multhopp (NACA TM 1036) is used to transform the wing-fuselage combination into an equivalent wing-alone configuration. Lifting line theory, which is then applied to this transformed configuration, employs two-dimensional, experimental airfoil characteristics to obtain the lift, drag, and pitching moment coefficients at each station on the wing span. For a selected value of fuselage angle-of-attack, an approximate distribution of section lift coefficient is assumed. This distribution is then used to calculate the section angles of attack at each spanwise station on the wing. From curves of experimental section lift versus angle-of-attack, new values of section lift are obtained and compared with the initial values. Using the differences between initial and calculated values, a new and better approximation to the lift distribution is calculated. An iterative procedure is then employed until the guessed and calculated values agree. Once the correct lift distribution is established, the distributions of drag and pitching moment are obtained from the curves of experimental two-dimensional airfoil section characteristics. Spanwise integration of the lift, drag, and pitching moment distributions yield the overall wing lift, drag, and pitching moment, respectively. If calculations are made at a sufficiently high value of fuselage angle-of-attack a point on the span will be reached where the local angle-of-attack equals or exceeds the angle of-attack for maximum lift as determined from the two-dimensional section data. When this occurs the wing is said to stall. Thus the method can be used to predict the spanwise location of initial stall on the wings of wing-fuselage combinations.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 10,295 source statements
PRICE: Program $370.00 Documentation: $22.50
PROGRAM NUMBER: LAR-11013

Theoretical Prediction of Interference Loading on Aircraft

A method is developed for theoretically predicting the loading on pylon mounted stores in subsonic compressible flow. Linear theory is used, without two-dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. The interference loading is integrated over the store length by considering the local crossflow, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach .8 are compared to wind tunnel data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 series
PROGRAM SIZE: Approximately 1,600 source statements
PRICE: Program $590.00 Documentation $22.00
PROGRAM NUMBER: LAR-11249

Theoretical Prediction of Interference Loading on Aircraft Stores - Supersonic Case

A program was developed for theoretically predicting the loading on pylon-mounted stores in supersonic flow. Linear theory is used, without two-dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. Aircraft shock wave locations are predicted, and their effect on the flow field is included through a transformation of the aircraft geometry. The interference loading is integrated over the

store length by considering the local crossflows, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 1.2 are compared to wind tunnel data. The method is computerized, and program user information is included. A companion report presents the method in subsonic flow.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,310 source statements
PRICE: Program $700.00 Documentation $21.50
PROGRAM NUMBER: LAR-11250

An Improved Method for Design of Expansion Chamber Mufflers with Application to an Operational Helicopter

An improved method for the design of expansion-chamber mufflers for reciprocating engines is described and applied to the task of reducing exhaust noise generated by a helicopter. The method is an improvement of standard transmission line theory in that it accounts for the effect of the mean exhaust-gas flow on the acoustic-transmission properties of muffler system, including the termination boundary condition. The method has been computerized, and the computer program includes an optimization procedure that adjusts muffler component lengths to achieve a minimum specified desired transmission loss over a specified frequency range. A field test of a muffler designed with the aid of this method was conducted on a helicopter (H130 with a known exhaust-noise problem. When the exhaust noises of the helicopter with a standard exhaust system and a similar helicopter with a muffler system installed were compared for hover flight conditions, the muffler system was found to reduce the exhaust noise by approximately 11 dB ?A). No significant degradation in the engine performance was observed.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 817 source statements
PRICE: Program $350.00 Documentation $10.00
PROGRAM NUMBER: LAR-11548

Computer Program for Design Point Performance of Turbojet and Turbofan Engine Cycles

This program is one designed for the calculation of design-point performance of turbojet and turbofan engine cycles. This program requires as input the airplane Mach number, the altitude-state equations, turbine-inlet temperature, afterburner temperature, duct-burner temperature, bypass ratio, coolant flow, component efficiencies, and component pressure ratios. The output yields specific thrust, specific fuel consumption, engine efficiency, and several component temperatures and pressures. The thermodynamic properties of the gas are expressed as functions of temperature and fuel to-air ratio. The program is provided with an example case.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 370 source statements
PRICE: Program $250.00 Documentation $7.50
PROGRAM NUMBER: LEW-10952

Analysis of Jet Engine Burst Rotor Containment Devices

The turbojet engine in wide use today has proven itself to be the most reliable and trouble free aircraft engine in the history of aviation. Yet, the uncontained failure of high-speed rotating turbojet engine parts, due either to an undiscovered fault in the engine, or catastrophic ingestion of foreign matter, is a well-documented problem. The possibility of just one commercial airliner crashing because of an uncontained engine failure is sufficient incentive to search for a solution to the problem. A computer program (JETI) has been developed to predict the large two-dimensional elastic-plastic dynamic deformations of a free, non-uniformly heated circular ring subjected to an initial impulse loading followed by a time-dependent forcing function which could be defined to simulate the forces which result from the interaction of a burst rotor blade and a containment ring. Provisions which account for temperature-dependent material properties and effects of temperature-induced thermal stresses are included. Temperature-dependent, strain-hardening, and strain-rate effects of the ring material are taken into account. A new method which uses measured ring position data obtained from high-speed motion picture film is proposed to calculate the approximate "external forces" acting on the ring caused by a fragment-ring interaction. The required accuracy in position measurements to obtain meaningful forces is presented together with resulting example forces.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,491 source statements
PRICE: Program: $590.00 Documentation. $17.50
PROGRAM NUMBER: LEW-11339

Computer Programs for Predicting Turbopump Inducer Loading, Stress Magnitude, Distribution and Vibration Characteristics

Inducers are widely used in rocket engine turbopumps to prevent cavitation in the pump main stages, thereby, permitting higher turbopump operating speeds and/or reduced pump inlet pressure. In the design of an inducer, hydrodynamic performance can be accurately predicted from empirical loss and deviation data. The prediction of operating stresses presents a problem, however, because (1) there is a lack of information on blade pressure loading and (2) the complexity of the inducer blade shape prevents simple steady and vibratory stress analysis. Consequently, inducer mechanical design is usually based on several approximations, with liberal safety factors being applied. This approach results in relatively heavy inducers with undesirably thick blades. Three computer programs have been developed for the prediction of (1) design and off design hydrodynamic blade loading under cavitating and non-cavitating conditions, (2) blade stresses due to hydrodynamic and centrifugal loading, and (3) blade resonant frequencies and relative stress distribution for turbopump inducers. The hydrodynamic computer program predicts internal flow conditions and blade pressure loadings within an inducer. The input can be divided into two parts: (1) A geometric description of the inducers; and (2) a description of the inducer operating flow parameters. More than one set of flow parameters may be input for a given inducer geometry. The stress computer program breaks the inducer blade into flat triangular elements for analysis. The program then calculates stress magnitude and distribution caused by pressure loading and centrifugal force using the matrix displacement method. Input to the stress program generally consists of: A physical description of the inducer, a description of the finite

store length by considering the local crossflows, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 1.2 are compared to wind tunnel data. The method is computerized, and program user information is included. A companion report presents the method in subsonic flow.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,310 source statements
PRICE: Program $700.00 Documentation $21.50
PROGRAM NUMBER: LAR-11250

An Improved Method for Design of Expansion Chamber Mufflers with Application to an Operational Helicopter

An improved method for the design of expansion-chamber mufflers for reciprocating engines is described and applied to the task of reducing exhaust noise generated by a helicopter. The method is an improvement of standard transmission line theory in that it accounts for the effectof the mean exhaust-gas flow on the acoustic-transmission properties of muffler system, including the termination boundary condition. The method has been computerized, and the computer program includes an optimization procedure that adjusts muffler component lengths to achieve a minimum specified desired transmission loss over a specified frequency range. A field test of a muffler designed with the aid of this method was conducted on a helicopter (H130 with a known exhaust-noise problem. When the exhaust noises of the helicopter with a standard exhaust system and a similar helicopter with a muffler system installed were compared for hover flight conditions, the muffler system was found to reduce the exhaust noise by approximately 11 dB ?A). No significant degradation in the engine performance was observed.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 817 source statements
PRICE: Program $350.00 Documentation $10.00
PROGRAM NUMBER: LAR-11548

Computer Program for Design Point Performance of Turbojet and Turbofan Engine Cycles

This program is one designed for the calculation of design-point performance of turbojet and turbofan engine cycles. This program requires as input the airplane Mach number, the altitude-state equations, turbine-inlet temperature, afterburner temperature, duct burner temperature, bypass ratio, coolant flow, component efficiencies, and component pressure ratios. The output yields specific thrust, specific fuel consumption, engine efficiency, and several component temperatures and pressures. The thermodynamic properties of the gas are expressed as functions of temperature and fuel-to-air ratio. The program is provided with an example case.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 370 source statements
PRICE: Program $250.00 Documentation $7.50
PROGRAM NUMBER: LEW-10952

Analysis of Jet Engine Burst Rotor Containment Devices

The turbojet engine in wide use today has proven itself to be the most reliable and trouble free aircraft engine in the history of aviation. Yet, the uncontained failure of high-speed rotating turbojet engine parts, due either to an undiscovered fault in the engine, or catastrophic ingestion of foreign matter, is a well-documented problem. The possibility of just one commercial airliner crashing because of an uncontained engine failure is sufficient incentive to search for a solution to the problem. A computer program (JETI) has been developed to predict the large two-dimensional elastic-plastic dynamic deformations of a free, non uniformly heated circular ring subjected to an initial impulse loading followed by a time-dependent forcing function which could be defined to simulate the forces which result from the interaction of a burst-rotor blade and a containment ring. Provisions which account for temperature-dependent material properties and effects of temperature-induced thermal stresses are included. Temperature-dependent, strain-hardening, and strain-rate effects of the ring material are taken into account. A new method which uses measured ring position data obtained from high speed motion picture film is proposed to calculate the approximate "external forces" acting on the ring caused by a fragment-ring interaction. The required accuracy in position measurements to obtain meaningful forces is presented together with resulting example forces.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,491 source statements
PRICE: Program: $590.00 Documentation: $17.50
PROGRAM NUMBER: LEW-11389

Computer Programs for Predicting Turbopump Inducer Loading, Stress Magnitude, Distribution and Vibration Characteristics

Inducers are widely used in rocket engine turbopumps to prevent cavitation in the pump main stages, thereby, permitting higher turbopump operating speeds and/or reduced pump inlet pressure. In the design of an inducer, hydrodynamic performance can be accurately predicted from empirical loss and deviation data. The prediction of operating stresses presents a problem, however, because (1) there is a lack of information on blade pressure loading and (2) the complexity of the inducer blade shape prevents simple steady and vibratory stress analysis. Consequently, inducer mechanical design is usually based on several approximations, with liberal safety factors being applied. This approach results in relatively heavy inducers with undesirably thick blades. Three computer programs have been developed for the prediction of (1) design and off design hydrodynamic blade loading under cavitating and non-cavitating conditions, (2) blade stresses due to hydrodynamic and centrifugal loading, and (3) blade resonant frequencies and relative stress distribution for turbopump inducers. The hydrodynamic computer program predicts internal flow conditions and blade pressure loadings within an inducer. The input can be divided into two parts (1) A geometric description of the inducers; and (2) a description of the inducer operating flow parameters. More than one set of flow parameters may be input for a given inducer geometry. The stress computer program breaks the inducer blade into flat triangular elements for analysis. The program then calculates stress magnitude and distribution caused by pressure loading and centrifugal force using the matrix displacement method. Input to the stress program generally consists of: A physical description of the inducer, a description of the finite

element breakup to be used, and a description of the blade pressure distribution. The vibration computer program is a finite element analysis which uses many of the same subroutines as the stress program. This program calculates natural frequencies and the distribution of relative displacement and stress for each resonant frequency. Input to this program generally consists of: A physical description of the inducer, a description of the finite element breakup to be used, and a specification of the number of vibratory nodes required.

LANGUAGE: FORTRAN G (95.6%); ASSEMBLER (4.4%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,847 source statements
PRICE: Program $950.00 Documentation $43.50
PROGRAM NUMBER: LEW-11516

Computer Programs for Handling Propulsion System Noise Data

This is a system programs which deals with a variety of noise data reduction and analysis tasks. The data under consideration are 1/3 octave band spectra obtained from multiple far field angular microphone positions about a source. The central program (WODAG, for WOrking DAta Generation) takes raw measured data arrays, corrects them for atmospheric absorption for the test conditions and computes the source emission characteristics. These include the overall acoustis power level, the power spectrum and directivity index for each frequency. Standard day atmospheric absorptions are computed, and the data is extrapolated to various distances for which perceived noise levels are also computed. Of particular importance are the source emission characteristics which, in addition to their intrinsic value, are punched into a set of cards called working data which contain all the information necessary to reconstruct the acoustic field data. Retained by users, and in conjunction with other programs which are given, they provide non-programmers with comprehensive data manipulation and analysis capability. Many common computational tasks are relegated to subroutines permitting the user having special needs to easily program ordinary tasks and to concentrate on the special requirements.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,833 source statements
PRICE: Program $200.00 Documentation $8.00
PROGRAM NUMBER: LEW-12265

LAGLOP Landing Gear Loads Program

A computer program has been developed to compute landing gear ground reaction loads to be used for airplane-type landing gear. The program is written for the analysis of conventional airplane-type wheel-tire landing gear configurations consisting of a single nose gear and two main gears. When a gear consists of a multiple wheel assembly, the loads computed for that gear are divided equally among the wheels. The loads consist of vertical, drag, and lateral loads applied at the ground. The exceptions are the drag loads for the landing spin up and springback conditions which are applied at the axle. Input data consists of the vehicle weight, center of gravity, location, main and nose gear location, and the gear factor. Output consists of tabulation of vertical, drag, and lateral loads for the nose and main gear.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 279 source statements
PRICE: Program $160.00 Documentation $3.50
PROGRAM NUMBER: MSC-17572

AUXILIARY SYSTEMS

Includes auxiliary power sources such as chemical power units, fission electric cells, nuclear power units, electric batteries, electric generators, and solar power units; auxiliary gas turbines; hydraulic, pneumatic and electrical systems.

POSIMO—Power System Simulator Model

The power system is considered to be a group of both power consuming or power donating power elements. Each element may be either a passive load or a load which may serve as a source for subsequent connected loads. The numerous combinations in which such a set of power elements can interact to form a particular power system can be expressed in terms of kind and number of serial and parallel interconnections between these elements, while the various power flow configurations in any such power system are determined on the one side of the 2n combinations of the N status indicators and on the order side by the power dependant response of the sources involved. The analysis of the power element combinations to a particular power system is performed by program POSIMO PREParation while the calculation of the different power flow configurations and their inherant power balance and charge budget response is done by POSIMO EXECution. POSIMO PREP will generate the required data set for POSIMO EXEC from three different sources of input: 1. a load - source - assignment list, 2. a load - status - assignment list and 3. a set of coordinates denoting the efficiency vs. power response of the different sources. The outstanding feature of the approach lies in the simplicity of the lists to be entered, inasmuch as any list item refers to only one seperate power element disregarding its connections and impacts on any of the remaining elements of the system. The first list simply states how much power from which response to which of the power elements is received or submitted. The second list is simply represented by the Boolean expressions of status indicators for each power element. Both the sequence of element names appearing in the two lists and the status indicators in the Boolean expressions may be written in random order. Usually one parameter (the nominal power) will be sufficient to describe the power property of a single power element. For increased flexibility; however, POSIMO is prepared to take up to 3 power parameters along with one parameter processing designator. If more than one parameter shall be employed, the user can easily insert his own processing routines. Basically, POSIMO can handle power systems of any extent and configuration if they can be described by the three input sources as mentioned above. Limits due to reasonable array dimensions have been introduced into POSIMO for power systems considered to be sufficiently extensive and comprising up to 200 elements, 50 of which may be both loads and sources and up to 10 sources in series. The power systems may be controlled by up to 100 status indicators which may be combined in Boolean expressions with up to 8 ANDs and 8 ORs.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,131 source statements
PRICE: Program $560.00 Documentation $11.00
PROGRAM NUMBER: GSC-11505

Transformer Optimization Program

A computer program has been developed for performing transformer optimization. In using this program, values of flux density, frequency, primary and secondary voltage and current, materials constants, and input volts per turn ratio must be known or assumed. Given these parameters, the program computes: (1) primary and secondary turns, resistance, length of windings and losses; (2) core size, volume, weight and losses; (3) voltage regulation; and (4) overall transformer efficiency. The output tabulation consists of the computed results versus volts per turn ratio. Since frequency and flux density are not included in the transformer optimization routine, the program is not complete. In its present condition, it would make a good subroutine in a more general transformer optimization program.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 223 source statements
PRICE: Program $140.00 Documentation $19.50
PROGRAM NUMBER: LEW-10299

ESATA—Executive Subroutines for Afterheat Temperature Analysis of a Mobile Gas Cooled Nuclear Reactor Power

The ESATA computer program has been developed to analyze the thermal safety aspects of post-impacted mobile nuclear power plants. The program calculates the transient temperature and pressure response for a gas-cooled thermal reactor power plant following impact. The analysis is based on a closed containment vessel system

with trapped helium gas where the nuclear afterheat must be dissipated by conduction through the containment wall without exceeding the creep-rupture strength of the containment vessel. In addition to the heat transfer mechanisms of conduction, convection, and radiation, phenomena such as core and shield melting and displacement, fission product release from the reactor core and shield melting and displacement, fission product release from the reactor core followed by subsequent condensation and re-evaporation, metal-water chemical reactions, and pressure buildup due to increased temperatures and volatile products are simulated. Flexibility was built into the program to consider variable core, shield, and containment vessel dimensions, variable weight, initial temperatures and several shield options. In addition to the problem described, one option of the program permits solution of problems involving transient or steady state heat transfer in multi-dimensional systems having arbitrary geometric configurations, boundary conditions, initial conditions, and physical properties. The program can be extended to analyze mobile power plant concepts utilizing reactor concepts such as the liquid metal cooled fast reactor. In addition, the program could be extended to perform meltdown analysis of stationary power plants or analysis of post impacted fuel capsules following re-entry.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/7044
PROGRAM SIZE: Approximately 6,551 source statements
PRICE: Program $680.00 Documentation $28.50
PROGRAM NUMBER: LEW-11693

SESOP - Program for Solar Energy Heating Systems Analysis

This program deals with energy conservation and contains thirteen subroutines for the analysis of heating, ventilation and air conditioning systems with solar energy utilization for space heating and hot water heating. Operations performed by the program include: (1) Calculation of the hot water demand profiles. (2) Calculation of the space heating and cooling loads. (3) Calculation of the electric demands. (4) Analysis of flat plate non-tracking solar collectors and calculation of the energy collected by the solar collectors. (5) Calculation of the purchased energy requirements (electricity, fuel oil and natural gas) of the heating, ventilation and air conditioning system, as well as, water and electricity utility systems. (6) Comparison of the energy requirements of the conventional systems and the solar energy systems. Hot water demand profiles are calculated by use of empirical equations with the number of occupants per dwelling unit and the number of dwelling units being the independent variables. The space heating and cooling loads are calculated for each building based on outside environment, desired inside conditions, building construction and geometry, domestic power usage, occupancy rate and occupant metabolic rate. Upon completion of calculation of the loads for each of the buildings, the loads are summed to determine the requirements of the central utility systems. Based upon input descriptions of the environment and the solar collectors, an analysis is performed to determine a profile of the amount of useful energy which can be collected by the solar collectors. The program uses the load profiles and solar energy profiles to determine the energy required by alternative systems to meet the utility demands.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series, Exec 8
PROGRAM SIZE: Approximately 2,296 source statements
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR Formatted Tape
PRICE: Program $530.00 Documentation $10.50
PROGRAM NUMBER: MSC-14853

BIOTECHNOLOGY

Includes life support systems; bioengineering (bioinstrumentation, biometrics, biotelemetry, cardiography, electroencephalography); personnel training, evaluation, and maintenance (medical).

Veterans Administration Automated ECG Analysis System, CDC 3000 Series Version

This program was designed and written to assist in the automatic analysis and diagnostic classification of electrocardiographic (ECG) data. The analysis performed consists primarily of three general phases: (1) Pattern recognition of individual beats and their component wave forms. The purposes of pattern recognition are to locate noise spikes in the ECG input data, to locate the heart cycles within the input record and to locate the beginnings and ends of wave forms within each beat. (2) Calculation of measurements on the recognized beats and analysis. The measurement analysis performs four interrelated functions, single lead wave form analysis, calculation of the set of descriptive measurements on each recognized beat, measurement selection and averaging, and a beat-to-beat analysis for rhythm determination. (3) Diagnostic classification of the record. This diagnostic classification performs measurement modification, diagnostic classification for conduction defects, diagnostic classification based on QRS and ST-T measurements, diagnostic classification based on P wave measurement and diagnosis of ventricular strain and wall injury based on ST-T measurements. Estimated error rates are given in the form of misclassification matrices, computed from large numbers of tracings, where the correct diagnoses were taken from clinical, laboratory and autopsy information.

LANGUAGE: FORTRAN IV (99%); ASSEMBLER (1%)
MACHINE REQUIREMENTS: CDC-3200, MSOS version 4.0
PROGRAM SIZE: Approximately 6,250 source statements
PRICE: Program $810.00 Documentation $19.00
PROGRAM NUMBER: COS-02450

Veterans Administration Automated ECG Analysis System, Varian 73 Version

This program was designed and written to assist in the automatic analysis and diagnostic classification of electrocardiographic (ECG) data. The analysis performed consists primarily of three general phases: (1) Pattern recognition of individual beats and their component wave forms. The purposes of pattern recognition are to locate noises spikes in the ECG input data, to locate the heart cycles within the input record and to locate the beginnings and ends of wave forms within each beat. Calculation of measurements on the recognized beats and analysis. The measurement analysis performs four interrelated functions, single lead wave form analysis, calculation of the set of descriptive measurements on each recognized beat, measurement selection and averaging, and a beat-to-beat analysis for rhythm determination. (3) Diagnostic classification of the record. This diagnostic classification performs measurement modification, diagnostic classification for conduction defects, diagnostic classification based on QRS and ST-T measurements, diagnostic classification based on P wave measurement and diagnosis of ventricular strain and wall injury based on ST-T measurements. Estimated error rates are given in the form of misclassification matrices, computed from large numbers of tracings, where the correct diagnoses were taken from clinical, laboratory and autopsy information.

LANGUAGE: FORTRAN IV (89%); ASSEMBLER (11%)
MACHINE REQUIREMENTS: VARIAN 73
PROGRAM SIZE: Approximately 7,656 source statements
PRICE: Program $810.00 Documentation $17.00
PROGRAM NUMBER: COS-02451

MIMS—Medical Information Management System

The Medical Management Information System (MIMS) was developed to handle all aspects of data related to patient care. Its prime benefits are (1) the ability to recall a record of a specific patient in a matter of seconds, (2) to search for specific types of data among patient records, and (3) the ability to do medical research with a readily available data base. The flexibility of the system allows the user to (1) decide the categories of data, (2) decide on the format of the data, (3) change any data entry without regard to the length of the original data field, (4) retrieve any selected item of data or all of the data. (5) generate tabular information assembled from the comparison of all the records in the system, and (6) generate statistical information. MIMS provides an efficient method of flexible and complete data retrieval.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 4,000 source statements
PRICE: Program $720.00 Documentation $15.50
PROGRAM NUMBER: GSC-11540

Proton Tissue Dose for the Blood Forming Organ in Human Geometry: Isotropic Radiation

This program contains seventeen subroutines and calculates proton dose averaged over the limbs, trunk, and skull of the blood forming organ. The program was written to calculate the anticipated dose distribution in the human body in the radiation environment encountered in radiation shield and dosimeter design, and for space mission analysis. Usually the human body is approximated by simple geometries such as a sphere, slab, or cylinder, with resultant disagreement among the various approximations and consequent disagreement on shield and dosimeter design and undesirable impact on mission objectives. However, this program treats human body geometry in detail. The program calculates the areal density distribution function, fluence-to-dose conversion factors, and incident fluence spectrum. These functions are integrated to give an intermediate function which in turn is used in the integration of the dosage parameter. The result is always a conservative estimate of dose and is given as physical dose and dose equivalent. Although originally programmed on a 60-bit machine, round-off error on shorter word machines should not be a problem for these calculations.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 554 source statements
PRICE: Program $330.00 Documentation $2.50
PROGRAM NUMBER: LAR-11802

Metabolic Balance Analysis Program

This program calculates body metabolic energy availability, oxygen and water requirements, body wastes production, and total packaged food weight requirements for space missions. These data have been estimated in the past. These past estimates have, of necessity, been very conservative and have resulted in excessive design requirements for consumables. Because of critical weight limitations on most space missions, the need existed for a more accurate determination of consumables requirements and wastes production. This program could be useful in determining or evaluating diets for hospital patients. Also, the program would be applicable to determining food and water requirements for military or industrial groups working in isolated, remote areas.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6500
PROGRAM SIZE: Approximately 477 source statements
PRICE: Program $340.00 Documentation $5.50
PROGRAM NUMBER: MFS-21237

VECTAN II: A Computer Program for the Analysis of Vectorcardiograms

VECTAN II is designed to analyze vectorcardiographic (VCG) data from normal individuals during rest and controlled orthostatic stress procedures. The program accepts as input digitized three lead Frank VCG data sampled at 320 samples/second/lead, analyzing one VCG complex in each five second interval for experiments of up to 25 minutes duration. The program calibrates these data, locates the three major waveforms (P-wave, QRS complex, and T-wave), performs waveform analyses and produces a statistical summary of the analyzed data. The waveform recognition technique employed to find the beginning and end points of the three basic waveforms uses the VCG spatial vector length rather than its derivative to reduce the effects of high frequency noise and to eliminate sensitivity to differences in waveform location among the three leads. The waveform analysis is designed to give the minimum number of parameters that fully characterize an individual's response to a stress protocol. These analyses utilize the eigenloop concept to characterize the three dimensional vector loops of the QRS and T waves with the results including the eigenloop area, circumference, depth and orientation angles as well as fractional circumference vector parameters characteristic of the eigenloop shape. Conventional parameters such as ventricular gradient, J-junction offset, ST segment slope, and waveform temporal measurements are also produced. Because VECTAN is designed to measure VCG variations in normal subjects, no diagnostic options are included. For VCG analysis procedures designed for use in a clinical setting with diagnostic options refer to program numbers COS-02450, COS-02451, and COS-02452.

LANGUAGE: FORTRAN V (98%), UNIVAC Assembler (2%)
MACHINE REQUIREMENTS: UNIVAC 1108 (EXEC II - Monitor) SC-4060 Microfilm Recorder
PROGRAM SIZE: Approximately 2,095 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program $490.00 Documentation $27.50
PROGRAM NUMBER: MSC-14385

Nutritional Evaluation of Diets

Evaluation of the diet of people (or animals and plants) is important in understanding their health. However: 1) The complete list of nutritionally important food components (vitamins, minerals, fatty acids, amino acids, etc.) is lengthy and easily exceeds 50 items; 2) A person's diet may contain one to two dozen different foods; 3) These foods may be measured in a variety of units; and 4) The recommended nutritional levels of food are a function of sex, age, and, in some cases, special dietary considerations. These four items entail a considerable amount of work by anyone trying to evaluate diets by hand computations. Some of the computer programs designed to solve this problem do not handle the full range of nutrients. This program solves the above problems. This program has been designed to handle lengthy lists of nutritional recommendations (up to 100) and still provide a neat, readable, and complete list of the results. The program also computes the cost of the amount of food used in the diet. The program interconverts units so that the units of measure of a particular food can be referred to as cups in one run, grams in the next, pounds in a third run, and ounces in a fourth run. Thus, if a diet card states that a person ate "½ each" of a medium sized banana that cost $0.25 for 2 pounds, the program would compute the cost of that half a banana and the nutritional value in it. If one knew the weight or mass of the banana (in ounces, pounds, or grams) then that quantity and that unit could be entered instead of "½ each." The program has a table of recommended nutritional values, which is a function of age, sex, pregnancy and lactation, and, for infants, is also a function of infant weight. For special dietary considerations, any (or all) of the standard recommendations can be easily modified to any desired value. The program, as presently written, can handle up to 100 different foods (and 100 nutrients per food). If more disk space were available, a trivial program modification would allow the handling of more foods. The "program" is very modular to simplify making changes. It actually consists of four seperate programs. Three of he programs set up the basic date and are run infrequently. The fourth program (the

Analysis Program) performs the diet analysis. This Analysis Program consists of the main program and three subroutines. Again, the concept was to keep the Analysis Program itself modular in order to simplify making changes.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-1130
PROGRAM SIZE: Approximately 600 source statements
PRICE: Program $390.00 Documentation $9.00
PROGRAM NUMBER: NPO-13206

CHEMISTRY

Includes chemical analysis and identification, chemical engineering, electrochemistry, inorganic and physical chemistry.

Qualitative and Quantitative Analysis of Low Resolution Mass Spectra Computer Program

This program was written to determine the precise gas constituents from an analysis of low resolution mass spectra. The documentation includes the analysis technique; preparation of the reference-library mass spectra; preparation of the mass spectrum of the gas mixture to be analyzed; a sample problem, with interpretation of the analysis results; and instructions for use of the computer program. Applications for this program include gas analysis for work in space environmental simulators, space environment, and air pollution monitoring.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 844 source statements
PRICE: Program $380.00 Documentation $10.00
PROGRAM NUMBER: GSC-11279

Chemical Equilibrium of Ablation Materials Including Condensed Species

This program package consists of a computer program which calculates chemical equilibrium compositions of ablation materials over a range of temperatures. It has been used for pyrolysis products of phenolic nylon at temperatures from 500-3500°K, but may be used to calculate multiphase chemical equilibrium compositions of arbitrary systems. It differs from most programs of this type by including condensed species as well as gaseous species in the calculations. The program can accept 90 gaseous species and 10 condensed species at one time. Equilibrium is determined by finding the minimum free energy using the method of steepest descent applied to a quadratic representation of the free energy surface. The program has been shown to be accurate by the comparison of computer solutions to exact solutions for simple reacting systems, also computer programming logic has been used which results in good computing speed. The program is written entirely in FORTRAN IV to operate in batch mode and presently runs on CDC Series machines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 656 source statements
PRICE: Program $450.00 Documentation $6.50
PROGRAM NUMBER: LAR-11801

General Chemical Kinetics Computer Program for Static and Flow Reactions with Application to Combustion and Shock Tube Kinetics

This program can be used for any homogeneous reaction in either one dimensional flow or a static system. It is flexible, accurate and easy to use. It can be used for any chemical system for which species thermodynamic data and reaction rate constant data are known The program handles several types of reactions: bimolecular exchange reactions, unimolecular decompositions, bimolecular decompositions and the reverse recombination process. An implicit numerical integration method is used for the solution of the differential equations that describe a complex reaction. A new step size optimization procedure has been developed to make this technique work efficiently for a wide range of conditions. This includes the extremes of very slow and very fast reactions. The program can be used to compute: (1) chemical reaction behind a shock wave, (2) ignition and combustion in a flowing or static system, (3) ignition, combustion, and nozzle expansion in supersonic flow, (4) chemical reaction in any flowing gas mixture whose velocity does not reach the speed of sound, (5) chemical reaction in any static system, and (6) constant temperature and/or constant volume reactions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7044/94 Direct-Couple System (DCS)
PROGRAM SIZE: Approximately 5,625 including 2,038 data cards
PRICE: Program $820.00 Documentation $17.00
PROGRAM NUMBER: LEW-11467

ACE—Aerotherm Chemical Equilibrium Computer Program

The Aerotherm Chemical Equilibrium (ACE) computer program is an extremely versatile code for calculating quantities of importance to a broad variety of thermochemical processes. The thermochemical processes treated may be divided into two categories: closed systems and open systems. Closed systems are those for which the relative amounts of each chemical element in the system is prespecified. Open systems are those for which the relative amounts of chemical elements depend on various mass transfer rates due, for example, to boundary layer convection or solid surface degration. The ACE program

can treat both systems in chemical equilibrium and systems for which certain reactions are kinetically controlled.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 3,067 source statements
PRICE: Program $720.00 Documentation $16.00
PROGRAM NUMBER: LEW-11722

Computer Program for Calculation of Complex Chemical Equilibrium Compositions, Rocket Performance, Incident and Reflected Shocks, and Chapman-Jouguet Detonations

The knowledge of chemical equilibrium compositions of a chemical system permits calculation of theoretical thermodynamic properties of problems in chemistry and chemical engineering. Some applications are the design and analysis of equipment such as compressors, turbines, nozzles, engines, shock tubes, heat exchangers, and chemical processing equipment. This program has been developed to solve numerically, through the use of nonlinear algebraic equations, chemical equilibria in complex systems. A free minimization technique is used. The program permits calculations such as chemical equilibrium for the following assigned thermodynamic states: (1) Temperature and pressure; (2) Enthalpy and pressure; (3) Entropy and pressure; (4) Temperature and volume or density; (5) Internal energy and volume or density; and (6) Entropy and volume or density. Other problems capable of being calculated are: (1) Theoretical rocket performance; (2) Chapman-Jouget detonations; and (3) Shock tube parameter calculations. The condition for equilibria may be stated in terms of any of several thermodynamic functions such as the minimization of the Gibbs free energy or Helmholtz free energy. If it is desired to use temperature and pressure to characterize a thermodynamic state, the Gibbs free energy is most easily minimized since temperature and pressure are its natural variables. Similarly, the Helmholtz free energy is most easily minimized if the thermodynamic state is characterized by temperature and volume (or density). Topics included in the complex equilibrium calculations are: mathematical analysis and techniques for obtaining chemical equilibrium; formulas for obtaining thermodynamic mixture properties and derivatives; criteria for inclusion of condensed phases; calculations at a triple point, inclusion of ionized species; and applications.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,177 including 1,860 of data
PRICE: Program $630.00 Documentation $22.00
PROGRAM NUMBER: LEW-11740

Three Bit Mass Spectral Search Program

The purpose of this program is to assist the chemist in identifying low resolution mass spectra by means of a library search against a file of 6,880 mass spectra. For each unknown spectrum, the program provides a list of ten compounds in the library whose spectra are "closest" to the unknown by some goodness of fit criterion. Extensive testing of the program has shown it to be highly reliable and extremely rapid for pure compound and binary mixture identification. In the 3 bit library search, the peaks heights of both the unknown mass spectrum and the library spectrum are encoded to 3 bits, or 8 levels. At each nominal pass, the peak height is an integer 1, where 0=1=7. The transitions between levels have been set logrithmetically as a function of the percent total ion current. The maximum mass range covered in the search is amu 12-243. By means of data input, narrower mass ranges can be searched. By relatively simple coding changes, it is also possible to mask out certain masses or mass number ranges in the search. Two versions of the program, using approximately the same amount of core is available: (a) Up to 30 unknowns per pass through the library can be handled. No detailed side-by-side spectral summary is provided. (b) Up to 20 unknowns per pass can be handled. A detailed side-by-side spectral summary is provided at the conclusion of the program. In both programs, core requirements are roughly proportional to the maximum number of unknowns to be handled on each pass through the tape.

LANGUAGE: FORTRAN IV (98%); ASSEMBLER (2%)
MACHINE REQUIREMENTS: IBM-360/44 with 128K bytes of core
PROGRAM SIZE: Approximately 7,821, including 6,832 data cards
PRICE: Program $280.00 Documentation $10.00
PROGRAM NUMBER: NPO-11960

can treat both systems in chemical equilibrium and systems for which certain reactions are kinetically controlled.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 3,067 source statements
PRICE: Program $720.00 Documentation $16.00
PROGRAM NUMBER: LEW-11722

Computer Program for Calculation of Complex Chemical Equilibrium Compositions, Rocket Performance, Incident and Reflected Shocks, and Chapman-Jouguet Detonations

The knowledge of chemical equilibrium compositions of a chemical system permits calculation of theoretical thermodynamic properties of problems in chemistry and chemical engineering. Some applications are the design and analysis of equipment such as compressors, turbines, nozzles, engines, shock tubes, heat exchangers, and chemical processing equipment. This program has been developed to solve numerically, through the use of nonlinear algebraic equations, chemical equilibria in complex systems. A free minimization technique is used. The program permits calculations such as chemical equilibrium for the following assigned thermodynamic states: (1) Temperature and pressure; (2) Enthalpy and pressure; (3) Entropy and pressure; (4) Temperature and volume or density; (5) Internal energy and volume or density; and (6) Entropy and volume or density. Other problems capable of being calculated are: (1) Theoretical rocket performance; (2) Chapman-Jouget detonations; and (3) Shock tube parameter calculations. The condition for equilibria may be stated in terms of any of several thermodynamic functions such as the minimization of the Gibbs free energy or Helmholtz free energy. If it is desired to use temperature and pressure to characterize a thermodynamic state, the Gibbs free energy is most easily minimized since temperature and pressure are its natural variables. Similarly, the Helmholtz free energy is most easily minimized if the thermodynamic state is characterized by temperature and volume (or density). Topics included in the complex equilibrium calculations are: mathematical analysis and techniques for obtaining chemical equilibrium; formulas for obtaining thermodynamic mixture properties and derivatives; criteria for inclusion of condensed phases; calculations at a triple point, inclusion of ionized species; and applications.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,177 including 1,860 of data
PRICE: Program $630.00 Documentation $22.00
PROGRAM NUMBER: LEW-11740

Three Bit Mass Spectral Search Program

The purpose of this program is to assist the chemist in identifying low resolution mass spectra by means of a library search against a file of 6,880 mass spectra. For each unknown spectrum, the program provides a list of ten compounds in the library whose spectra are "closest" to the unknown by some goodness of fit criterion. Extensive testing of the program has shown it to be highly reliable and extremely rapid for pure compound and binary mixture identification. In the 3 bit library search, the peaks heights of both the unknown mass spectrum and the library spectrum are encoded to 3 bits, or 8 levels. At each nominal pass, the peak height is an integer 1, where 0=1=7. The transitions between levels have been set logrithmetically as a function of the percent total ion current. The maximum mass range covered in the search is amu 12-243. By means of data input, narrower mass ranges can be searched. By relatively simple coding changes, it is also possible to mask out certain masses or mass number ranges in the search. Two versions of the program, using approximately the same amount of core is available: (a) Up to 30 unknowns per pass through the library can be handled. No detailed side-by-side spectral summary is provided. (b) Up to 20 unknowns per pass can be handled. A detailed side-by-side spectral summary is provided at the conclusion of the program. In both programs, core requirements are roughly proportional to the maximum number of unknowns to be handled on each pass through the tape.

LANGUAGE: FORTRAN IV (98%); ASSEMBLER (2%)
MACHINE REQUIREMENTS: IBM-360/44 with 128K bytes of core
PROGRAM SIZE: Approximately 7,821, including 6,832 data cards
PRICE: Program $280.00 Documentation $10.00
PROGRAM NUMBER: NPO-11960

COMPUTERS

Includes programs and systems designed to manage, evaluate, and effect control of the operations of hardware resources; systems for the design, implementation, processing, and monitoring of software resources; general systems for the management of user data including information searches and retrieval and graphics support packages.

FLOW-CHARTER, A Program for Producing Flow Charts of FORTRAN Source Decks, IBM-360 Version

The FLOW-CHARTER program is designed to produce flowcharts of programs written in FORTRAN G or FORTRAN H. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the programs under consideration. The program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 600 source statements
PRICE: Program $350.00 Documentation $2.50
PROGRAM NUMBER: COS-02210

SLACMON—SLAC Software Monitor, Version 2.2

SLACMON, operating as a systems task or job, is designed to monitor hardware and software performance over a given period of time. A series of reports is produced that should aid in identifying areas of low utilization as well as performance bottlenecks. Monitoring is performed by counting various events (SVC calls I/O interrupts) and by sampling other (the changing of control blocks). Those familiar with statistical techniques will realize that as the number of these samples increase, the sampling results become more accurate (this is derived from the Law of Large Numbers). Thus, by using this sampling technique, it is possible to obtain a significant amount of performance data with very little additional systems overhead. SLACMON itself consists of three seperate modules whose structure and functions are often highly dependent upon various services provided by the OS Supervisor. Multitasking is used to obtain WAIT time and to perform the sampling mentioned above. This program, then, must be run under MVT or MFT with subtasking. Input to SLACMON IS twofold: the parameter field on the EXECUTIVE card, coupled with the corresponding operand in the operator's START command allows various functions to be performed or omitted: five data sets (optionally) provide names (of Q's, I/O devices, or modules) that SLACMON will look out for. Therefore, by careful control of these inputs, overhead can be reduced to a minimum; unwanted reports can be eliminated. Output from SLACMON consists of a series of reports (up to twelve) followed by a page summarizing both these reports and the run itself. Certain summary data may appear on the console device, if desired. The MVT software monitor is generally intended to identify bottlenecks and interactions rather than measure performance, although it certainly does the latter adequately. The output is most useful for tuning a system for peak performance and for indicating desirable hardware and software reconfiguration. SLACMON is written in Assembler Language (f, G, or H levels). It runs on IBM System/360 under OS/360 MVT or MFT with subtasking. No special requirements are imposed.

LANGUAGE: ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 7,013 source statements
PRICE: Program $870.00 Documentation $12.50
PROGRAM NUMBER: COS-02241

PROGLOOK - SLAC Program Performance Monitor

PROGLOOK consists of two programs, PROGTIME and PROGPLOT, which provide the user with a simple tool for making detailed measurements of his program while it is running. It can be used to measure any user program that can be run under OS/MVT, OS/MFT or VS2 rel 1.6, and with it the user can ascertain what action is necessary for him to take in order to improve the performance of the program. Performance improvement in frequently used programs benefits an entire computation facility by reducing run time and thus improving turnaround time. PROGTIME uses the control clock to catch a picture of any program running under it and records this information in a data set. It is designed to handle overlay structures and dynamic programming linkages. The only constraint associated with this is that a task cannot attach more than

254 subtasks. The new version of PROGTIME uses an improved technique to eliminate interference from other jobs in the system. It will also properly time programs using the LOAD macro. These improvements increase the usefulness and accuracy of the system considerably. PROGPLOT accepts the specially formatted data sets and prints summaries of the observations. The two programs work in conjunction with each other to produce graphs that show where the program has spent its time (both run and wait time) and how performance can be improved.

LANGUAGE: ASSEMBLER (75%), FORTRAN IV (23%), JCL (2%)
MACHINE REQUIREMENTS: IBM OS/MVT, OS/MFTVS2 rel 1.6
PROGRAM SIZE: Approximately 2,901 source statements
PRICE: Program $640.00 Documentation $7.00
PROGRAM NUMBER: COS-02251

BIBSYS - Bibliographic System

The Bibliographic System (BIBSYS) is a computer based system that was developed to enable users to establish and maintain a machine readable file of bibliographic information in standard MARC II processing format and produce a variety of bibliographic tools from the basic format. The BIBSYS system is composed of four independent subsystems. These are File Maintenance, File Inversion, Report Production and Retriever. The File Maintenance updates the master bibliographic information file. The updating permits additions, deletions and changes to be performed both on whole records and on fields and subfields within individual records. The final phase of processing produces an accession number index which gives the status of each record on the master file and the date of the last transaction affecting it. The File Inversion program provides a generalized system that makes it possible to sort the master file records on a combination of various fields and subfields. This program also has an explode capability to provide a separate copy of the record for each time the tag is repeated, i.e., a record with three authors will appear three times in the final report-once for each author. The Report Production program is a two program generalized package which produces a variety of printed output from the BIBSYS file. The first program produces a print file on tape and the second program prepares and prints the report in the specified format. The Retriever program builds a sub file of records selected from the master file on the basis of parameter cards read at the start of processing. The parameter cards constitute queries for records that meet certain qualifications. The queries are Boolean in nature and may be batched for processing.

LANGUAGE: ANS COBOL
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 12,000 Source Statements
PRICE: Program $1,300.00 Documentation $26.00
PROGRAM NUMBER: COS-02480

Fortran Analyzer

The Fortran Analyzer program is designed as an aid in the revision, machine conversion and documentation of existing Fortran programs. Source languages allowed as input for analysis are IBM Fortran G and H, CDC Fortran 66 and 63, GE 600 Series Fortran IV, IBM 7090 FORTRAN IV and HITAC (HITACHI) 5020 HARP Fortran. For use in machine conversion, the user can also specify as an 'object' Fortran any one of the source Fortran languages and any statements in the input program will be detected that are not allowed in the 'object' Fortran. Processing time is approximately one minute per 1000 Fortran source statements, and unless output is omitted, lines equivalent to four times the number of input cards are printed out. Printed output is controlled by the user and includes a program listing with flags showing the results of the analyses, a symbol table giving symbol attributes, symbol cross reference table, statement number cross reference table, a storage map showing the locations of symbols within COMMON areas, subprogram definition and cross reference tables containing subprogram names, argument forms, subprogram reference locations, and undefined subprogram names. Additional user control options include output page titles, internal table size specification, input source Hollerith code control (BCD, EBCDIC or HITACHI), standard input and output logical unit number control, and printer page size control.

LANGUAGE: Fortran IV (93%)
Assembler (7%)
MACHINE REQUIREMENTS: IBM 370
PROGRAM SIZE: Approximately 10,887 source statements
PRICE: Program $970.00 Documentation $10.50
PROGRAM NUMBER: COS-02510

EXTRAN - Expression Translator

This program is a language compiler for translating source instructions written in EXTRAN which is a symbolic language designed to emulate human communication methods in program construction by proceeding from general aspects to particulars. That is, a number of general statements are first written which describe the entire processing operation. Their form must conform to basic syntax requirements, but each statement can be set in a form similar to English sentences. In other words, the program design description itself is coded. Next, the meaning of the terms used in each general statement is explained in another set of lines. Then the meaning of new words used in the explanation are explained in a new paragraph. An EXTRAN program is complete when the expressions introduced within it are all defined by means of forty basic supplied expressions or expressions previously defined in terms of these basic expressions and available in user libraries. Expressions introduced in the programming process may be in the form of phrases or sentences and are not limited to just one symbol or lexical term. An EXTRAN program is executed either by invoking the generator component to convert the set of basic expressions resulting from complete expression substitution into FORTRAN and then processing the FORTRAN source code or else an interpretive evaluation of the program may be carried out as an alternative option of the compiler component effecting expression substitution. Because of the macro expansion capability, interpretive execution capability for all or part of a program, and the capability for adding a program into a library for common use, the EXTRAN compiler can be used not only as a general purpose computer language but also in the following ways: (1) Elimination of the requirement for flow charting in the design of programs because the design specifications can be written in EXTRAN. (2) Construction of specific problem oriented languages without the need for individual compiler development by specifying expression forms and the contents of commands to be introduced which are then entered into a user library. (3) Preparation of general purpose programs in EXTRAN from which special purpose FORTRAN programs can be

generated at compile time through user stipulation of parameters and expression substitution.

LANGUAGE: IBM FORTRAN (95%), IBM ASSEMBLER (5%)
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 10,400 source statements
DISTRIBUTION MEDIA: 9 Track Unlabelled Magnetic Tape
PRICE: Program $1,180.00 Documentation $17.00
PROGRAM NUMBER: COS-02520

NIPS - National Military Command Information Processing System, System 360 Formatted File System

The NIPS System 360 Formatted File System (NIPS 360 FFS) is a generalized information management and analysis system utilizing an English like control and query language capable of accepting any machine readable data source having a definable format. Structurally and operationally the NIPS 360 FFS is most easily described in terms of the following major components which operate on the data files on the system: (1) the File Structuring component (FS) which generates the communication arrays known as File Format Tables (FFT) describing the hierarchal relationships, relative location, and attributes of each data element within the records of a file and which are stored as part of the data file to be accessed by the other components when processing user language statements. (2) the File Maintenance Component (FM) which generates and or revises the user's data files. Several user languages are provided which permit the analyst to specify data validation procedures, logical data examination and manipulation, and summarization. The normal output of this component is the data file in updated form, however, auxiliary output files can be requested. (3) the Retrieval and Sort Processor (RASP) is used to extract information from one or more data files based on search criteria specified in the form of retrieval statements or queries and to sequence this extracted information in a variety of ways as determined by the requirements of the final report to be produced. Replacement of query operands and sort variables for prestored queries is permitted at execution time. Relational (conditional) operators may include user defined functions or subroutines. (4) the Output Processor Component (OP) which is used for formal report production based on user formatting specifications. A data file itself or an output data file from the RASP component may serve as input to the Output Processor. Output from the OP may be directed to a printer, card punch, or magnetic tape, and may include editing, data conversion and arithmetic computations. (5) the Terminal Processing Component (TP) which utilizes local IBM 2250 devices and remote 2260, 2741, or 1050 terminals as input output units allows the terminal user to interrogate data bases with queries that are edited on line before being processed against a data file through the Quick Inquiry Processor (QUIP). Other functions available through QUIP are similar to those performed by RASP and OP including report formatting. Output data may be reviewed in a conversational mode at a terminal or directed to a printer. The Source Data Automation (SODA) processor of the TP component provides the capability of remote data file maintenance with input data edited, corrected, and processed using prestored FM logic statements. The structure of data records which the NIPS 360 FFS supports is hierarchal where a collection of record data elements at the same level is termed a *set*. At the first level in the data record hierarchy is a *fixed set*, of which there may be one per record, consisting of data elements requiring only one value to meet recording requirements. Subordinate to the fixed set may be *periodic sets* of dynamic data consisting of generations or *subsets* of data elements that are logically related and where all subsets of a given periodic set are identically formatted. For each fixed set the user may define up to 255 independent periodic sets each of which may have from 1 to 100 defined fields with the number of subsets for a given periodic set also user specified. In addition to the fixed and periodic sets a record may contain, *variable length sets* containing unformatted data (usually of textual variety) definable at the periodic level. One variable set may be associated with the fixed set and one with each periodic subset. The data element value modes available to the user are numeric, alphanumeric (the full EBCDIC character set) and the geographic coordinate mode which allows storage of latitude and longitude coordinates for retrieval using the geographic retrieval operators. Under the NIPS 360 FFS the user has the capability of defining routines which may be used to perform data value conversion for transaction data elements as well as for data elements residing in stored records. In addition numeric mode elements may be edited during output processing to suppress leading zeroes, insert decimal points, and perform other editing functions. Although each component of the NIPS 360 FFS has its own language they are basically similar and differ only in their application to a problem. Each language is free format and consists of two basic types of words: (1) System reserved words analogous to verbs or conjunctions in English sentences which are recognized as indicating specific operations and which in combination define the logic to be used by the system component. (2) User supplied words analogous to the subject and or objects of an English sentence that indicate typically the specific qualification for action or in general identify what is involved in a processing function and the result obtained. The NIPS 360 FFS has been designed and programmed for an IBM System 360 Model 50H (256k core size). It will also operate on a Model 40H and larger models of the System 360. Without on line terminals, it will operate on a Model 40G or 50G (128k core size). A minimum configuration can include three IBM 2311 Disk Units or a single IBM 2314 Disk storage unit, a card reader, and an online printer. Tape drive requirements are determined by the user's requirements and range from none to a quantity sufficient to perform the largest sort the user may require. When available disk sorting is used to the capacity of the direct access devices. NIPS 360 FFS will operate under PCP, MFT, MVT, VS1, or VS2 operating system configurations and is not restricted to any one level of the operating and uses subsequent releases as they become available.

LANGUAGE: ASSEMBLER (Executable code also supplied)
MACHINE REQUIREMENTS: IBM System 360 Series
PRICE: Program $2,470.00 Documentation $100.00
PROGRAM NUMBER: DOD-00017

General Purpose Overlay Loador for CDC 6000 Series Computers

This program package is a modification and improvement of the NASA Structural Analysis (NASTRAN) Linkage Editor for CDC 6000 Series computers which is designed to utilize central memory storage efficiently for medium to large programs. It allows the user to arrange a program into an overlay structure consisting of links and segments within links which can be assigned the same origin addresses and loaded at different times. Advantages of this linkage editor and associated segment loader over others available are an unlimited number of overlay levels; the description of overlay segments to the linkage editor

through directives specifying subprograms to be included and the libraries they reside on this allowing the program to be structured after it has been coded; the implicit loading of segments facilitated by their storage on a random access file; the dynamic allocation of memory as each segment is loaded; the explicit positioning of named commonblocks; the acceptance of either FTN or RUN Fortran object code by the linkage editor; the maintenance of communication between all levels of overlay; the capability of updating individual links without relinking the entire program; and the ability to selectively rename external references. This linkage editor executes under the SCOPE Operating System (Versions 3.3 or earlier) as a user program with the linkage editor object code loaded using the CDC loader. This vendor loader is also used to load the zero level link generated by the linkage editor. The zero level link remains in central memory at all times; thereafter all link and segment load requests are serviced automatically by a segment loader contained in this link utilizing tables generated by the linkage editor for all segments required. Minimal memory requirements for execution of this linkage editor are 64K octal words. This field length will typically accomodate a program containing up to 200 subprograms.

LANGUAGE: FORTRAN IV (43%)
COMPASS (57%)
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 9,624 source statements
PRICE: Program $1,250.00 Documentation $13.50
PROGRAM NUMBER: DOD-00038

S/360 AUTOFLOW Preprocessor System

Since programs written for non IBM computers cannot be directly processed by the S/360 AUTOFLOW System (a flow charting procedure), four preprocessors have been developed to convert Assembly Language and FORTRAN programs into a format acceptable to S/360 AUTOFLOW. AUTOFLOW functions on the printer or the SC-4020 plotter. The four preprocessors are written in S/360 Assembly Language and they each occupy approximately 250K bytes of core. The AUTOFLOW System, with preprocessors, is comprised of three load modules. The first module, the Master Control routine, is held in memory and is called in via the EXEC card. The second module, one of the four preprocessor versions, is called in by Master Control and processes the input data producing two temporary data sets on disk. The third routine, the AUTOFLOW load module, is called by Master Control to process the data sets on disk. Each preprocessor requires the Master Control routine, a FORTRAN processor, General subroutines Part A and B, and Input Output and System Macros. System Macros are used to ease the assembly language burden, making use of the macro capability feature of the 360 Assembler. Four preprocessor versions are currently available accepting as input programs written in Assembler or Fortran. Version 1 (GSC 11330) is for use with programs written for SDS 900 Series machines. Version 2 (GSC 11331) for DDP 24,124, or 224 machines. Version 3 (GSC 11332) for CDC 3000L Series machines, and Version 4 (GSC 11333) for Univac 1100 Series machines.

LANGUAGE: Assembler
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 7600 source statements
PRICE: Program $580.00 Documentation $14.00
PROGRAM NUMBERS: GSC-11330, 11331, 11332, 11333

FORTAP—FORTRAN Tape Conversion Package

This system is a package of subroutines written to permit the UNIVAC 1107/1108 to read or write unformatted FORTRAN tapes compatible with other binary computers. The FORTRAN tape conversion package - FORTAP - consists of two externally identified subroutines - CREAD and CWRITE - and six other subroutines. These subroutines convert single precision integers and real numbers with single or double precision into a compatible form. The FORTAP subroutines are dependent upon the UNIVAC FORTRAN Compiler and the FORTAP Computer Characteristics Table. Any change to the compiler that effects the number and type of machine instructions may require rewriting the FORTAP package. CREAD and CWRITE alter the machine code generated by the FORTRAN read or write statements. The other routines are serially reusable and can be used in loops with a parameter that can be established by the computer identifier. The parameter for CREAD and CWRITE and its values is limited to those computer identifiers which are contained in the computer characteristics table. The FORTAP Computer Characteristics Table lists an associated program symbol for each of 19 items and gives a verbal description of each item. The associated program symbols are not associated with any particular values until the proper computer is found in the table. When the computer if found, then, the particular values for that computer are stored in the respective symbolic addresses. At present, the following computers are included in the table: CDC 3200, 3600, 3800, 6600, IBM 360, 7030, 7040, 7090, and 7094.

LANGUAGE: SLEUTH
MACHINE REQUIREMENTS: UNIVAC 1108, EXEC II
PROGRAM SIZE: Approximately 3,601 source statements
PRICE: Program $610.00 Documentation $6.50
PROGRAM NUMBER: GSC-11398

Source Deck Compression and Update Program

A computer program, CAPS, has been developed to produce and update compressed symbolic decks from Hollerith source decks, and provides for their reconversion to Hollerith form. This procedure allows compact storage of programs on cards, tape or disk. The size of a compressed deck, in most cases, is less than one fourth that of the Hollerith deck. The CAPS program may be used to process any source language provided that the language uses only column 1 through 72 and does not contain any of the CAPS card statements. A CAPS library is a compressed symbolic library of CAPS decks on a sequential data set. The library can be selectively updated by a single CAPS run and the Hollerith output may be used for subsequent assembly or compilation. The complete program is written in FORTRAN and ASSEMBLER language for the 360 using OS 360. It requires 100000 (DEC) BYTES of memory including system library routines. The user is to supply system subroutine LAND (logical and function). Linkage will give an unresolved external reference error if this function is not used.

LANGUAGE: FORTRAN IV (95%), ASSEMBLER (5%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,073 source statements
PRICE: Program $310.00 Documentation $4.00
PROGRAM NUMBER: GSC-11545

SGINDEX-OS/360 - System Generation Cross Reference Index

This program provides an easy-to use but comprehensive cross reference index of the sysgen results which can be used for modifying the Operating System (OS), applying PTF's, or writing subsystems which interface with OS. The program collects key data from the Stage II input for an OS/360 sysgen upon generation of a new operating system, sorts it, and prints a formatted listing of the index entries collected. A number of parameters are available for controlling the content and format of the output listings. SGINDEX is written in PL/I and uses a region of about 200K in an MVT environment, although this may be decreased by compiling with OPT=0. It requires SYS1.PLILIB for linkage editing and SYS1.SORTLIB for the OS sort package at run time.

LANGUAGE: PL/I
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,511 source statements
PRICE: Program $200.00 Documentation $5.50
PROGRAM NUMBER: GSC-11612

CSS - Character String Scanner

A computer program called Character String Scanner (CSS), is presented. It is designed to search a data set for any specified group of characters and then to flag this group. The output of the CSS program is a listing of the data set being searched with the specified group of characters being flagged by asterisks. Therefore, one may readily identify specific keywords, groups of keywords or specified lines of code internal to a computer program, in a program output, or in any other specific data set. Possible applications of this program include the automatic scan of an output data set for pertinent keyword data, the editing of a program to change the appearance of a certain word or group of words, and the conversion of a set of code to a different set of code.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 79 source statements
PRICE: $95.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: GSC-11787

STRCMACS - OS/360 Assembly Language Structured Programming Macros

STRCMACS is a set of twenty four macros that enable structured programming techniques to be incorporated into IBM OS 360 Assembler language programs by providing the basic control structures which replace the use of bc/bcr branch instructions and by providing aids for doing stepwise refinement programming. Control structures provided include a method for grouping statements into blocks through block initiating and block terminating macros, a decision structure implementing the if-then-else construct, and an iteration structure, which may be conditional, through the DO and WHILE macros. Additional convenience macros provided to simplify conceptualization and coding include the DOCASE and EXIT macros. To aid stepwise refinement, STRCMACS provides for module definition through the procedure delineating macros PROC and CORP with the resultant procedure invoked by using the IBM CALL macro. Debugging options whose invocation is under user control designed into the structured macros include the option to print on the assembler source listing as comments the name, sequential number, and static nesting depth of each block; the ability to force all proc names to be generated as in-line character constant to facilitate location of the corresponding code in dumps, the option to maintain execution count statistics on specified procedures and blocks; and a procedure trace option which maintains a record of the last 257 procs executed.

LANGUAGE: ASSEMBLER
MACHINE REQUIREMENTS: IBM 360/OS
PROGRAM SIZE: Approximately 3,041 source statements
DISTRIBUTION MEDIA: 9 Track, 800 BPI, no label tape
PRICE: Program $790.00 Documentation $24.50
PROGRAM NUMBER: GSC-11938

Library Documentation System

Bibliographic Products Subsystem is a system of programs designed to create and maintain a bibliographic data base. The system was designed to process MARC II 'Processing Format Structure' records, used by the Library of Congress, described in 'Books: A MARC Format', Library of Congress, Washington, 1972. MARC II compatible records are added, changed, or deleted in a bibliographic file at the word, subfield, tagged field, or record level. Generated sort keys are appended for arranging the output in product, collection, and filing sequence. Catalogs may be dictionary, divided or combination. Entries are arranged in alphabetical sequence according to rules established by the Library of Congress. Title, subject, and/or content keyword indexes are filed by key word then title and, or call number.

LANGUAGE: COBOL (96%), ASSEMBLER (4%)
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 11,113 source statements
PRICE: Program $1,230.00 Documentation $20.50
PROGRAM NUMBER: GSC-11952

BCMRET - Bellcomm Information Retrieval System

BCMRET, the Bellcomm Information Retrieval System, has been developed over the past two years to satisfy Bellcomm's need for a generalized information storage and retrieval system. The file generation and file maintenance programs which have been written for BCMRET are general purpose routines. These programs make it possible to use the system not only in the usual applications involving administrative data and document information, but also in applications involving purely numerical, engineering data. BCMRET is capable not only of generating and maintaining a file, but also of gathering statistics, sorting output, and generating final reports for output. In order to use any retrieval system on an aggregate of information elements, the aggregate must first be given some structure which will make possible the computer recognition of each element. Such a structured aggregate is called a file. There exist two general types of file: a *fixed file*, in which the exact location of each information element is predetermined, and a *variable file*, in which the location of an information element depends on the size of every element and on the total number of elements. BCMRET makes use of a variable file and admits an arbitrary number of information elements of arbitrary size. This flexibility gives the user great ease in changing, adding to deleting information anywhere in a file.

LANGUAGE: FORTRAN V (94.7%); ASSEMBLER (5.3%)
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 15,229 source statements
PRICE: Program $1,120.00 Documentation $18.00
PROGRAM NUMBER: HQN-10425

PLTCON - Contour Plotting Program

PLTCON, Contour Plotting Program, provides a general contour plotting capability using interpolation to reduce the number of function values required. In many studies the function f is now known as a simple equation but rather the determination of its value for a particular x and y involves costly computations or measurements. It is, therefore, desirable to be able to generate and plot the various contours of f using as few function values as possible. Let f(x,y) be a continuous function whose value is known at a subset of a discrete set of equally spaced points of the x-y plane. PLTCON reads a number of such function from any number of files and oversees the generation and plotting of f, x, or y constant contours of these functions. SC-4020 and/or printer plots are generated with up to ten sets of contours per frame for the SC-4020 plots. The printer plots contain one set of contours per page. Two directional parabolic interpolation is used to provide sufficient point density without increasing the function evaluations required.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020 Plotter
PROGRAM SIZE: Approximately 3,600 source statements
PRICE: Program $350.00 Documentation $3.50
PROGRAM NUMBER: HQN-10651

RECON/STIMS - Remote Console and Scientific and Technical Information Modular System

The current NASA/STIMS (Scientific and Technical Information Modular System) system consists of five unique subsystems. These are the Online Input and Photocomposition subsystem, the File Maintenance Subsystem, the batch processing Search and Retrieval Subsystem, the Publications Subsystem, and an online search and retrieval system called RECON. The NASA Online Input and Photocomposition System includes all the activities necessary in document data reduction, online and batch data entry, and online data correction for the STIMS Data Base. The File Maintenance Subsystem can be used independently of the other subsystems to build and maintain a data base. The File Maintenance Subsystem accepts transactions, converts them to internal system codes, and updates the data base. The data base architecture is built on a generalized record structure. The data characteristics, which make one file different from others, are placed in data definition, parameter tables. These parameters function to identify fields, establish maximum field lengths, determine whether a field is to be fixed or variable length, determine whether fields can have subfields, and specify the characteristics of the data. The Search and Retrieval Subsystem uses Boolean logic equations to search the data base for the information requested by the user. In preparing a publication, the Search and Retrieval Subsystem extracts the data for the publication. The Publications Subsystem then formats the publication according to the parameters in a publication format table. The output from the Publications Subsystem can be either printer output or magnetic tape. The RECON system is an on line search and retrieval subsystem that accesses the data base prepared by the File Maintenance Subsystem. RECON is available separately from STIMS as program number HQN-10694.

LANGUAGE: PL1 and ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
DISTRIBUTION MEDIA: Four 9 Track, Standard level IBM IEHMOVE 'Unloaded PDS' Magnetic Tape
PRICE: Program $2,530.00 Documentation Hardcopy $274.00 Microfiche $40.00
PROGRAM NUMBER: HQN-10699

FFCP1 - Fortran Flow Chart Program

The purpose of this program is to provide the capability of producing computer program flow charts suitable for inclusion in final program documentation utilizing FORTRAN IV type of coding. Thus the program precludes the requirement for manual preparation of flow charts and provides a presentation using standard flow chart symbols. The input to the program is comprised of one or more FORTRAN card decks, from which all control cards and blank cards are removed. If these cards were not removed the program would just compile. Each deck normally starts with a comment card, but may start with a FORTRAN statement. Each deck must end with an End card. The output from the program consists of a magnetic tape which, when processed by the SC-4020 plotter, produces final computer program flow charts and a cross-reference listing between program statement numbers and flow chart page numbers. Options of microfilm only or both hardcopy and microfilm are available.

LANGUAGE: FORTRAN IV (5%) GMAP (95%)
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 396 source statements
PRICE: Program $190.00 Documentation $7.00
PROGRAM NUMBER: KSC-10450

ADMIS - Automated Data Management Information System

The Automated Data Management Information System (ADMIS) is a computerized information and retrieval system used to control manned space flight management and administration documents. The sophisticated input, verification and standardization is controlled by the Mainline subsystem which is a composite of six programs. The mainline subsystem contains 3 master files, a Document and Distribution Master File, a Code File Master, and a Common Data File Master. The ADMIS Document and Distribution Master File contains all data oriented toward a specific document; it is the primary source of reports generated by the ADMIS system. Each Document is represented on the Document and Distribution Master File by a group of records all containing a unique Document Serial Number. This group of records is composed of one document record, one distribution record for each recipient of the document, and one summary record. The ADMIS Code File provides system discipline by insuring that standard codes and standard nomenclature is used throughout the system. The input data is compared with the ADMIS Code File standards, and any deviation causes a rejection and the creation of appropriate error messages. Data that is accepted by Code File standards allows related data sets to be generated and entered into the Document and Distribution Master File. The Common Data File contains data for each Requirement Document on the Document and Distribution File. It is used to generate transactions to update documents which respond to a related requirement. These generated

records represent data which is common to both the requirement and the response document. The mainline subsystem contains a program to list all records on a Master file and a program that will give a statistical analysis of data traffic for the past 6 months and predict data traffic for the next 12 months. The Keyword subsystem consists of three programs and one masterfile. This system will produce a cross-reference listing and also retrieve documents on a keyword basis. The remainder of the system contains 12 report programs that give a variety of information such as: distribution lists, mailing labels, data by package type, title lists, document indexes, etc.

LANGUAGE: COBOL (80%); GMAP (20%)
MACHINE REQUIREMENTS: GE 635
PROGRAM SIZE: Approximately 25,000 source statements
PRICE: Program $2,410.00 Documentation $176.00
PROGRAM NUMBER: KSC-10619

Multiple Utility Computer Program

This is a system of two computer utility programs that permits an individual with very little data processing training to establish a field by field update of a master file and then select different sorts and reports without establishing a new program each time. The user can input data on an (EAM) card and receive up to ten sorts of specific data fields designated by the user. The user also has the capability of controlling report headings and card column positions. The multiple utility computer program permits various sorting of information and displaying this information in many different ways. It was necessary to use an 80 80 input keypunch card and to allow the user to have complete control of data input, field length, headings and sorts. Previously, manual methods were used or a special program for each system was required. The programming delays and inconveniences for obtaining simple sorts with headers, page numbering, etc., were excessive. Some of the advantages are an extremely fast and efficient way to sort data so that the user has almost complete control, rapid turnaround time, and the elimination of development costs for programming changes each time a new requirement occurs. The program operates using less than 10 minutes (CPU) task and wait time. It was originally designed and written for an IBM-360/65 OS MVT using 2314 discs and 9 track tape drives, but can be modified to operate on available hardware.

LANGUAGE: ANSI COBOL, Level 77
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 598 source statements
PRICE: Program $470.00 Documentation $3.50
PROGRAM NUMBER: KSC-10778

RFI - Remote File Inquiry System

The Remote File Inquiry (RFI) system is designed for maintaining and interrogating user definable data files from remote terminals using an English like free form query language easily learned by persons not proficient in computer programming. The RFI system operates in an asynchronous mode allowing any number of inquiries within the limitation of available core to be active concurrently. The file structures supported by RFI include variable length text records as well as repeated fields. For on line information retrieval using RFI an inquiry sentence is composed of five functional parts: (1) the function name or file identification, (2) an optional title phrase used to provide report titles, (3) the verb phrase, (4) the object or qualifier phrase, and (5) an optional sort phrase giving the capability of sorting the selected data in ascending or descending order. For data retrieval two verbs are available: LIST which prints out the contents of a specified field in all records which meet the selection criteria and TALLY which totals a specified numeric field or simply counts the number of qualified records if no field is specified. For on-line updating of records within a file, three additional verbs are available. ADD will add a complete record, including specific values for all fields listed. DEL (delete) will remove any record or sub-record meeting the criteria listed. CHG (change) will change the contents of the fields listed to the values included in the command statement. The qualifier phrase for record may be examined for equal, not equal, greater than, less than, and combination conditions (e.g., not less than.) Both AND and OR connectives are available for compounding conditions. RFI provides security control for all files loaded on the system. A five position code, which can be changed easily by the operator, is used to control access to each file. Separate codes can be provided for reading and updating, if required. The RFI system is designed for the IBM 360 (Model 40 or above) operating under OS/MFT and assumes the availability of at least two IBM 2314 (or equivalent) disk drives and one IBM 2401 tape drive. Minimum core storage required totals 120K for two OS MFT partitions; approximately 40K for the Message Control Program and a minimum of 80K for the Inquiry Partition. This is expanded automatically if more core is made available to allow for simultaneous operation of more requests. The system is designed to service up to 99 Teletype or Teletype-compatible terminals in its present form; however, by redesign of the Message Control Program any type of terminal using a page format may be accomodated.

LANGUAGE: IBM ASSEMBLER (Level F)
MACHINE REQUIREMENTS: IBM 360/370 OS/MFT
PROGRAM SIZE: Approximately 20,000 source statements
PRICE: Program $1,590.00 Documentation $37.00
PROGRAM NUMBER: KSC-10837

Generalized Digital Contouring Program

This is a digital computer contouring program developed by combining desirable characteristics from several existing contouring programs. It can easily be adapted to many different research requirements. The overlaid structure of the program permits desired modifications to be made with ease. The contouring program performs both the task of generating a depth matrix from either randomly or regularly spaced surface heights and the task of contouring the data. Each element of the depth matrix is computed as a weighted mean of heights predicted at an element by planes tangent to the surface at neighboring control points. Each contour line is determined by its intercepts with the sides of geometrical figures formed by connecting the various elements of the depth matrix with straight lines. Although contour charts are usually thought of as being two dimensional pictorial representations of topographic formations of land masses, they can also be useful in portraying data which are obtained during the course of research in various scientific disciplines and which would ordinarily be tabulated. Any set of data which can be referenced to a two dimensional coordinate system can be graphically represented by this program.

LANGUAGE: FORTRAN IV (13.3%), COMPASS (86.7%)
MACHINE REQUIREMENTS: CDC 6000 SERIES
PROGRAM SIZE: Approximately 17,446 source statements
PRICE: Program $1,360.00 Documentation $7.50
PROGRAM NUMBER: LAR-10872

CODER - Common Generation Program

CODER is a computer program designed to provide common storage to FORTRAN non-executable associated statements. The program automatically generates the type, common, dimension and equivalence statements for FORTRAN programs. Manual methods of designing and updating common storage are tedious and errors associated with common storage are often elusive. Some of the advantages of using CODER are: (1) It automatically computes the length of common by summing the array lengths in the data base; (2) Efficient use of core storage can be kept at a minimum by eliminating unused or imbedded common storage; (3) Common blocks may be completely redesigned by rearranging the data base input deck during program development or for production updates; (4) Arrays may be reduced to the lowest definable size; (5) Only common variables used in a subroutine need to appear in that subroutine; (6) A storage locator will be referenced by the same symbol wherever it is utilized; (7) Each variable in common is defined which is a very important component of program documentation; (8) Programming updates which involve the common block are simplified and automatic. CODER may be easily converted to other computer systems which have FORTRAN compilers.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 674 source statements
PRICE: Program $230.00 Documentation $2.50
PROGRAM NUMBER: LAR-10959

DOC - Automatic Documentation Computer Program

DOC is a computer program that automatically generates internal documentation of each program, function, or subroutine as a unit. The following items are output for each element: (1) List of arguments (2) List of subroutines required (3) List of local symbols (4) List of common variables that are computed and used (5) List of common variables that are computed only (6) List of common variables that are used. The purpose of DOC is to facilitate documentation of computer programs, especially large scale programs. All variables used in a program unit are identified and placed in one of several lists. Internal documentation of each program element is provided via comment cards that may be placed within the source deck. Automatic documentation is meticulously accurate and complete. DOC provides documentation of an average subroutine (400 lines) in 4.0 seconds of CDC-6500 computer time and utilizes only 60,000 words of storage. Manual methods of providing the same information are time consuming, costly, and inaccurate. 8

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,964 source statements
PRICE: Program $590.00 Documentation $5.00
PROGRAM NUMBER: LAR-10980

ALTLIB - Automatic Computer Subprogram Selection from Application Program Libraries

Modular programming techniques are currently in widespread use in the development of scientific and engineering computer programs at the NASA Langley Research Center. These techniques involve the development of frequently used algorithms into modular (subprogram) form and the collection of application modules supporting a particular area into an application-oriented library. This library can then be employed repeatedly by programmers working in the same area of application to simplify new-program development. A major problem; however, for people maintaining their own application-oriented library is the complexity and volume of control-card programming that must be performed to achieve subprogram selection. The Alternate Library Access (ALTLIB) program provides a solution to this problem. ALTLIB is a general-purpose digital computer program that automates the subprogram selection process. ALTLIB analyzes the user's program to determine all external requirements. ALTLIB then proceeds to select from the alternate library file all subprograms that a user's program requires. The selected subprograms and the user's object file are then merged onto a file designated by the user for subsequent loading and execution.

LANGUAGE: FORTRAN IV (53%); COMPASS (47%)
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 956 source statements
PRICE: Program $370.00 Documentation $5.50
PROGRAM NUMBER: LAR-11124

ODINEX - Executive Computer Program for Linking Independent Computer Programs

ODINEX is a computer program for linking independent computer programs into an interdependent system of programs by controlling the sequence of execution of a network of program elements and maintaining a data base of common information which forms the communication link among the programs. Any program element may access or modify the data base through the ODINEX executive. The ODINEX program is structured to provide the following: (1) A dynamically constructed data base containing all interprogram data. These data can be saved at user selected points in the simulation. (2) A language for controlling the execution of an arbitrary network of independent programs by simple commands. The flow path may be based on information from the data base. (3) A control card data base for storing information with regard to the retrieval and execution of individual programs. These data base files can be updated either by a separate run or dynamically in the simulation. (4) A language for automatically retrieving data base information as input to any program in the network using an information access and retrieval system included as an integral part of the ODINEX executive. The language requires no modification to the independent program. (5) A simple technique for allowing any program in the network to update the data base. The technique does not influence the normal stand-along operation of the program. (6) A capability for generating one or more reports describing the status of the design. This information can be printed as a part of the normal computer output. (7) Operational flexibility to allow batch or interactive modes of operation. ODINEX has general applicability throughout industry wherever multiple program tasks are involved. Any process involving more than one program for which the independent program elements are available can be synthesized.

LANGUAGE: FORTRAN IV (93%), COMPASS (7%)
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 4,571 source statements
PRICE: Program $650.00 Documentation $17.50
PROGRAM NUMBER: LAR-11324

BLKIO - An I/O Buffering Scheme with Skipping Capability

The subroutine BLKIO provides an efficient structure to accomplish input/output commands. It does this by

blocking data. Blocking is a process of accumulating (or removing) logical records in a buffer. For reading, one large buffered (also called blocked) record is read. Then, as a read request is made, one logical record is removed from this buffer. For writing data, data is accumulated in a buffer until it is filled. A write request for this buffer is made, and the process resumes filling. BLKIO reduces the number of calls to disk or tape; therefore, reduces Operating System calls. It provides an alternative to FORTRAN I/O requests. BLKIO provides a complete file manipulation that allows forward and back spacing of record and forward and back spacing of files in addition to its read/write capability. The read/write capabilities also provide certain flexibilities not available in the FORTRAN read/write. BLKIO requires the user to follow precise calling sequences. For instance, the last write must be followed by an end-of-file request by means of an end-of-file BLKWRIT call to flush all data from the buffer. The logical record size is important. If the logical record size is between 1 and N, when N=the buffer size, BLKIO does provide a speed advantage. If N is greater than the buffer size, BLKIO should not be used. The time advantage for I/O can be closely approximated by the buffer size used. This advantage is approximately equal to the buffer size/(1$n), where n is the average record size used.

LANGUAGE: COMPASS
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 903 source statements
PRICE: Program $50.00 Documentation $2.50
PROGRAM NUMBER: LAR-11414

Program for Interfacing a H-P Model 9830 Calculator with a H-P Model B Multichannel Analyzer

This program is a software package designed to allow interfacing a Hewlett-Packard Model 9830 calculator with a Hewlett-Packard Model 5401B multichannel analyzer.

LANGUAGE: BASIC
MACHINE REQUIREMENTS: H-P 9830 and H-P 5401B
PROGRAM SIZE: Not Applicable
PRICE: $35.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: LAR-11698

FORTRAN IV - Subroutines for Generating Printed Plots

This set of four subroutines provides printed plots as part of normal output. The subroutine PLOTXY is called for plotting a single curve, while PLOTMY is called for plotting multiple curves. When using PLOTXY, the values to be plotted in the x-direction must be in sequence; if they are not, prior to calling PLOTXY, subroutine SORTXY must be called to make the necessary rearrangements. For either PLOTXY or PLOTMY, if the range of a variable to be plotted is unknown, the subroutine SKALE must be called prior to calling PLOTXY or PLOTMY. These subroutines have been generalized so that, if desired, the programmer may choose to use one or more of several options that permit him to control such things as the appearance of the grid, the scale for either variable, and plotting character. The programs are almost entirely machine independent and the documentation is written to simplify the changes required to adapt the plotting system to other machine configurations.

LANGUAGE: FORTRAN G or H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 582 source statements
PRICE: Program $280.00 Documentation $9.50
PROGRAM NUMBER: LEW-10857

PLOT3D——A package of FORTRAN Subprograms to Draw Three Dimensional Surfaces

Plot3D is a package of programs to draw three-dimensional surfaces of the form z = f(x,y). The function f and the boundary values for x and y are the input to PLOT3D. The surface thus defined may be drawn after arbitrary rotations. However, it is designed to draw only functions in rectangular coordinates expressed explicitly in the above form. It can't, for example, draw a sphere. Output is by off-line incremental plotter or on-line microfilm recorder. This package, unlike other packages, will plot *any* function of the form z = f(x,y) and portrays continuous and bounded functions of two independent variables. With curve fitting; however, it can draw experimental data and pictures which can't be expressed in the above form. The method used is division into a uniform rectangular grid of the given x and y ranges. The values of the supplied function at the grid points (x,y) are calculated and stored; this defines the surface. The surface is portrayed by connecting successive (x,y) points with straight-line segments for each x value on the grid and, in turn, connecting successive (x,y) points for each fixed y value on the grid. These lines are then projected by parallel projection onto the fixed yz-plane for plotting.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360 and on-line CDC microfilm recorder
PROGRAM SIZE: Approximately 355 source statements
PRICE: Program $160.00 Documentation $5.00
PROGRAM NUMBER: LEW-10482

Algorithm for Reducing the Number of Required Points in a Graphical Data Set

The overspecification of graphs by a large number of points often makes the time required the graphs excessive. A subroutine called RDCPTS has been developed for reducing the number of points required to produce the graph. RDCPTS will produce an accurate and exact graphical display with a much reduced data set. Where plots of lower precision are acceptable, the algorithm can be even more effective in reducing the time and cost required in graphical production. The technique used in RDCPTS involves testing for deviation from line segments. The subroutine finds a subset of the original set of points such that all of the original points are within a certain tolerance of the line segments defined by the subset. The algorithm used in RDCPTS is fast, but does not necessarily reduce the number of points to the minimum number that satisfy the tolerance. As currently written, RDCPTS cannot reduce the number of points by a factor greater than 32. The first and last points are always included. This subroutine is particularly valuable for use with Benson-Lehner plots since it can make the plotting much less expensive. In addition, the resulting plots are much sharper and easier to read.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 123 source statements
PRICE: Program $260.00 Documentation $2.50
PROGRAM NUMBER: MFS-15107

QSAM —Variable Length Input/Output Routine

This is an OS/360 assembly language routine with FORTRAN (OS/360) calling sequences using QSAM data management routines to read/write sequential data sets. Only one data set each can be input and output at a time. To input/output more than one data set, the old data set must be closed prior to input/output of the new set. Data sets are automatically open when GETR or PUTR is called and the DCB for GETR or PUTR is closed. Data sets are closed via calling ENDQ. Two options are provided for closing data sets: close and position at beginning of the data set and close and position at the end of the data set. This routine is very useful in that it provides the ability to read records of unknown length on OS/360. Program documentation consists of a program source deck and a program listing with extensive documentation on the usage and description of the routine within the comments of the listing.

LANGUAGE: ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 300 source statements
PRICE: $25.00
NOTE: The price includes the documentation and a program listing. The documentation is not sold seperately from the program listing.
PROGRAM NUMBER: MFS-18725

MIRADS—Marshall Information Retrieval and Display System

The Marshall Information Retrieval and Display System (MIRADS) is an on-line data storage and retrieval system which allows the user to extract and process information from stored Data Bases. The use of remote terminals to extract and display data from the Data Bases provides a fast and responsive method of obtaining needed information. This on-line processing eliminates the extensive data processing cycle normally required when using an off-line or batch processing mode. The system consists of a general purpose computer program containing several functional subsystems that provide the overall capabilities of the total system. MIRADS is a command driven system with on-line editing of user commands which provides error diagnostic messages and recovery procedures that assist in the utilization of the system. The system can process any number of data files via a file Dictionary (one for each file) which describes the structure of the file to the system. New files may be added to the system at any time by creating a file Dictionary for the new file. MIRADS provides a highly diversified choice of data processing functions to satisfy user requirements. MIRADS consists of several programs, each performing a series of distinct functions. These programs are grouped together to form two subsystems, Search and Retrieval Subsystem (S & R) and Direct Access Data Display Subsystem (DADDS). Each program is further subdivided into modules to perform various subfunctions. The Search and Retrieval Subsystem provides the user the capability to select and process process variable data without extensive searches. In response to a user query, the system provides the capability of searching specified data files, sorting the files into a specified order, performing simple or complex computations, printing or displaying the results, and updating the Data Base. The Direct Access Data Display Subsystem provides the capability to access data files, process data, and present results as specified by user commands and specified output formats.

LANGUAGE: FORTRAN V (10.8%) Assembler (22.5%) COBOL (66.7%)
MACHINE REQUIREMENTS: UNIVAC 1108 DCT-500 or Uniscope 300
PROGRAM SIZE: Approximately 23,500 source statements
PRICE: Program $2,470.00 Documentation $38.00
PROGRAM NUMBER: MFS-22536

Computer Utilization Prediction Model

This program was designed to assist in computer utilization prediction. The method used in developing the model to predict the computer utilization was to forecast (1) the utilization of each component series separately, (2) based on past utilization records. The aggregation of the component series utilization predictions would then produce a more accurate utilization prediction. In a component aggregation such as this, the errors in prediction tend to cancel each other.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 SERIES
PROGRAM SIZE: Approximately 470 source statements
PRICE: Program $90.00 Documentation $5.50
PROGRAM NUMBER: MFS-22688

Merge and/or Modify Tabular Data Computer Program

In some analysis programs it is often necessary to determine the effects of variations in the tabular input data. This program can modify an existing data deck, with a minimum of additional input data. In addition, two existing card decks can be altered and merged to form a new card deck. The changes which can be accomplished are shown below: (1) The independent variable can be biased (±) on one or two decks. (2) The dependent variables of these decks can be added or subtracted to form a new set. (3) The dependent variables can be multiplied by a constant factor and/or a term (±) can be combined (again, on two new sets and combined if desired).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 62 source statements
PRICE: $35.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-24360

FORTRAN Read Package

The lack of a flexible input scheme in many large digital programs becomes a problem to both program users and programmers. Many input schemes require card formats, a fixed card order, or a specific number of cards. These requirements make program usage cumbersome and error prone. MThe use of this read package offers the following advantages. No card format or special order of cards is required. The package is controlled by a small set of parameters which can be changed to account for differences in computers and digital programs. The parameter's location in COMMON is used to identify the parameter. This location number is placed anywhere in the first five columns on the data card. The value of the parameter is placed anywhere on the rest of the card and followed by an asterisk. Sequential locations may be defined on the same card. The read package determines what type of parameter is being defined and automatically

differentiates between integer, real, octal, and Hollerith input. The program has the following capabilities: (1) Times may be input in HR/MIN/SEC or MIN/SEC; (2) Aside from FORTRAN F- or E-type input, the package accepts Hollerith, octal, and double precision input; (3) The capability to specify any parameter in COMMON for printing is provided; Multiple designation may be used to set an entire array equal to the same value; (5) Comments may be intermixed with data to identify input; (6) Continuations from one card to another are allowed during sequential input; (7) A sophisticated error checking capability is provided; and (8) The read package is written entirely in FORTRAN IV and can be used on any computer no matter how many bits are used to define one computer word. A routine has been included in the Read Package which is not used during the input phase. This routine is called SPECPR and has been included to allow the printout of any parameters in COMMON. This routine can be added to the print routine of any program and, when used in conjunction with the Read Package, allows parameters to be specified for printing from input.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 709 source statements
PRICE: Program $260.00 Documentation $2.50
PROGRAM NUMBER: MSC-14161

Hewlett-Packard 65 Emulator

The HP-65 Emulator was designed to aid in the development and checkout of programs written for the Hewlett-Packard Model 65 Programmable Pocket Calculator. The HP-65 Emulator simulates on a large computer a user defined HP-65 program. The diagnostic aids offered by the emulator help reduce development and checkout time and the automated documentation reduces bookkeeping and improves the reliability of the documentation task. The Emulator consists of a processor, and executor and a set of library routines. The processor converts the HP-65 program, as defined on input data cards, into a Fortran program which is then compiled, the executor executes this program as requested by the user through run control cards, and the library supplies the basic functions requested by the program, such as trigonometric, logarithmic, and exponential functions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,700 source statements
PRICE: Program $340.00 Documentation $7.00
PROGRAM NUMBER: MSC-14815

CONSTAT - A Program For Concordances and Statistics

CONSTAT was conceived as a literary research tool which would serve a variety of users and provide a concordance and every conceivable textual statistic that might be desired for authorship ascription and determination of sequence of composition. It has since proved useful as an aid to proof-reading, indexing, and stylistic and vocabulary analyses. It is readily adapted to automatic key word extraction of machine readable text. An objective has always been to achieve the utmost in economy of machine time. Thus, once machine-readable text is available, many mechanical textual manipulations can be economically performed. During the process of composition, for example, one may maintain a running index of what one has written and the total number of words. The program may also be used to search through machine readable material to find desired passages or to determine whether the material is of interest. Though the manipulation of the text is strictly mechanical, the concordance thus obtained is quite useful and the statistics produced are the ones most commonly used in textual analyses. For statistical validity, more than usual emphasis is placed on the importance of the common words. These latter occur in large numbers and thus form a more reliable basis for statistical inference as to authorship or chronology. The program has provisions (such as for upper case). It will not, in general, be necessary to adapt existing machine-readable text to the program. A wide variety of outputs are offered. All data may be obtained through the printer, statistical distribution curves may be plotted and both tape and card output may be obtained of the concordances of the works of one writer or of several writers, or one may wish to make correlations of the statistics of several texts to determine most probable authorship or sequence of composition.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,356 source statements
PRICE: Program $200.00 Documentation $17.00
PROGRAM NUMBER: MSC-17484

CHANGE—FORTRAN IV Digital Program Change

This program is used to modify FORTRAN IV source language programs to aid in their debugging, checkout, and final documentation. Three modifications may be accomplished: (1) rearrangement and incrementing of statement numbers, (2) insertion of card identification and sequencing, (3) insertion and/or removal of end-of-batch symbols. The program is designed to allow the user to modify his program without sacrificing turnaround time. Thus, the user has the option to compile, link edit, and execute the modified program as a normal run. There are other programs available that have the rearrangement and incrementing features but the automatic sequencing of statement numbers and insertion of end-of-batch symbols are assumed to be original.

LANGUAGE: ASSEMBLER (75%); FORTRAN IV (25%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 2,104 source statements
PRICE: Program $310.00 Documentation $4.50
PROGRAM NUMBER: MSC-17567

Indices and Cross References From Computer Readable Text

This program was developed to provide indices and cross reference tables from computer readable texts. The program will produce an index on selected words or phrases. The program will search the text and reference all occurrences of the specific words or phrases used as search keys. This program has been configured to process Administrative Terminal Service (ATS) generated texts. The program will operate with the Time Share Option (TSO) or on batch processing computers.

LANGUAGE: PL1
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 97 source statements
PRICE: $50.00
NOTE: The program price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19423

3-D Plotting Program, HP 9820A

. This procedure allows any 3 dimensional object to be rotated to any angle in any view and plotted (drawn). The plot can be made of the object from top view, side view or end view and if desired, all three views can be plotted on one piece of paper. Dynamics have not been included and this program does not suppress lines which define the far side of the object.

LANGUAGE: Not Applicable
MACHINE REQUIREMENTS: Hewlett-Packard 9820A Hewlett-Packard 9862A
PROGRAM SIZE: Not Applicable
PRICE: $45.00
NOTE: The documentation price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19460

Contour Plotting, FORTRAN IV Subroutines

These FORTRAN IV subroutines are designed to produce a contour graph for a user-coded bivariate function. The routines are independent of the specified plotting equipment and; therefore, can be used with basic plotting subroutines for any equipment. A grid-scanning approach is used rather than a curve-following method. Resolution depends entirely on the fineness of the grid specified by the user. Since a curve following method must include some form of scanning to avoid missing isolated curves, it is believed that the approach used here is more efficient than curve-following when graphic display is the desired end-product. For applications requiring extreme precision, the contours produced as above could be refined by gradient methods or by reapplication of the routine, using a finer grid on smaller regions containing the curves of interest. The number of function evaluations, NX x NY, is fixed by the user's specification of NX and NY and, in particular, is independent of the number of different contour values requested. It is not necessary to be able to store the entire matrix of NX x NY grid values simultaneously. An array of (NX + 2) words provides all the space needed to save values at grid points. The construction of contour strings uses list-processing techniques, so it is not necessary to anticipate the number of distinct contour curves or the number of points per curve. If the storage available for the contour strings becomes exhausted, the subroutine interrupts processing so that the strings can be sent to the basic plotting subroutines before processing is resumed.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7090/7094, SC 4020 plotter
PROGRAM SIZE: Approximately 938 source statements
PRICE: Program $140.00 Documentation $12.00
PROGRAM NUMBER: NPO-10127

SFTRAN—Structured Programming to Fortran Translator

The program SFTRAN (Structured Programming to Fortran Translator) was written to allow Fortran programmers to use the logical control elements of structured programming. These elements include the fundamental syntactical elements IF( ) THEN, ELSE, and DO WHILE as well as certain other elements supplied for user convenience such as PROCEDURE declarations, DO UNTIL, DO CASE and DO FOR. Because the Fortran language does not recognize the basic language structures used in structured programming, SFTRAN is a translator that converts structured programming source statements into Fortran statements acceptable to the Fortran compiler. The source code distributed by COSMIC for SFTRAN is written in structured Fortran, however the executable code for SFTRAN is also recorded on the distribution magnetic tape.

LANGUAGE: SFTRAN
MACHINE REQUIREMENTS: Univac 1100 Series
PROGRAM SIZE: Approximately 680 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program $380.00 Documentation $9.00
PROGRAM NUMBER: NPO-13602

FLOWCHARTER—Program For Producing Flow Charts of Fortran Source Decks, GE-635 Version

The Flo Chart program is designed to produce flowcharts of programs written in FORTRAN IV or FORTRAN II. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the program under consideration. This program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 591 source statements
PRICE: Program $160.00 Documentation $5.00
PROGRAM NUMBER: WLP-10030

3-D Plotting Program, HP 9820A

. This procedure allows any 3 dimensional object to be rotated to any angle in any view and plotted (drawn). The plot can be made of the object from top view, side view or end view and if desired, all three views can be plotted on one piece of paper. Dynamics have not been included and this program does not suppress lines which define the far side of the object.

LANGUAGE: Not Applicable
MACHINE REQUIREMENTS: Hewlett-Packard 9820A Hewlett-Packard 9862A
PROGRAM SIZE: Not Applicable
PRICE: $45.00
NOTE: The documentation price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19460

Contour Plotting, FORTRAN IV Subroutines

These FORTRAN IV subroutines are designed to produce a contour graph for a user-coded bivariate function. The routines are independent of the specified plotting equipment and; therefore, can be used with basic plotting subroutines for any equipment. A grid scanning approach is used rather than a curve-following method. Resolution depends entirely on the fineness of the grid specified by the user. Since a curve following method must include some form of scanning to avoid missing isolated curves, it is believed that the approach used here is more efficient than curve-following when graphic display is the desired end-product. For applications requiring extreme precision, the contours produced as above could be refined by gradient methods or by reapplication of the routine, using a finer grid on smaller regions containing the curves of interest. The number of function evaluations, NX x NY, is fixed by the user's specification of NX and NY and, in particular, is independent of the number of different contour values requested. It is not necessary to be able to store the entire matrix of NX x NY grid values simultaneously. An array of (NX + 2) words provides all the space needed to save values at grid points. The construction of contour strings uses list processing techniques, so it is not necessary to anticipate the number of distinct contour curves or the number of points per curve. If the storage available for the contour strings becomes exhausted, the subroutine interrupts processing so that the strings can be sent to the basic plotting subroutines before processing is resumed.

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LANGUAGE: SFTRAN
MACHINE REQUIREMENTS: Univac 1100 Series
PROGRAM SIZE: Approximately 680 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program $380.00 Documentation $9.00
PROGRAM NUMBER: NPO-13502

FLOWCHARTER—Program For Producing Flow Charts of Fortran Source Decks, GE-635 Version

The Flo Chart program is designed to produce flowcharts of programs written in FORTRAN IV or FORTRAN II. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the program under consideration. This program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 591 source statements
PRICE: Program $160.00 Documentation $5.00
PROGRAM NUMBER: WLP-10030

ELECTRONICS

Includes electronic circuit design and analysis; design and development of basic electrical and electronic components; feedback and control theory.

VASP—Variable Dimension Automatic Synthesis Program

VASP is a Variable dimension Fortran version of the Automatic Synthesis Program called ASP. The program is used to implement the Kalman filtering and control theory. Basically, it consists of a 31 subprograms for solving most modern control problems in linear, time-variable (or time-invariant) control systems. These subprograms include operations of matrix algebra, computation of the exponential of a matrix and its convolution integral, and the solution of the matrix Riccati equation. The user calls these subprograms by means of a FORTRAN main program, and so can easily obtain solutions to most general problems of extremization of a quadratic functional of the state of the linear dynamical system. Particularly, these problems include the synthesis of the Kalman filter gains and the optimal feedback gains for minimization of a quadratic performance index. The VASP is an outgrowth of ASP and has the following improvements: (1) more versatile programming language; (2) more convenient input/output format; (3) some new subprograms which consolidate certain groups of statements that are often repeated; and (4) variable dimensioning. The pertinent difference between the two programs is that VASP has variable dimensioning and a more efficient storage. The documentation for the VASP program contains a VASP dictionary and some example problems. The dictionary contains a description of each subroutine and instructions on its use. The example problems include dynamical response, optimal control gain, solution of the sampled data matrix Ricatti equation, matrix decomposition, and a pseudo inverse of a matrix.

LANGUAGE: FORTRAN IV, H LEVEL compiler
MACHINE REQUIREMENTS: Tested on IBM 360/67 TSS
PROGRAM SIZE: Approximately 2,259 source statements
PRICE: Program $590.00 Documentation $15.00
PROGRAM NUMBER: ARC-10616

AUTOWIRE—IBM-360 Version

The AUTOWIRE/360 program is used to assist the logic designer in the translation from his original design to the finished hardware. The assistance is in the form of diagnostic tests, module placement guides, and machine instruction cards to drive the Gardner-Denyer Automatic Wire-Wrap machine. The hardware is in the form of six socket panels mounted on an aluminum frame. A total of 360 14 pin dual in-line packaged integrated circuits may be plugged into the six boards and interconnected by the AUTOWIRE/360 program. The wired frames are mounted in multiple in conventional rack type drawer assemblies. Although the program is designed for a particular panel assembly, it may easily be modified to support similar panel/socket assemblies. Program documentation consists of a user's guide, programmer's guide, operator's guide, and logic designer's guide.

LANGUAGE: FORTRAN IV (98.8%); ASSEMBLER (1.2%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 4,553 source statements
PRICE: Program $840.00 Documentation $36.00
PROGRAM NUMBER: GSC-11526

Puzzle—Computer Aided Design

This program package represents engineering design software. It is a single program which is applicable to problems of designing printed circuit boards and is capable of designing two-sided boards with a variety of components. The technique of man-machine interaction is used in which the designer retains control over certain design decisions while the computer solves topological problems and furnishes graphic output suitable for printed circuit production. This technique of man-machine interaction has the advantage of minimizing costly computer time necessary for the completion of a circuit card. Restrictions of the programs are: (1) path lengths are not minimized, the routing logic tends to produce short paths but no effort is made to assure that they are the shortest paths possible; (2) through holes are not minimized, (a smoothing routine tends to reduce the number of holes carrying lines back and forth through the surfaces of the board, but the algorithm does not minimize them); (3) solutions to portions of the topological routing may be incomplete, requiring unnecessary jumpers or touch-up of the artwork. Also the pen and ink drawings are produced by a Cal Comp Plotter and may be used to produce prototype circuit boards by direct reproduction, but if the high quality needed for a production run is to be produced an optical plotting system is needed. In this case, a Gerber optical plotting system has been used to plot PUZZLE output. It produces high quality film positives directly. The program operates in interactive mode and though it is presently written for CDC 6000 Series machines. It is written entirely in FORTRAN IV and it would be reasonably

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convenient to convert the program for use on other machines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series with Cal Comp Plotter (see abstract)
PROGRAM SIZE: Approximately 2,427 source statements
PRICE: Program $700.00 Documentation $14.50
PROGRAM NUMBER: GSC-11947

AUTOSKEM I—Automatic Electronic Schematics Program

This program package represents a utility program for drawing electronic schematics on a digital plotter. Schematic symbols included are lead, circle, arc, ground, node, number, resistor, capacitor, inductor, battery, AC sources, diodes, and transistors. The program can draw either a 'B' or 'C' size drafting paper outline and has been designed to be used by personnel with no prior computer programming knowledge. A high degree of versatility is allowed by the program and constraints are few. The program operates in batch mode and requires the availability of two 7 track tape units and a Calcomp plotting package.

LANGUAGE: FORTRAN IV (95%) MAP (5%)
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,558 source statements
PRICE: Program $570.00 Documentation $2.50
PROGRAM NUMBER: GSC-11948

SEE—Systems Effectiveness Evaluation Computer Program

A system of eight integrated computer programs has been developed to assess the effectiveness of any complex electronic system. The programs were originally developed to assess the reliability and maintainability of twelve sets of Acceptance Checkout Equipment/Spacecraft ZAEC-S/C), each set containing 175 racks of equipment and 1,000 price parts. Input to the System Effectiveness Evaluation (SEE) Programs consists of system configuration data, elapsed time meter readings and edited failure reports. The outputs of the SEE Programs are: (a) Mean-Times-between-Failures (MTBF) and Mean-Times-To-Repair (MTTR) for all unique parts of assemblies, for all subsystems and for the system, with associated confidence parameters and flagging of weak links. (b) Printer-plotter trend charts of the MTBF's and MTTR's. (c) MTBF and MTTR correlation charts comparing performance of all ground stations. (d) Computation of system reliability, availability and expected cumulative downtime during a simulated mission. (e) Numerous utility programs used in spares prediction and to assist in identification of problem areas. Proper and timely integration of three separate and distinct data areas are essential for desired results: A set of translation tables to precisely encode the complete logical description of all equipment to be assessed; systematic reporting and processing of failure experience; periodic recording and processing of equipment operating time. The primary feature of the SEE Program is the ability to rapidly pin-point equipment problem areas for corrective action down to the lowest possible level of assembly. The programs can be modified to be utilized by any large complex electronic system.

LANGUAGE: FORTRAN (67.65%); GMAP (32.35%)
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 12,175 source statements
PRICE: Program $1,000.00 Documentation $21.00
PROGRAM NUMBER: HQN-10306

ASAP—Automated Statistical Analysis Program

ASAP (Automated Statistical Analysis Program) was designed to perform a Monte Carlo statistical analysis on the d-c currents and voltages of transistor and diode circuits. It was intended that the ASAP user be required only to provide a simple topological description of the circuit in an English-text form. The ASAP program, through a pattern-recognition subprogram, scans and analyzes input data, producing a table which indicates the sections of this data. The program then uses this data to write a set of Kirchoff equations and then solves them algebraically using the Gauss reduction method. ASAP will build a mathematical model of the circuit and its nonlinear components, then a subroutine will perform the statistical analysis. The topological description of the circuit may include resistors, voltage sources, current sources, diodes, and transistors. The diodes and transistors are represented by voltage-current tables supplied as input data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 5,000 source statements
PRICE: Program $530.00 Documentation $10.00
PROGRAM NUMBER: LAR-11125

STICAP—Linear Circuit Analysis Program with Stiff Systems Capability

Most computer aided network analysis programs are designed to relieve the user of the following burdens: (a) Circuit translation - the obtaining of the differential and algebraic equations governing the network, starting from an easily specified description of the circuit in the terminology of the network designer, and (b) Numerical integration - the obtaining of a numerically accurate solution of the initial value problem for this set of circuit equations. The present state of the art allows a reasonably effective solution of the former problem. However, most first generation circuit analysis programs are somewhat restricted in scope, as regards the latter, in the instance of stiff networks which are characterized by widely separated time constants. In such circumstances the numerical integration techniques implemented in the first versions of programs like CEPTRE and ECAP require such prohibitively small time steps that they become impractical as aids to analysis. The primary reason for the design of STICAP is the motivation to combine the capabilities of circuit translation using the state variable topological approach with efficient numerical integration techniques for transient analysis, using algorithms which possess both stiff and non-stiff capabilities. The STICAP program is restricted to the analysis of linear time invariant networks. It represents a merging, with some modifications to each, of Pottle's circuit analysis program CORNAP with Gear's program ALGORITH 407 - DIFSUB, for the automatic integration of ordinary differential equations. The program package is best viewed as consisting of three seperate components, or modes of operation, each having some advantages and disadvantages over the others in different circumstances. In each mode the common method of circuit translation is that originally employed in program CORNAP; a topological approach the result of which is a set of first order linear differential equations governing the time evolution of the circuit state variables. The CORNAP mode makes selectable the program CORNAP with all previous capabilities, but optional selection of certain data printing features. These capabilities include calculation of transfer functions, zeroes of transmission, frequency and time response of the circuit. The fourth order numerical

integration algorithm implemented in CORNAP for time domain analysis is absolutely stable; hence, it may be used for either stiff or non-stiff networks. However, the stepsize is fixed throughout the duration of computation, a feature which can be uneconomical in some instances. Further, other than impulse or step functions, the only type of circuit input is sampled data. The Gear and Matrix modes may be used to compute time domain transient, impulse, or step responses only, with the option of calling CORNAP subroutines to obtain transfer functions and zeroes of transmission. The Gear mode allows the selection of either an Adam's integration method, suitable for non-stiff equations, or else the methods of Gear, suitable for stiff equations. This mode can be used for analysis of the general linear time invariant network, with forcing functions specified using the full power of the FORTRAN language, or by means of sampled data. In both cases, *automatic* order selection techniques and variations in the step size are employed as the integration proceeds, to achieve a desired level of accuracy with the minimum number of integration steps. The maximal order truncation error selectable by changing from one algorithm to another via the automatic order selection process is an eighth order Adam's method or a sixth order stiff algorithm. In the matrix mode, a special decomposition of the system matrix in terms of its eigenvalues is employed, to obtain a closed form solution which avoids a numerical integration. The resulting method is computationally rapid and may be used for either stiff or non-stiff networks; however, it is applicable only in the case of no repeated eigenvalues of the system matrix, and for systems whose forcing functions are linear combinations of sinusoidal, cosinusoids, impulse, or step functions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 9,268 source statements
PRICE: Program $1,440.00 Documentation $24.50
PROGRAM NUMBER: LAR-11184

Design of Microstrip Components by Computer

This study presents a number of computer programs used in the synthesis of microwave components in microstrip geometries. The programs compute the electrical and dimensional parameters required to synthesize couplers, filters, circulators, transformers, power splitters, diode switches, multipliers, diode attenuators and phase shifters. Additional programs are included to analyze and optimize cascaded transmission lines and lumped element networks, to analyze and synthesize Chebyshev and Butterworth filter prototypes, and to compute mixer intermodulation products. This group of programs can be divided into component synthesis and design programs. The single strip programs include synthesis of low pass filters, lumped high pass filters, microstrip stopband filter, stepped impedence transformer, hybrid ring and finite circulator. The coupled microstrip lines include end coupled bandpass filters, parallel coupled bandpass filters, microstrip directional coupler and hybrid T synthesis. Design aids include the Chebyshev response, spurious intermodulation products, and analysis/optimization. Multiplier design aids are diode characteristics and analysis, output and idler circuits, and the microstrip tripler. This is a very complete and comprehensive system that would be useful to any environment requiring design or analysis of microstrip components.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 6,000 source statements
PRICE: Program $950.00 Documentation $15.50
PROGRAM NUMBER: LAR-11210

Computerized Technique for Documenting Complex Wiring

This software package is an electrical engineering program developed for documenting the wiring interconnections in complex electrical systems. This computerized technique eliminates the need for drafting numerous detailed wiring diagrams, and the attendant problems of keeping them up to date with the many changes which often occur during development and testing. The characteristics and functions of each conductor in the elctrical system are input to the program. Each component is assigned a unit number and a sequential signal number identifies all conductors from each unit. The output tabulations include each conductor with both termination points; and a brief description of the function of the conductors in the system are given. The output wire lists show the origin of each conductor, its destination, the cable designation number, and the electrical characteristics of the circuit. The program is particularly adaptable to complex systems where a large number of components are to be interconnected. The program operates in batch mode.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 472 source statements
PRICE: Program $330.00 Documentation $7.00
PROGRAM NUMBER: LEW-11749

ECAP—Electronic Circuit Analysis Program, IBM 360 Version

The Electronic Circuit Analysis Program (known as ECAP) is an integrated system of programs designed to aid the electrical engineer in the design and analysis of electronic circuits. This system of programs can produce DC, AC, and/or transient analyses of electrical networks from a description of the connections of the network (the circuit topology), a list of corresponding circuit element values, a selection of the type of analysis desired, a description of the circuit excitation, and a list of the output desired. ECAP recognizes a set of standard electrical circuit elements. Any electrical network that can be constructed from any or all of the different elements in the set can be analyzed by ECAP. There is almost no limit to the number of ways that the circuit elements can be arranged in the network. The set of standard circuit elements does not include electronic components, but in many cases, these components are easily simulated by means of equivalent circuits constructed of standard elements. A number of examples are included in this manual that involve the use of equivalent circuits. ECAP allows the circuit designer to economically and efficiently examine the performance of a circuit during the various stages of its design, by using a computer rather than a "breadboard." In this way, the designer can rapidly determine the variations in circuit response that correspond to changes in circuit parameters. Studies can be made of circuits that contain costly components that may be difficult to obtain. Destructive excitation can be applied to the circuit with no fear of destroying expensive electronic circuit elements. Worst case combinations, which are hard or practically impossible to realize in the laboratory, can be examined. Measurements that may be difficult to make, and time consuming to instrument, can

be made quite simply on the computer. Circuit connections can be changed rapidly. In many cases, ECAP can leave the designer with a clearer insight into the operation of the circuit than could be obtained with a breadboard study, and often at considerably less cost.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360/370, CDC 6000 Series, UNIVAC 1100 Series
PROGRAM SIZE: IBM Vers. - Approximately 5600 source statements
CDC Vers. - Approximately 10,000 source statements
UNIVAC Vers. - Approximately 7,000 source statements.
PRICE: IBM Vers. - Program $820.00 Documentation $19.00
CDC Vers. - Program $600.00 Documentation $9.50
UNIVAC Vers. - Program $630.00 Documentation $8.50
PROGRAM NUMBERS: IBM Vers. - MFS-13094
CDC Vers. - LEW-10667
UNIVAC Vers. - NPO-11417

CIRCUS—A Digital Computer Program for Transient Analysis of Electronic Circuits

This program is designed to simulate the time domain of response of an electronic circuit to an arbitrary forcing function. CIRCUS uses a charge control parameter model to represent each semiconductor device. When given the primary photocurrent induced in the semiconductor devices, the transient behavior of a circuit in a radiation environment can be determined. The program initially sets up time-domain circuit equations from a topological description of the network. Steady-state initial conditions are found by setting the differential equations to zero, then evaluating the transient solution by numerical integration of the differential equations. The program output includes the input data and columnar listings of network variables vs. time. Virtually any circuit variable including currents and voltages internal to the semiconductor devices, may be displayed. Although no plotting capability is ordinarily supplied with CIRCUS, provisions have been made for saving variables on tape for subsequent plotting or further analysis by other programs.

LANGUAGE: FORTRAN H (93%), ASSEMBLER (7%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 6,987 source statements
PRICE: Program $700.00 Documentation $23.00
PROGRAM NUMBER: MFS-15002

MPP—Control Program to Determine Minimum Phase from Variable Gain Characteristics

In designing control systems, it is required to design a passive electrical network which satisfies specified gain and phase characteristics. It is assumed that a passive network can be constructed whose corresponding transfer function reflects stability of the network. If the minimum phase lag associated with a specified gain characteristic is less than a desired phase lag, then an actual electrical network can be constructed which will satisfy both gain and phase characteristics set forth by the engineer. The Minimum Phase Program determines the minimum phase lag of passive electrical networks reflecting the degree of stability of the transfer functions basically established by the gain characteristics determined by the engineer in the program input. The phase lag is determined in the program as a function of frequency for a specified gain characteristic. To describe gain characteristics, the program user inputs a tabular array of gain versus frequency and two slopes. The slopes are used to define the gain curve for frequencies before and after the frequencies in the tabular defined region. The slopes are inputs. The integration technique employed is the trapezoidal method and the integration can be expressed as a function of frequency. The limits of integration are computed from a fraction and multiple which are multiplied by each ith frequency value. The fraction and multiple integration limits are user input. The accuracy of the technique depends primarily on the increment used to form the base of each trapezoid. The user can divide the curve into three regions, each with its own frequency increment. The frequency increments are also user input.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 412 source statements
PRICE: Program $380.00 Documentation $7.00
PROGRAM NUMBER: MFS-15045

Computerized Logic Design of Digital Circuits

A computerized logic design procedure is presented for a specially developed computer program that performs all the work required for the logic design of digital counters of sequential circuits and the simplification of Boolean expressions. The program provides a simple, accurate, and comprehensive logic design capability to users both experienced and totally inexperienced in logic design. The program has been developed for two modes of operation: Counter design and Boolean simplification. In the counter design mode, the program provides the simplified flip flop input equations for any desired sequence and using in either sum-of product or product-of sum form for any one or all of the flip flop types. The program also provides printout of the intermediate design steps used in obtaining the flip flop input equations. In the Boolean simplification mode, the program simplifies Boolean logic functions that can be entered in either sum of product or product-of sum form. The counter design mode can also be used for design of sequential circuits other than counters. The program can be used for any sequential design application where a group of flip flops are required to change states in a prescribed order. Another useful feature of the program is that for a given count sequence, the counter design equations can be obtained for several or all of the available type flip flops. The designer can compare these equations for simplicity or some other desired characteristic and select the optimum type flip flop for the given sequence. Considerable effort was expended in the development of these programs to reduce the input data requirements to the simplest level possible and to present the output results in a self explanatory and instructive format.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 1,067 source statements
PRICE: Program $710.00 Documentation $17.50
PROGRAM NUMBER: MFS-22401

Tolerance Analysis Program

This program can be used to determine the mean and tolerance values of an end to end signal chain or flow path. Unlike many tolerance determination techniques, this program does not assume the nature or shape of the individual building block or circuit element probability density functions (PDF). Instead, it takes known circuit element hardware test data, which may be in the form of a histogram or specified as a nominal value with an associated set of limits, and statistically sums the PDF's of the individual circuit elements into overall PDF for the

complete end-to-end signal path. From this overall PDF, a set of limits is computed which contains a desired and preselected amount of probability included between these limits. This program is particularly well-suited for defining the tolerances to be specified in procurement or test specifications, as well as having a utilitarian value in the synthesis and analysis phases of the subsystem design process.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,400 source statements
PRICE: Program $570.00 Documentation $12.00
PROGRAM NUMBER: MSC-17487

Wire Chain Program, UNIVAC-1108 Version

The Wire Chain Program is of use to anyone doing complicated electrical/electronic circuit layout or design involving either wired or printed circuit routing. It provides a listing of the contents of given electrical chains. A chain is a group of links (wire between two pin points) which are tied together electrically, and a listing of links which are not tied electrically. The program requires three types of input data: control, chain vertex (starting vertex of a given chain), and link data. The program determines the format, the source of the link input and what type of output is required from the control data card. The chain vertices are read in and initial the condition set up. As many as 50 chain vertices during one run can be handled by the program and there can be N number of links.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 1,026 source statements
PRICE: Program $140.00 Documentation $2.50
PROGRAM NUMBER: NPO-11332

MTRAC—Computer Program for Analysis of Circuits Including Magnetic Cores

Transient analysis of circuits that include magnetic cores is complicated by the nonlinearity of the switching-core model and by the magnetic coupling among the loop currents. These difficulties have been overcome by incorporating static and dynamic core models into the automated circuit analysis computer program TRAC. The program has been modified by including provisions for successive modes of operation, conditional monitor printout of variable values in different portions of the program, plot and print-plot routines with external or internal specifications for scales, units, and frame sizes, normal and circuit-failure run termination, nonlinear inductor and resistor models, etc. The modified computer program is named MTRAC. Time variables (voltages, currents, MMF's, fluxes, etc.) of complex magnetic-core circuits (up to 60 nodes can thus be computed and plotted automatically. All that the user has to supply is the general run-control specifications, the circuit topology, and the values of the circuit-element parameters. The MTRAC program consists of two sections, one dealing with initialization, and the other with the transient solution. The initialization section performs the following five tasks: (1) Read in and print out general input data, (2) Read in and print out the circuit-element data, (3) Solve initial conditions (optional), Print out and store initial conditions, and (5) Read in and print out continued run-data (optional). The transient-solution section performs the following seven tasks: (1) Compute the magnitudes of the time-variable current and voltage sources, (2) Until convergence is achieved, compute by iterations (using a routine for solving matrix equations and a modified Newton-Raphson method for solving matrix equations and a modified Newton-Raphson method for solving transcendental equations) all the nodal voltages and all the currents through the nonlinear elements (diodes, transistors, and magnetic-core windings); if necessary reset the unknown values and cut the time step, -t, (3) Compute the currents through the linear elements, (4) Adjust -t according to the recent convergence conditions and update the time variables for the next -t, (5) Store (for plots) and print out the resulting time variables, (6) If the run-time limit is about to be exceeded, punch the final results necessary for a future continued run on cards, and (7) Print-plot the specified variable waveforms and store the plot data on a tape, begin a new mode, or exit. Instructions for data entry by the user are provided. These include definitions of special functions and/or auxiliary variables, and input data cards specifying the run control and the circuit-element topology and parameter values. The MTRAC program has been applied successfully to transient analyses of several magnetic-core circuits.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 5,750 source statements
PRICE: Program $920.00 Documentation $25.00
PROGRAM NUMBER: NPO-11494

FACILITIES, RESEARCH AND SUPPORT

Includes simulators and simulation methods; test facility and test equipment design and operation; cost effectiveness, examination and selection of equipment, materials, personnel, and methods for optimum performance of tasks; support facility administration, management and inventory control.

Digital Program for Solving the Linear Stochastic Optimal Control and Estimation Problem

This problem is a mathematics package containing fourteen subroutines to solve the linear stochastic optimal control and estimation (LOSCHE) problem. The program subroutines are largely implementations of published algorithms which were previously unavailable as computer programs. The solution to the LSOCE problem is a Kalman filter, which estimates the system states, coupled through a set of optimal regulator gains to produce the desired control signal. The key to solving the LSOCE problem is the solution of the matrix Riccati differential equation. This equation occurs in solving for both the finite time optimal linear regulator gains and the finite time optimal linear estimator (Kalman filter) gains. An important special case is the finite time LSOCE problem, in which the main equations to be solved use algebraic (steady state) matrix Riccati equations. The program is written so as to handle systems of any order and is restricted only by computer storage size and accuracy. The program has been applied in designing control systems for supersonic inlets. It operates in batch mode and uses five subroutines (ARRAY, SIMQ, FACTR, HSBG, and MINV) from the IBM Scientific Subroutine Package.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,798 source statements
PRICE: Program $420.00 Documentation $18.00
PROGRAM NUMBER: LEW-12505

Magnetic Tape Library System

The Magnetic Tape Library System is a system of programs used to manage magnetic tape utilization in a computing facility. The input to the system consists of a tape library master file, a date control card, and transaction cards. The date control card contains the run date as well as fields used in selecting the reports to be printed. The transaction cards contain one of seven codes to designate what action is to be taken with the data on the remainder of the card. Incoming transactions are verified and edited, then processed against the master file. Generated output consists of an updated master file, control reports and a report file. Nine reports are available to the user. The Error Report (R1), the Transaction Report (R2) and the Summary Report (R3) are printed at the time of processing on an on-line printer and are control reports. The remaining six reports, Assigned Tape Listing by Employee (R4), Unassigned tape listing (5), Tape Release Schedule (R6), Tape Release Schedule ** Final Notice ** (R7), Assigned Tape listing by Tape (R8) and the Tape Assigned Summary by Individual (R9) are user reports that are printed off-line by an OS SLAVE print program that is also a part of the system.

LANGUAGE: ANSI COBOL
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,800 source statements
PRICE: Program $680.00 Documentation $8.00
PROGRAM NUMBER: ARC-10942

CPM—Critical Path Method Computer Program

The Critical Path Method (CPM) program was developed to assist in the planning and management of a project where the interrelationships between activities and functional areas are numerous and involved, or if the responsibilities for various phases are fragmented or widely spread, or if the project is so large or complex it is difficult to visualize as a whole. This program assists in project management by utilizing the systems concept for planning, scheduling, and control of an organization's project objectives and plans. The system is based on the network approach, essentially an advanced concept of the flow diagram, with the network made up of two basic components-activities and events. Activities are physical or mental work to be accomplished and make up the project time or life span, and are seen in a network as arrows between events. Events are connection points between activities, marking their beginning and ending. They appear in a network as nodes or junctions at which activity arrows converge or diverge. With the development of the project plan, the network then displays sequential

and parallel relationship between items of work by its arrangement of activity arrows.

LANGUAGE: FORTRAN V (90%), ASSEMBLER (10%)
MACHINE REQUIREMENTS: UNIVAC 1108, Exec 8
PROGRAM SIZE: Approximately 11,366 source statements
PRICE: Program $1,440.00 Documentation $69.00
PROGRAM NUMBER: COS-02390

NGPSS—NADC General Purpose Simulation System for CDC 6600 Series Computers

This program package is an adaptation of the IBM General Purpose Simulating System to CDC equipment. The simulation system may be used for conducting evaluations and experiments on systems, methods, processes, or designs. It can be applied to problems in which transactions, people, or equipment are competing for services of other people or equipment, when it is of interest how well the service organization will respond to demands. System testing and time compression is an advantage of simulation systems such as NGPSS. The input parameters to NGPSS are determined from a flow chart of the system being simulated. An output editor allows three output options. Output includes statistics on transactions, as well as plotter produced histograms and graphs. Limitations of the package are few; any system with identifiable entities may be simulated and over two billion characteristics can be assigned to the transactions being modeled. The package represents an entire simulation system for CDC 6000 series machines operating under SCOPE 3.3. The system operates in batch mode from card input.

LANGUAGE: COBOL (52%) FORTRAN (31%) COMMPASS (17%)
MACHINE REQUIREMENTS: CDC 6000 Series SCOPE 3.3
PROGRAM SIZE: Approximately 17,552 source statements
DISTRIBUTION MEDIA: 7 Track CDC SCOPE Formatted Mag. Tape
PRICE: Program $1,980 Documentation $11.00
PROGRAM NUMBER: DOD-00037

CANS—Computer Assisted Network Scheduling System

The computer Assisted Network Scheduling System (CANS) was developed and implemented to meet the needs of the Manned Space Flight Network. This system provides efficient, effective management and control of resources in a complex scheduling environment. The system is an automated storage and retrieval management tool. The system stores, in computer files, resources available for scheduling, accepts and analyzes requests or demands for use of resources; matches resources with demands, and produces conflict free schedules for the time periods specified by the user. Conflict analysis is provided for requested events that cannot be scheduled due to resource conflict. This is a general purpose program that can be adapted to assist management in solving planning, controlling, and conflict free scheduling problems in a complex resource scheduling environment.

LANGUAGE: FORTRAN IV, ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: One 2400 ft. magnetic tape (unloaded data set)
PRICE: Program $1,280.00 Documentation $13.00
PROGRAM NUMBER: GSC-10909

GREMEX—Goddard Research and Engineering Management Exercise Simulation System

GREMEX is a man machine simulation game of the life of a Research and Development project plan through the construction phase. The game is computer based to the extent that a computer is used to calculate (simulate) the effects of management actions and contractor performance. GREMEX is not new in that it has previously had wide distribution, but the program and documentation has been revised innumerable times in the past. This report is for the revised version as it exists to date. The basic action of the GREMEX program is to simulate one month of project work for each computer input or play. The project itself is described in terms of a PERT network and is originally established by data cards at the start of the game. The numerical reactions of the model are related to typical R&D projects and the PERT data cards include probabilities of meeting the time, cost and performance goals. Provisions for student inputs (decisions) to change these values are provided. The computer program itself must be supported by other paper simulation data such as project plan or contractor evaluation and selection documents. This simulation may be adjusted for the teaching intent or needs of the group in emphasis on the various areas of the project. The general purpose GREMEX program handles a project that consists of one to fifteen contracts. Any sort of system may be represented by the program provided that it consists of a connected sequence of events that can be described in a flow chart. The program will accept any project that consists of less than 1,000 events. A smaller memory computer could be utilized by reducing the number of events and redefining certain dimension statements through the routines. Initially, the players are presented with the project with the understanding that no ground rules exist; however, NASA policy should be their guide. They are permitted to do almost anything and the model will react as it would in real life. To each player or team of players there is assigned a referee-instructor who serves as the interface between the players and the computer program. He converts the players decision to a form that will be acceptable to the model.

LANGUAGE: FORTRAN H (93%); ASSEMBLER (7%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 5,706 source statements
PRICE: Program $610.00 Documentation $52.00
PROGRAM NUMBER: GSC-11512

GEMS—Generalized Evaluation Model Simulator

Generalized Evaluation Model Simulator (GEMS) is a stochastic, time event, digital computer program designed to aid the analyst system designs, and in determining the sensitivity of system performance to changes in design parameters. The program simulates, to a high level of detail, the responses of complex systems of equipment and personnel as they are subjected to a time-varying load. A prime application is to situations where a number of "customers" must compete for the services of a system with limited resources of equipment and personnel, where the equipment can fail and personnel can commit errors, and where the correction of these malfunctions is constrained by operations and maintenance policy and procedures. The program consists of over 60 modular routines. Although experience has shown that these subroutines can be readily modified for special application, GEMS has a wide applicability without modification because of the general nature of the responses it simulates, and because the load and system characteristics are defined by the input data. It is especially useful when the system parameters are either empirically obtained and cannot be readily incorporated in an analytic model, or where they are unknown and "best values" must be established by sensitivity analyses. GEMS deals in

abstract entities known as "customers" and "functions," whose real world definitions are maintained external to the computer; only their pertinent characteristics are entered as input to the simulation. Customers are any entities that arrive at the system input and demand a specified set of equipment or personnel functions to be interconnected into an operational configuration. A customer could be a satellite coming in view of a ground station, a batch of raw data arriving at a central computing facility for processing and reduction, or an individual requesting a communications circuit from an operator.

LANGUAGE: FORTRAN IV (83%); PL/I (14%); ASSEMBLER (3%)
MACHINE REQUIREMENTS: IBM 360/95
PROGRAM SIZE: Approximately 3,504 source statements
PRICE: Program $840.00 Documentation $28.00
PROGRAM NUMBER: GSC-11641

CALICO—Capital Assets Location Inventory Control

The Capital Assets Location Inventory Control (CALICO) system is designed to computerize and maintain a location index for every item which is considered accountable property. To provide this function, a complete list of items is maintained on magnetic tape. This tape (CALICO MASTER) is updated by the program and scanned to obtain several reports to be used by the stock room and management personnel to guarantee current and accurate location information about each item and its history of previous usage. Two property listings are generated showing the most current location index for each item on the CALICO MASTER tape. The Active Property Inventory shows all items which are actively in inventory. The remaining items which have been loaned, or transferred from the property record, or have been temporarily used as equipment for a short term contract, are combined with the active property to form a Total Property Inventory Report. Other reports include Delinquent Reports, Location by Line Reports, and Chronological History Reports.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: CDC 3000L Series
PROGRAM SIZE: Approximately 927 source statements
PRICE: Program $460.00 Documentation $13.00
PROGRAM NUMBER: GSC-11652

Boeing Computerized Preventative Maintenance Program

From 1965 to 1970 there was no effective system for scheduling and documenting performance by routine preventive maintenance on Boeing assigned Ground Support Equipment. Preventive maintenance was being controlled by manually scheduling work orders for release of work and verification of completion of the procedure and on the work order. As preventive maintenance consists of a large number of small repetitive tasks, this control system proved to be cumbersome and did not provide timely reporting for management surveillance. A computerized maintenance program was implemented to take care of the above problem. There are currently 7,000 active maintenance items on file, generating approximately 25,000 task performances per year. Since implementation, the system has proven to be an effective management tool for administering the preventive maintenance program. The Boeing Preventive Maintenance System is a computerized scheduling and reporting system which automatically schedules preventive maintenance activities, records historical data relative to maintenance performance and provides detail scheduling and work load visibility. Automatic scheduling is accomplished as a function of last complete data and prescribed frequency. Since implementation, 100 percent of the hardware has been maintained on schedule. The system can generally be readily adapted to any existing work instruction media without changing format. The weekly management reports give detailed visibility of delinquent maintenance to be performed 10 weeks in advance.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: Any computer with COBOL Compiler and 200 k bites of storage, 2 tape drives and one disc drive.
PROGRAM SIZE: Approximately 4,338 source statements
PRICE: Program $770.00 Documentation $8.00
PROGRAM NUMBER: KSC-10805

Logistics, Hardware and Services Control System

This computer system permits on-site direct control of logistics operations which includes spare parts, initial installation, tool control, and repairable parts status and control, through all facets of operations. The system will integrate all logistics actions and control receipts, issues, loans, repairs, fabrications and modifications to effectively predict and allocate logistics parts and services. The user inputs data on paper tape while posting a ledger and maintaining a real time inventory posting file. Subsequent reports can be batch processed as needed to provide up to 20 different reports. Status of all logistics requirements is posted as needed with all repair, unserviceable transfers, purchases, and shortages displayed on one ledger for complete inventory control. Configuration of parts is further maintained via the use of a provisioning ledger report which shows all next higher assembly application, etc. The system permits a real-time operational mode of logistics issues, receipts, loans, shortages, etc. by making direct inputs into a mini computer, receiving hard copy after edit, and batching data on paper tape for remote batch processing to obtain management and working reports. The large computer costs are minimized without degredation of service and edit checks are performed at three distinct levels of operation (input to mini, card punch and ledger print calculation edit; data element vs. table edit. The advantages are the real time mode of the inventory balance, the generation of an edited message, and the subsequent batch processed reports which integrate the provisioning function, tracking function, and the inventory status into a completely controlled logistics operation linked to the user's (or production division) requirements.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM 360/65
PROGRAM SIZE: Approximately 5,168 source statements
PRICE: Program $770.00 Documentation $27.00
PROGRAM NUMBER: MSC-10819

LRC NASA PERT III

This program package is an information system designed to provide the information flow necessary for project planning, monitoring, evaluation, and coordination at the management level. The system provides effective project control in the areas of time, cost and manpower; although developed for NASA projects, the design can be modified to cross manufacturing lines. PERT TIME III has incorporated many of the important features of earlier logic flow systems plus many improved and desirable innovations to further assist the user. The system consists of eleven basic processing phases including path location, expected start and completion dates, and the production

abstract entities known as "customers" and "functions," whose real world definitions are maintained external to the computer; only their pertinent characteristics are entered as input to the simulation. Customers are any entities that arrive at the system input and demand a specified set of equipment or personnel functions to be interconnected into an operational configuration. A customer could be a satellite coming in view of a ground station, a batch of raw data arriving at a central computing facility for processing and reduction, or an individual requesting a communications circuit from an operator.

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of milestone and activity reports. The system uses a time oriented network structure. Network capacity is characterized by a minimum field length (core) of 52K; there can be 500 starts for every 1100 activities; one path cannot contain more than 700 branches; and the network cannot have more than 10,000 paths. The network time span is limited to a 30 year period from start date to latest completion date. The program operates in batch, uses the CDC RUN compiler, and has a plotting option using a Calcomp or Varian plotter.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 7,979 source statements
PRICE: Program $820.00 Documentation $12.50
PROGRAM NUMBER: LAR-11887

LABCON—Laboratory Job Control Program

The LABCON program provides a budget control system in a component test laboratory whose workload is made up from many individual budgetary allocations. A job requiring laboratory effort requires the combined support of several jobs and a common denominator is applied to an incoming job, to which all effort is charged and accounted for. The common denominator is the Laboratory Job Number System and the facilities of the Data Processing Department. A job comes in and is inserted into the computer through a Job Input Data Sheet; it is numbered and a prime unit or group is realized along with the other units who will work on it. Each employee makes out a Weekly Job Card each week. This form has a keypunch format, and contains spaces for the employee's serial number, straight time hours, overtime hours, and Laboratory Unit Code. The computer program will tally all hours worked against this given Job File Number each week and carry these hours over from week-to-week so that, when this job is finally completed, all laboratory effort generated by the request is compiled. The unit code number serves as a function and/or equipment utilization code. This code will provide, through selected sort and list operations, valuable information required for proposals and equipment justifications, based upon the amount of loading on a particular facility, system or function.

LANGUAGE: PL/I
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 319 source statements
PRICE: Program $350.00 Documentation $14.50
PROGRAM NUMBER: MFS-18141

Network Path Program

Network Path is a FORTRAN IV computer program to determine the Nth best minimum or maximum paths in a network. The program was developed from a paper by W. Hoffman and R. Pavley, *A Method for the Solution of the Nth Best Path Problem*. The minimum tree concept as developed by E.F. Moore and G. B. Dantzig is employed to compute the best path. The minimum tree is then superimposed upon the network to determine the Nth best path, using a theorem. Any path P from O to D, which is not minimal, is a deviation from a path Q from O to D, such that V(Q)=V(P). If P is minimal, then either P is unique or P is a deviation from another minimal path. The method relative to computer application considers first finding all the paths of minimal value, i.e., $\emptyset$ is computed. Next is a calculation of all deviations from the paths in $\emptyset$ and arranging them in numerical order according to the path value which allows determination of $\emptyset$. All deviations from paths in $\emptyset$ are then computed, ordered, and merged with non-minimal deviations from paths in $\emptyset$, thus determining $\emptyset$, etc. Only the Nth best path values are stored at any stage of the computation; therefore, for large networks, the required storage is essentially that which is needed to store the network. This program is written to handle up to 500 nodes, and the branch links cannot exceed 5,000.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 521 source statements
PRICE: Program $230.00 Documentation $5.00
PROGRAM NUMBER: MFS-18691

Special Program for Discounted Cash Flow/Rate of Return Evaluations

This is a set of three programs that is designed to aid the industrial engineer of businessman with an economically sound system for making investment decisions. They are written for any time-sharing remote computer terminal system compatible with BASIC language. The main program is Discounted Cash Flow/Rate of Return Evaluations (DCFROR). This program features a running option for a complete detailed printout of all period cash flows, both net cash flow and discounted cash flow, or final answers only. The program also provides for choices of input and output for cash flows based on annual, semi-annual, quarterly, bi-monthly, or monthly periods, with answers converted to an annual basis if other than annual periods are used for higher accuracy of results. The DCFROR program has served to eliminate the lengthy, time consuming and error prone manual solutions for the payout and DCF/ROR percentage results and has upgraded the economic soundness of evaluations by permitting the use of monthly, bi-monthly, quarterly or semi-annual net cash flow periods in addition to the conventional annual periods, plus further providing a continuous rate of return percent in addition to the conventional period rate of return percent. INTFAC is a computer program used to provide calculated data for various interest factor considerations such as compound amount data, present worth data for any specified initial amount, interest rate and quantity of years. The program will further provide the requested information as a table of dollars, as a table of percentages, or as a table of factors. Although this program is principally used for component calculations in discounted cash flow/rate of return economic evaluations, it will provide interest data for any desired purpose. DEPREC calculates the year beginning book value, annual depreciation amount, and cumulative depreciation through the year ending, for any of the following methods: (1) Two Hundred Percent (200%) or Double Declining Balance. (2) One Hundred Fifty Percent (150%) Declining Balance. (3) Sum of Digits or Sum of Year's Digits. Program output is a table of dollars, a table of factors, or a table of percentages. Another feature of the program is that it has amounts for annual, quarterly and monthly periods. If only an annual printout is required, the quarterly and monthly periods are excluded, resulting in faster output.

LANGUAGE: BASIC
MACHINE REQUIREMENTS: GE 420 REMOTE TERMINAL
PROGRAM SIZE: Approximately 657 source statements
PRICE: Program $290.00 Documentation $22.00
PROGRAM NUMBER: MFS-19040

MIS—Manpower Management Information System

The ultimate objective in the design of this system of programs was to provide the capability of building and maintaining a data bank that integrates all parameters of manpower administration. The system is designed to provide management and division directorate levels with detail information at the program/system level. In addition to processing planning data the system also integrates actual performance data (by month and to date) in order to provide management with regular evaluation reports and to provide a source of data for special management exercises on manpower. The system has been designed to satisfy the following criteria: (1) *Dynamic Analysis*-Emphasis is on an integrated management intelligence system. (2) *Control Reports*-These inform top management of functional operating performance as compared to predetermined plans. (3) *Operating Reports*-These inform functional management of the current performance of operations. They are a comparative analysis of current operations and operations of previous periods, as well as current performance compared to predetermined plans for the immediate period. (4) *Planning Reports*-These show the various aspects of the structure of the limited manpower resource and provide a basis for alternate courses of management action. (5) *Exception Reporting*-The exception reporting principle has been employed as a guide to management in isolating problems or out of line areas. This is done by flagging excessive variances on monthly variance reports with an asterisk and then using them in the computer logic to generate selected charts for the specific division or office when the number of flagged variances is excessive. Exception reporting improves the information content and applicability of report data.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: UNIVAC 1108, SC-1020 Plotter
PROGRAM SIZE: Approximately 12,619 source statements
PRICE: Program $1,200.00 Documentation $19.00
PROGRAM NUMBER: MFS-21477

Vehicle and Equipment Operations Management Program

This is a system of programs developed to support the Transportation Division of the Technical Services Office at Marshall Space Flight Center by providing management reports, statistical data and preventive maintenance scheduling on wheeled vehicles and engineering types of equipment. The programs have the following functions: (1) They assist the Transportation Division in the Evaluation of General Support Contractors. (2) Assist in forecasting budget and manpower requirements for all types of vehicles and equipment. (3) Furnish statistics for the users of the vehicle and equipment, including mileage, cost, and depreciation of equipment, and (4) Provides a smooth inspection workflow to the transportation division maintenance shops. The system generates notifications of all major and minor maintenance inspection requirements of all vehicle and equipment based upon gallons of fuel consumed, and/or the months elapsed since the maintenance was issued.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: UNIVAC 1108, EXEC 8
PROGRAM SIZE: Approximately 10,898 source statements
PRICE: Program $500.00 Documentation $24.00
PROGRAM NUMBER: MFS-21478

Job Resource Optimization Monitor for Project Management System (PMS) Program

The program for Job Resource Optimization to monitor the PMS (Project Management System) Pert and Resource Allocation Program (RAP) routines consists of two routines. The first routine, (Resource Utilization Monitor) RUM, is used to analyze the output of PMS and adjust the resource levels of the input to PMS to increase the utilization percentage of each resource. The second routine is a control routine, DRIVER, to execute the PMS and RUM routines in a sequential process over and over until RUM returns a code to signal completion of the optimization process. The PMS program was used for the base for building the optimization process since PMS handles the job resource Pert network data already and outputs the results in a readily accessible format for the optimization process. The optimization process to increase the utilization percentage is simply a method of automatically and systematically reducing the resources available until either the schedule is exceeded or a resource is limited by the quantity needed for the largest single job. Cost is also a consideration for a minimum because even though the resource levels are being reduced, the total job is being lengthened resulting in people required for a longer time period. Minimizing total project cost is therefore the key overall criteria in selecting the best allocation plan from a series of iterations involving many different combinations of manning levels and schedules within the same overall project start and end dates. The second routine (DRIVER) is an assembler program and is not a part of this program package, but a listing of the routine is included in the documentation.

LANGUAGE: PL1
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 406 source statements
PRICE: Program $250.00 Documentation $11.00
PROGRAM NUMBER: MFS-21669

Job Resource Allocation, GPSS Model

This program was developed to allocate resources (manpower, equipment, facilities, etc.) for a large number of jobs or tasks based on job priority and resource availability and relating a workable model to conventional computer programs for solving complex management tasks indicates new directions for computer application. The program develops a model that takes a job (GPSS transactions) and allocates resources (GPSS storages) based on priority as a job becomes eligible after initial tasks are completed. Jobs are performed when all of the required resources are available. Resources are set initially for each run depending upon the overall job requirements. If the resources are not available, the job must wait or pre empt if possible, a job of lower priority. The meeting of a milestone is thus dependent directly on the required resources available at the time needed. The model essentially eliminates hand manipulation time to schedule jobs based on available resources.

LANGUAGE: GPSS
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 526 source statements
PRICE: Program $250.00 Documentation $5.00
PROGRAM NUMBER: MFS-21670

MARVES - Marshall Vehicle Engineering Simulation System

The MARVES system is a computer language developed to aid in the solution of problems related to dynamic

systems that can be described by a system of ordinary differential equations. The MARVES system contains a collection of models which represents the problems to be solved and a description of one or more events peculiar to the problem. The simulation of dynamic systems on a computer requires a numerical method of integrating differential equations and a method of interrupting the integration to introduce discrete changes in the mathematical model. These requirements have led to the development of six basic processes. (1) The *initialization* process consists of reading input data, computing certain parameters which remain constant thereafter, such as starting conditions for the integration process, and setting certain logical constants. (2) The evaluations of the *differential equations.* (3) The *numerical integration* process consists of providing a numerical procedure whereby the differential equations may be evaluated stepwise until stopping conditions have been reached. (4) The *interrupt* process consists of providing a method of interrupting the integration procedure when certain conditions are satisfied, or changes in dynamics are to be made. (5) The *end of step* process consists of evaluating variables at the end of each integration step. (6) The *termination* process consists of satisfying given stopping conditions making needed terminal computations. The primary function of the MARVES language is to provide source statements which specify operations that tailor the program to suit a particular application. These statements furnish a short hand notation for (1) specifying the method of numerical integration, (2) the conditions under which the numerical integration is to be interrupted for special event computation, and (3) input/output statements that are easy to code and debug. The MARVES processor program accepts MARVES statements, converts them to Fortran code, and then executes the Fortran program in the same manner as any other Fortran program.

LANGUAGE: ASA Fortran
MACHINE REQUIREMENTS: IBM 360, IBM 7094, UNIVAC 1108, EMR 6050 and Raytheon 520
PROGRAM SIZE: Approximately 5,200 source statements
PRICE: Program $990.00 Documentation $17.00
PROGRAM NUMBER: MFS-21701

FAA Balanced Field Length, Critical Engine Failure Speed, and Landing Distance Computer Programs

This program was developed to evaluate the ability of a multiengine aircraft to survive an engine failure during takeoff. If an engine should fail, a decision must be made to shutdown and stop reaching the end of the runway or to continue takeoff with reduced power. The parameters necessary for making this decision are, (1) the Critical Engine Failure Speed or the velocity achieved during takeoff roll at which the distance necessary to continue takeoff with one engine inoperative equals the distance needed to shut down all engines, apply brakes, and stop, and (2) FAA Balanced Field Distance or the runway length needed to accelerate with all engines to the critical engine failure speed, then continue takeoff and clear a 35 foot obstacle at the end of the runway with one engine out, or refuse takeoff and stop. By using the takeoff characteristics of a specific plane, this program can calculate these parameters.

LANGUAGE: BASIC
MACHINE REQUIREMENTS: SIGMA 7
PROGRAM SIZE: Not Applicable
PRICE: $25.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-21873

MARSYAS - Marshall System for Aerospace Simulation

MARSYAS (Marshall System for Aerospace Simulation) was developed by NASA's Computation Laboratory at Marshall Space Flight Center to furnish engineers with a software system that allows quick and easy simulation of physical systems on a digital computer. MARSYAS is a simple, flexible language which can be coded by users who are unfamiliar with computer programming. It is designed for the engineer with little experience in simulation who desires to simulate large physical systems. The language can be used to solve a system of differential equations or to simulate control systems including analog computer block diagrams or both simultaneously. Thus, the user has the ability to mix differential equations with diagrams in his model. The block diagrams can contain, among other things, adders, integrators, transfer functions, multiple input/output nonlinear devices, algebraic equations and nonlinear ordinary differential equations. A block diagram is specified by the user-given names of its models and submodels, inputs and outputs, element names, parameters (if any), and their inter-connections. Submodels can be nested to any degree required. With MARSYAS, no present pattern of connecting elements is required. Elements can be connected in pairs, groups or any manner desired by the user. A large library of Standard Elements and Excitation Functions is part of the MARSYAS system. DEVICE and FUNCTION statement operators allow the user to construct unusual element excitation functions as needed. MARSYAS is a flexible language in that, with few exceptions, there is no rigid statement operator structure within a given module. Most statements can be used without regard for the order in which MARSYAS is installed, the user has the capability of storing models in a Functional Data Base. The Fortran Object Program generated from the MARSYAS source program can be extracted and run separately, if the user's computing facility can accomodate this feature. When using CHANGE operators, the user has multiple simulation capability without the necessity of either rewriting his model or resubmitting his deck. An elaborate plotting system is part of the MARSYAS language allowing the user nearly unlimited flexibility in specifying his graphical output. Additionally, the Fast Fourier Transform of any output variable can easily be obtained. A tabular listing of a model in the Functional Data Base or of a model currently being run can be obtained using the LIST operator. Automatic features of MARSYAS include the detection and solution of linear and nonlinear algebraic loops. For problems which contain discontinuities, the MARSYAS system automatically changes integration schemes to integrate through the discontinuity. MARSYAS is designed in modular form so that modifications to the systems models can be made with a minimum effort. In order to achieve comprehensive analysis capability and effective computation, modern control theory is used as the mathematical foundation of MARSYAS. The differential equations generated from block diagrams, or coded as equations, are rearranged internally into vector-matrix state equations which are then solved. The language is designed so that the user transmits to the computer only the information essential to describe the mathematical model and specify the simulation run. MARSYAS is divided into four successive modules which describe independent functions of the simulation.

These modules are as follows: (1) Description Module, (2) Modification Module (optional), (3) Simulation Module, (4) Post Processing Module. The user has the ability to control some of the internal processing of the simulation by specifying his numerical integration method, integration step size or even the truncation error. Normally, he need not concern himself with these details since MARSYAS handles these details automatically. MARSYAS names can be up to 36 characters in length so that the same names as found in engineering documentation can be used. The MARSYAS alphabet consists of the letters A through Z, the numbers 0 through 9, and the backward slash (/). There are no reserved words in MARSYAS.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 15,000 source statements
PRICE: Program $1,240.00 Documentation $22.00
PROGRAM NUMBER: MFS-22672

A Computerized Solution of the Kepner-Tregoe Method Algorithm

This package is a set of procedures designed to perform a computerized solution of the Kepner-Tregoe Method. (The Rational Manager, A Systematic Approach to Problem Solving and Decision Making, C.H. Kepner and B.B. Tregoe, McGraw-Hill Book Company, Incorporated, 1965.) of selecting the optimal solution from a set of alternatives which satisfy an imposed set of objectives or constraints.

LANGUAGE: APL (A Programming Language)
MACHINE REQUIREMENTS: IBM Model 2741 or 1050 terminal and TSO System
PROGRAM SIZE: Not Applicable
PRICE: $95.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-22997

RETANN - MSFC Estimated Retirement Annuity Calculation Program

This program provides retirement annuity reports which outline the retirement benefits available to eligible employees and their survivors according to length of service, age, deposits, proposed separation date, and the current cost of living percentage with reductions to provide survivor annuity to widow or widower and health benefits premium. Necessary input parameters are the length of service, age, proposed separation date, deposits, and the current cost of living percentage.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1100 SERIES
PROGRAM SIZE: Approximately 667 source statements
PRICE: Program $90.00 Documentation $2.50
PROGRAM NUMBER: MFS-23073

Engineering Critical Components Listing

This program was designed to maintain an inventory of specifications and part numbers for engineer components. This inventory listing can be automatically updated with change cards and printed in a variety of optional lists

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-924
PROGRAM SIZE: Approximately 354 source statements
PRICE: Program $340.00 Documentation $2.50
PROGRAM NUMBER: MFS-24321

Plant Services Recall System

This system will provide an automated procedure for issuing Service Notices and will maintain a current file of proofload test due dates, preventive maintenance (P.M.) due dates, and dynamic averages of hours/task work assignments. It issues monthly, quarterly, semi-annual, and annual summaries of equipment service requirement schedules and loading. The purpose of this system is to develop a system of programs to detect and capture all due dates and automatically issue Recall-System Notices for proofloading and/or preventive maintenance on fixed or movable equipment and to maintain an average of hours per task performance. This dynamic average is to be used as an estimate for schedule loading. This system will assure timely notification to both the Using Department and Plant Services of due dates for proofload testing and P.M. The system will not depend upon the user to become aware of the due date, but will provide Automatic Notice to the using department heads. This program should facilitate the scheduling of proofload testing and preventive maintenance to maximize usage of manpower and should conform to contractual obligations for any large industry requiring a regular preventive maintenance program

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 8,084 source statements
PRICE: Program $500.00 Documentation $15.50
PROGRAM NUMBER: MSC-17122

Failure Mode and Effects Analysis Program (FMEA)

The Failure Mode and Effect Analysis program is a tool to be utilized with a failure point summary dictionary and standard storage and retrieval routines for the purpose of maintaining a data file of reliability analyses of various designs. The primary purpose of this program is to assist in the identification and correction of failures associated with critical effects prior to design release. This program was developed for the space shuttle contract but is general enough to be adapted to any aerospace or commercial reliability activities.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 137 source statements
PRICE: Program $430.00 Documentation $7.50
PROGRAM NUMBER: MSC-17446

Record of Task Progress

This program is a supervisory tool for manipulating task descriptions and milestones and printing them in several formats to give management a high degree of visibility and control of a large number of assigned tasks and milestones. The inputs to the program are task descriptions, milestones descriptions and due dates identified by project and responsible subordinate, and a description of the changes for which the program is being re-run. The output consists of: (1) a complete list of task descriptions, (2) a complete list of milestones, (3) a combined lists of tasks and milestones for each subroutine, and (4) a "Change Block," similar to those on engineering drawings, giving a chronological tabulation of the changes made each time the program was submitted.

LANGUAGE: FORTRAN IV (57%), ASSEMBLER (43%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 882 source statements
PRICE: Program $250.00 Documentation $10.50
PROGRAM NUMBER: MSC-17451

Cost Information Management Computer Program

CIM is a computer program designed to facilitate calculation and reporting of costs for programs organized to a Work Breakdown Structure. The model is general since the actual computing algorithm and all auxiliary information are inputs. In addition, the model is designed to handle multiple cases. After the program calculates the cost for the lowest level items for each cost category, it sums the cost categories and sums to higher levels automatically. Another added feature to the model is the ability for the user to "group" items in sets rather than the WBS hierarchical scheme.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 852 source statements
PRICE: Program $250.00 Documentation $2.50
PROGRAM NUMBER: MSC-17556

Logistics Resupply Computer Program

This program implements a logistics analysis in a computer program and provides a means for processing a variety of experiment scheduling and cargo resupply requirements. The processed data is presented as the summation of common cargo types for a period of ten years at monthly intervals, and are documented in tabular listings and CRT displays. This program provides a means of handling a complex array of logistics items and scheduling alternatives, it may be adaptable to military areas wherein logistics requirements are significant. Industries that involve large quantities of logistics materials may also avail themselves of this program.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 556 source statements
PRICE: Program $350.00 Documentation $2.50
PROGRAM NUMBER: MSC-19116

Manpower Accounting Program

This program provides the user with several different tables on which he can base his manpower use cost. The information given by these tables is as follows: (1) Provides summaries for weekly and monthly activity reports; (2) Keeps track of the expenditure of contractor hours and dollars with estimates of depletion so that procurement can be initiated in sufficient time to avoid interruption in contractor services; (3) Prepares summaries of which charge numbers are being used and at what rate; and (4) Provides data which can be presented to management for annual reviews or when there is some question about a particular phase of the employees use. Some of the tables are very detailed and some are merely summaries suitable for reports. The program recognizes several different breakdowns of personnel types and task categories and prepares separate tables for each of them. There are twelve different tables given in the output: (1) Personnel Tasks and Hours; (2) Current Tasks; (3) Detailed Activity Report; (4) Summary of Hours by Section and Task Catgeory; (5) Summary of Hours by Task Duration and Task Type; (6) Summary of Hours by Type of People; (7) Contractor Hours Expended; (8) Contractor Dollars Expended; (9) Tasks Completed; (10) Summary of Hours by Project; (11) Summary of Hours by Charge Number and (12) Missing Task Cards.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360/65 or any machine that has a compatible FORTRAN IV compiler
PROGRAM SIZE: Approximately 525 source statements
PRICE: Program $160.00 Documentation $9.00
PROGRAM NUMBER: NPO-11973

Morgantown Mass Transit Simulation Model

The Morgantown Transit System simulation model is a tool for studying the effects of various system designs and operating policies on the performance of the system. The model uses the viewpoint that the world is composed of entities and their attributes, various ordered sets of entities (such as vehicle queues), and events to describe the system and its operation. The flow of the model is as follows: Passengers arrive stochastically and are gathered into loads according to their common destinations. An attempt is made to assign a vehicle to each load. If successful, departure is scheduled by the dispatch algorithm. Otherwise, a vehicle departs, its arrival is scheduled at the destination station. After arrival, it unloads and the vehicle is available for reassignment. The guideway configuration linking the stations is specified by input, and can be as exact as available data permits. Station configuration, on the other hand, is an approximation, but the discrepancies are minor. There are extensive provisions for convenient interactive user control of the model, allowing for a variety of output reports. This program will run **only** on the National CSS timesharing system (NCSS).

LANGUAGE: SIMSCRIPT II
MACHINE REQUIREMENTS: NCSS System
PROGRAM SIZE: Approximately 2,200 source statements
PRICE: Program $560.00 Documentation $10.50
PROGRAM NUMBER: NPO-13522

Minority Business Capabilities File

This program is a management information system designed to generate reports on selected minority businesses. The program provides a file on business capabilities that permits ready identification of sources of specific or particular requirements. The program is extremely flexible in that the number of organizations and available capabilities in the file is limited only by the number of digits in the data control numbers assigned to the organizations and item descriptions or capabilities. The program provides for the selection of organizations by physical location or grouping of locations. On the other hand, organizations can be selected by the sphere of interest of their particular capabilities; i.e., local, regional, or national. Maximum versatility of terminology describing available capabilities is achieved by the permuted item description index. Keypunched data is input to the program to create or update a master file, the input is edited and error messages are printed. The output reports include: (1) Business Capabilities Register; (2) Business Capabilities Index; (3) Capabilities Index Headings and Particular Interests; (4) Item Description Cross-Reference; (5) Batch List and Error Report. The program operates in batch mode.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM OS 360/370
PROGRAM SIZE: Approximately 3,337 source statements
PRICE: Program $610.00 Documentation $15.00
PROGRAM NUMBER: NPO-13834

TIMER - A Tree-Like Task and Time Record System

TIMER provides a uniform system of reporting and displaying time charges for all task groups within a

multitude of work assignments. The system reports any combinations desired. It is flexible enough to make reportings as desired. Each week, each employee submits a Weekly Time Charge Sheet on which he has recorded the hours spent on each project, task, and subtask he worked on. The TIMER program then accumulates the time charges on a monthly basis and year to date. The accumulative man-months are printed for any combination of the item, department, employee class, project, task, and subtask. The main features of the program are: (1) a tree-like structure of tasks, (2) preassignment of tasks, (3) task definitions at any level of responsibility, (4) tasks defined at a lower or higher level of responsibility, which are under the same line of responsibility, are mutually inclusive, and (5) tasks defined at the same level of responsibility, are mutually exclusive. TIMER can be applied to almost any tree-structured system, such as parts lists and organization charts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 837 source statements
PRICE: Program $340.00 Documentation $8.00
PROGRAM NUMBER: NUC-10213

FLUID MECHANICS

Includes boundary layer flow; compressible flow; gas dynamics; hydrodynamics and turbulence.

MULTIWICK: A Computer Program that Numerically Integrates the Differential Equations that Describe the Hydrodynamics of a Large Class of Heat Pipes

MULTIWICK is a computer program to numerically integrate differential equations that describe the hydrodynamics of high performance heat pipes that have mutiple flow paths for condensate to return to the evaporator regions. The program MULTIWICK is applicable to the following types of flow paths: (1) *Wick* - a single piece of porous material that runs the length of the heat pipe. It is usually either a layer that lines the inner wall of the heat pipe or a diametral slab. (2) *Arteries* - porous-walled conduits that run the length of the heat pipe and are closed at the evaporator end. Primed arteries provide low flow resistance and a high capillary pressure. (3) *Excess-Liquid Reservoirs* - axial channels that primarily provide excess-liquid control in zero-gravity operation (excess liquid resides in the reservoirs rather than in a vapor-space slug). An excess-liquid reservoir can be either a porous-walled open-ended tube, or a channel formed by a tube in close proximity to the intersection of a wick and the heat pipe wall. Unlike arteries, reservoirs usually do not remain filled their entire length. (4) *Fillets* - liquid that forms in corners due to surface tension. The fillet size at a given point along its length is automatically set by the vapor-liquid pressure difference at that point. (5) *Bilge* - liquid that lies in the bottom of a heat pipe operating in a gravitational field. (5) *Circumferential Grooves* - distribute liquid under the action of surface tension across the inner surface of the heat-pipe wall. (7) *Vapor Spaces* - provide flow paths for vapor to return to the condenser sections. MULTIWICK has five operational modes that provide the user flexibility in answering crucial heat-pipe design questions. In the preliminary analysis of a new heat pipe, the designer uses one operational mode (Mode No. 1) to find the optimum amount of working fluid and the corresponding maximum heat-transfer rate for a specific condition. (The optimum amount of working fluid is defined as that amount that provides the greatest heat-transfer rate without resulting in a liquid slug in a vapor space). Once the amount of working fluid has been determined, the user can then find the maximum heat-transfer rate at any other operating condition for that amount of fluid (Mode No. 4). In Mode No. 2, the user specifies both the amount of working fluid and a heat-transfer rate. MULTIWICK then calculates the liquid distribution and the variation of the vapor-liquid pressure difference in the heat pipe. Such a calculation is useful, for example, to find the length of liquid slugs in vapor spaces that can result from liquid expansion at higher operating temperatures. In the case of an arterial heat pipe, MULTIWICK has two additional operational modes that calculate the maximum heat-transfer rate under which arteries will prime. One is for an optimum amount of fluid for priming (Mode No. 3); the other is for a specified amount (Mode No. 5). The MULTIWICK user specifies the heat input and rejection distribution. The heat pipe is divided into sections and the fraction of the total heat throughout is specified for each section, then the program is not limited to heat pipes with only one evaporator, one adiabetic and one condenser section. The MULTIWICK program incorporates a mathematical model of flow through fibrous wicks that includes the effect of: (1) *Meniscus recession* - the reduction of the flow area with increasing vapor-liquid pressure difference due to the menisci at the wick's surface attaining a higher curvature. (2) *Partial saturation* - the emptying of the progressively smaller pores of the wick as the vapor-liquid pressure difference approaches the critical value where the wick fails. (3) *Hysteresis* - the relationship between the level of saturation of the wick and the vapor-liquid pressure difference depends on whether the pressure difference has been increasing or decreasing. The MULTIWICK user, therefore, specifies whether the heat pipe starts from a state where the wick is initially saturated or, as in the case after a burnout, from a state where the wick in the evaporator region has dried out. The user may also elect a simple model of fully saturated wick operation that does not include the above effects.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,381 source statements
PRICE: Program $710.00 Documentation $12.50
PROGRAM NUMBER: GSC-12009

Compressible Laminar or Turbulent Nonsimilar Boundary Layers Computer Program

This computer program was developed to solve the compressible nonsimilar-boundary layer equations for continuity, mean momentum and total mean enthalpy for an ideal gas with constant specific heat. An implicit finite-difference procedure is used. The program will solve problems with the following configurations: (1) two-dimensional, (2) axisymmetric where the boundary-layer thickness is much less than the body radius, and (3) swept infinite cylinders. The eddy viscosity is taken as a function of the local boundary layer thickness, the normal distance from the wall, and the mean velocity gradient in the boundary layer. The turbulent Prandtl

number may be either a constant or a specified tabulated function of the ratio of the normal distance from the wall to the boundary-layer thickness. By setting the eddy viscosity equal to Zero, nonsimilar-laminar-boundary layer flows may be computed. Since a finite-difference procedure is used, the effects of variable wall and edge boundary conditions and wall blowing or suction are easily included by modifying the program inputs.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,028 source statements
PRICE: Program $440.00 Documentation $11.00
PROGRAM NUMBER: LAR-10990

Program to Determine Radiating, Nonadiabatic, Inviscid Flow Over A Blunt Body by the Method of Integral Relations

This computer program was developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. The program calculates the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained agree with results from inverse and time-dependent techniques. The agreement indicates that this method of solution provides an accurate description of the blunt-body flow field in the subsonic region. The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a blunt body traveling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum and energy. The modified method of integral relations is used to transform the governing equations into a set of ordinary differential equations that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. Provisions have been made in the governing equations for coupled radiating flow-field analysis. The governing differential equations are solved by a fourth-order Runge-Kutta integration technique to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface. The documentation contains a description of the computer program along with the methods used in the digital approximations, flow charts, instructions for the user, and a test case with input and output listings.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 3,188 source statements
PRICE: Program $790.00 Documentation $14.00
PROGRAM NUMBER: LAR-11048

Numerical Solution of the Unsteady Navier-Stokes Equations

A computer program has been developed to solve the unsteady, two-dimensional, incompressible Navier-Stokes equations. The numerical method makes use of an iterative solution of a Poisson's equation for pressure followed by an explicit calculation of velocities. Unsteady flow in a two-dimensional, rectangular cavity with the upper wall moving at constant velocity is investigated using the computer program. The calculations start with the fluid at rest in the cavity and continues until no further change occurs in the velocity. Results are given for cavities with aspect ratios of ½, 1, and 2 with a Reynolds number of 100. Results are also given for several Reynolds numbers between 100 and 500 for a square cavity. Calculated velocities from the unsteady Navier-Stokes equations at large times are compared where possible to velocities calculated from the steady Navier-Stokes equations and to the results of steady experiments; good agreement is presented in the documentation. A technique for conducting a numerical flow visualization experiment in conjunction with the solution of the Navier-Stokes equations is described. The results of the experiment are recorded on film which may be shown on a projector.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 611 source statements
PRICE: Program $350.00 Documentation $8.50
PROGRAM NUMBER: LEW-11415

CFNA - Compressible Flow Network Analysis Computer Program

A computer program, CFNA, has been developed which solves the problem of an arbitrarily connected one dimensional compressible flow network with pumping in the channels and momentum balancing at flow junctions. The program has been specifically designed to include pressure drop calculations for impingement flow and flow through pin fin arrangement, as currently found in many air cooled turbine bucket and vane cooling configurations. The calculation part of the program consists of two major subdivisions. The first section computes the compressible pressure drop through a single passage including friction, orifice, and pumping losses. Provision is made for inlet losses, variable geometry, and pin fin arrays. The second part of the program balances flows and pressures throughout the network. This is an iterative procedure involving Matrix evaluations. It converges rapidly in most instances. The program alternates between these two sections on a minimum of three times, and reaches a required tolerance on percentage change of total flow before outputing results.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,898 source statements
PRICE: Program $590.00 Documentation $13.50
PROGRAM NUMBER: LEW-11859

Computer Program for Quasi-One-Dimensional Compressible Flow With Area Change and Friction for Application to Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasi-one-dimensional flow analysis which is valid for laminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals. This computer program enables the prediction of gas-film-face-seal performance when face deformation and/or radial area change is significant. The analysis is especially useful for choked flow conditions. The program must be supplied with the geometry of the seal, the gas properties, the reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain logical variables which control output. In general, AREAX performs the following operations in analyzing the flow across a seal: it reads the input data and checks that these data are consistent. When the input have been read, AREAX analyzes the flow for each combination of film thickness and tilt angle. The program first solves the Mach number equation and determines the Mach number distribution across the seal

number may be either a constant or a specified tabulated function of the ratio of the normal distance from the wall to the boundary-layer thickness. By setting the eddy viscosity equal to Zero, nonsimilar-laminar-boundary layer flows may be computed. Since a finite-difference procedure is used, the effects of variable wall and edge boundary conditions and wall blowing or suction are easily included by modifying the program inputs.

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PROGRAM NUMBER: LEW-11859

Computer Program for Quasi-One-Dimensional Compressible Flow With Area Change and Friction for Application to Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasi-one-dimensional flow analysis which is valid for laminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals. This computer program enables the prediction of gas-film-face-seal performance when face deformation and/or radial area change is significant. The analysis is especially useful for choked flow conditions. The program must be supplied with the geometry of the seal, the gas properties, the reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain logical variables which control output. In general, AREAX performs the following operations in analyzing the flow across a seal: it reads the input data and checks that these data are consistent. When the input have been read, AREAX analyzes the flow for each combination of film thickness and tilt angle. The program first solves the Mach number equation and determines the Mach number distribution across the seal

face. AREAX then determines the distributions across the seal face of pressure; temperature; density; velocity; mean friction factor; Reynolds number; mass and volume flow rates; Knudsen number; seal opening force; center of pressure; and where appropriate, rotational Reynolds number, variables associated with power dissipation, and axial film stiffness. This program should be used when the effects of seal-face distortions are desired and when the radial area change is significant.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,484 source statements
PRICE: Program $570.00 Documentation $10.00
PROGRAM NUMBER: LEW-12286

Calculation of Supersonic Stream Parameters of a Real Gas from Measurable Quantities

This package consists of a set of subroutines that are designed to calculate flow and thermodynamic properties of a supersonic stream of real gases from measurable quantities. These routines will calculate; (1) the isentropic mass flow rate of gases through subsonic and sonic flow nozzles; (2) the properties of a supersonic stream as determined from the stagnation pressure, stagnation-temperature and the pressure on the surface of a static-pressure wedge; (3) the properties of a supersonic stream as determined from the pressure wedge; (3) the properties of a supersonic stream as determined from the pressure and temperature in a plenum upstream of a supersonic nozzle and the stagnation pressure at the exit of the nozzle. The flow and thermodynamic properties calculated by this set of routines include velocity, density, enthalpy, enthropy, and isentropic exponent. These routines are specifically applied to air, nitrogen, oxygen, normal hydrogen, parahydrogen, helium, argon, steam, methane, and natural gas although the routines are apolicable to any gas whose properties are known. This package supersedes LEW-10820 (B69 10222) and LEW-11534 (B72-10362).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 2,600 source statements
PRICE: Program $450.00 Documentation $13.00
PROGRAM NUMPER: LEW-12326

Solution of Compressible Flows in Piping Systems

This computer program will determine the steady state flow of an ideal compressible gas in a piping system. The system may involve orifices, heat exchangers, area changes, constant loss factor elements, adiabatic pipes, non-adiabatic pipes, radius bends, and miter bends. Known values must include inlet temperatures. Other values which may be known or unknown are inlet and exit pressures, and flow charts in specific branches of the system. The unknown pressures and flow rates are computed, along with exit temperatures. Total and static pressures, total and static temperatures, and mach number of the flow are computed at each element in the system. Forces on each element and the loss factor for each element are computed together with approximation volume of each series system. The output data includes input data, exactly as punched. Computed output values include mach number, static and total pressure, static and total temperature, loss factor, and forces on each element. Output is grouped by series system and includes flow rate and approximate volume, as well as the connecting junctures. The systems for which flow rates are guessed, and the corresponding systems for which the error is computed is output. Limitations imposed by the program include that the system must be defined by not more than 25 series systems connecting not more than 25 junctures. Three times the number of series systems plus the total number of elements must not exceed 1,000.

LANGUAGE: FORTRAN II (65%), MAP (35%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,595 source statements
PRICE: Program $480.00 Documentation $12.00
PROGRAM NUMBER: MFS-00443

Compressible Flow Computer Program

This program solves problems involving compressible pipe flow with heat transfer through the use of an electrical analogy. To adapt the container data for program usage, the container surfaces are assigned node numbers. To balance the system to be a specified pressure drop, one of two compressible flow solutions can be used: the flow can be fixed and the orifice diameters adjusted or orifice sizes fixed and the flow corrected. Solving for manifold design parameters, the fixed flow routine is first used to determine approximate orifice sizes and flow rates. Container inlet temperature values are compared with the required temperatures and final adjustments are made on the variable flow routine to yield design values for orifice size, flow and temperature.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 471 source statements
PRICE: Program $140.00 Documentation $16.50
PROGRAM NUMBER: MFS-14683

KALV - Water Landing Loads Analysis

This program calculates a time history of depth of penetration, velocity, force, load factor, maximum pressure at the water line, and average pressure for a body of revolution impacting water. The nose shape of the body can be conical or a truncated cone frustum with a spherical nose cap. Forces on the body during submergence of the nose section are based on virtual mass theory. For submergence past the nose cone, body motion is determined by hydrodynamic drag. Either a drag coefficient for the body is calculated to balance the forces from the virtual mass theory at the intersection of the cylinder and nose cone or a coefficient of drag can be input to replace the calculated value. Some possible uses of the program are for military ordinance, water recovery of space and military vehicles, dropping of commercial or military payloads from aircraft.

LANGUAGE: FORTRAN-H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 280 source statements
PRICE: Program $340.00 Documentation $4.50
PROGRAM NUMBER: MFS-21955

Computer Program for Pressure Drop and Pumping Power for Fluid Flow through Round Tubes

This program calculates the pressure drop and fluid pumping power for flow through round tubes. The equations which are used are referenced in the following manner: Jelinek, D. *Active Temperature Control Fluid Systems Preliminary Design for Grand Tour Mission.* North American Rockwell Corporation, April 1971. The solution assumes laminar flow and has been designed for steady-state analysis. The program is written for the

Hewlett Packard 9100A electronic desk type computer. The documentation includes a program listing. No "source deck" is available as it is not required. Potential uses of this program include design of air heating duct systems, air cooling duct systems, hot water or steam lines, refrigeration system lines, and hydraulic system lines for use in homes, factories, or automobiles.

LANGUAGE: Data entered at the time of processing
MACHINE REQUIREMENTS: Hewlett Packard 9100A
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-24172

SMAC - Simplified Marker and Cell method for Calculating Incompressible Fluid Flows

The Marker-and-Cell (MAC) method was previously proposed for the numerical solution of problems concerning the time-dependent, viscous flow of an incompressible fluid in several space dimensions. A Simplified MAC (SMAC) method is described; it has at least as great a range of applicability as MAC, but is significantly simpler to use. The Marker-and-Cell (MAC) method is a numerical solution technique for investigating the dynamics of an incompressible fluid. It has been applied to a variety of time-dependent flow problems in several space dimensions, with results that agree well with experiments whenever comparison data have been available. The technique has several advantages for the calculation of confined flows, as shown in studies of the van Karman vortex street, various types of internal reactor flows, and two fluid problems with surface tension. The advantages of MAC are especially apparent for flows with free surfaces, such as the splashing drop problem, in which the surface configuration is continuously changing with time. Recent investigations have demonstrated, however, that the MAC method is excessively complicated in several respects. This is especially true of the boundary conditions, which require derivation that assures precise consistency among the momentum and pressure equations. There is relatively little difficulty for simple configuration, but in the presence of rigid obstacles and various input or output boundaries, both the derivations and the programming logic can become unduly tedious. A second difficulty with MAC is the solution of the Poisson equation, for which direct methods are available only for very simple types of configurations. Both of these inconvenient features are alleviated in the variation of MAC proposed here. In this Simplified MAC (SMAC) technique, the pressure never need be calculated. Accordingly, only the velocity boundary conditions and the free surface (normal and tangential) stress conditions are required for the momentum equations, while the Poisson equation for mass conservation needs only homogeneous boundary conditions everywhere.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 700 source statements
PRICE: Program $450.00 Documentation $11.50
PROGRAM NUMBER: MSC-17566

DUCT - Adiabatic Compressible Flow Duct Analysis Program

The DUCT computer program models the change in turbine stagnation exhaust temperature with respect to changes in turbine back pressure, so as to incorporate the effects of turbine efficiency and performance on exhaust duct pressure drop. The actual turbine back pressure (PI) is determined for any given ambient pressure (PO) by iterating on an assumed back pressure until the static pressure at the exit of an exhaust duct (P2, computed from the Fanno relations) is equal to the ambient pressure.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 96 source statements
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19178

Numerical Solution of Transonic Flow in a Convergent - Divergent Nozzle

In the throat region of a convergent-divergent nozzle the flow of a compressible fluid reaches sonic velocity. Due to the wall configuration in the convergent portion of the nozzle, the transonic flow in the throat region is non-uniform. A description of the transonic flow conditions is necessary to determine the mass flow through the nozzle and the supersonic flow field downstream of the throat. A knowledge of flow conditions along the nozzle wall upstream of the throat is useful in estimating the heat transfer to the wall in this region. This package of programs applies various methods in order to solve these flow conditions and give us a simple analytic description of transonic flow in the throat region. The programs use methods which include various functions for boundary values along the nozzle axis, yielding different types of flow field configurations. Any appropriate streamline in the flow field thus constructed can be considered as the nozzle wall contour. The method of calculating the subsonic flow field and the sonic line is discussed in detail in the documentation. A modification to the method of characteristics for calculating the supersonic flow immediately down stream of the sonic line is also described.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series.
PROGRAM SIZE: Approximately 833 source statements
PRICE: Program $280.00 Documentation $12.50
PROGRAM NUMBER: NPO-10895

Computer Program For Analyzing Piping Systems

This program allows mechanical and controls engineers to rapidly analyze complex piping systems. Input data are entered into the machine by means of punched cards—the card format is designed to expedite entry and minimize human error. Output data include the Kw and c values associated with each circuit component (pipe, valve, elbow, reducer, sudden enlargement and contraction, orifice, Potter, etc.). In addition L/gA, pipe volume and other data are computed. This information is required for the analog computer simulation of piping systems. A total of three individual flow rates can be input into the program. The computer will then calculate the pressure drop existing across each individual component. Further, all output variables can be summed at any time during the calculation, and the final system, c, kw, and pressure drop data are tabulated.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 746 source statements
PRICE: Program $160.00 Documentation $6.50
PROGRAM NUMBER: NUC-10376

GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; geodesy; hydrology and limnology; geochemistry and geomagnetism.

EXILE/EXIST/IRIS - Mineral Exploration Investment Optimization and Resource Estimation Computer Programs

EXILE This computer program is concerned with the economics of mineral exploration costs and investments The purpose of the program is to optimize investment policies relating to the search for an exploitable mineral deposit and the development of a deposit into the production stage The program and documentation present a method by which investments can be kept as low as possible with respect to a sufficient capitalization reserve and the leveling of shock effects due to sudden variations in consumption patterns The annual stocktable is calculated from annual metal requirements and accumulative reserves A capitalization scheme is calculated based on the 'first in first out' principle The unit exploration costs per ton of metal is calculated from the quality of the ore, probable number of deposits, and capitilization product price of the metal Projections of annual discovery rates are calculated by applying rate and production time The program does not take into account the costs of the actual capitalizations, only exploration costs and investments (including interest) EXIST The computer program EXIST optimizes the mineral exploration investments according to the criterions. (1) Sufficient capitalized reserve must always be accessible (2) Strong variations in exploration activities must always be accessible (3) Expenditures have to be minimal (4) Future adaptations of the economic definition of an exploitable ore deposit have to be forecasted and incorporated The major difference between EXILE and EXIST is given by the fourth criterion EXIST constructs a forecast on the development of the definition of an unexploitable ore deposit and calculates the unit exploration costs from the market value of the mineral IRIS The purpose of the IRIS program is to give an accurate prediction of the quantity of metal within a defined region The method applies a limited binominal expansion to the distribution of a metal within a certain area The formulation is such that a single constant defines the dispersion of the metal in the considered region The actual value of the constant can be calculated out of the known reserves Sequentially the distribution of ore deposits of any size and grade can be calculated IRIS can also calculate the distributions of minerals according to the log normal theory for comparison with the present results These programs operate in batch mode and use the Calcomp plotter

LANGUAGE FORTRAN (90%) ASSEMBLER (10%)
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE: Approximately 618 source statements
PRICE Program $250.00 Documentation $15.50
PROGRAM NUMBER: COS-02540

Geomagnetic Field and Field Line Calculation Computer Program

A set of computer programs has been developed for the calculation of the geometric field and the tracing of field lines in space The basic subroutine, geocentric ALLMAG, contains coefficients for seven recently published field models as built in data statements At execution time the user can vary the model and or the time period simply by changing input parameters Subroutine GDALMG are equivalent to Cain's FIELD AND FIELDG, with the added flexibility of the choice of seven models LINTRA traces field lines from any point in space to a specified altitude intersect in the same or opposite hemisphere, using any of the models contained in ALLMAG Input is in either geocentric or geodectic coordinates, and output is returned in both. McIlwain's INVAR package, which calculates B and L, has been adapted to use ALLMAG The program was checked on IBM 360 65 but innovator notes that it was tested with equal success on IBM 360 (40, 75, and 91), CDC 6600, IBM 7094, and UNIVAC 1108

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE: Approximately 1,844 source statements
PRICE Program $600.00 Documentation $7.50
PROGRAM NUMBER: GSC-11597

SSCO1 - Statistical Summary of Climatological Data Computer Program

This program performs a statistical analysis of surface wind observations The observations consist of wind velocity and direction recorded hourly for each day of the year Input to the program consists of the monthly observations of wind velocity and direction The wind velocity data are sorted by the program into 10 velocity ranges for each 17 wind direction ranges The program then summarizes the observations by the hour for each month and performs the following statistical calculations: (1) The percentage of frequency of wind direction by wind velocity (2) Total number of observations by wind direction and by wind velocity (3) Sum of the wind

velocities by wind direction. (4) Mean wind velocity by wind direction. (5) Monthly mean wind velocity. (6) Percentage frequency of each wind direction and velocity range. (7) Sum of the individual wind velocities squared. (8) Standard deviation of the wind velocity based on all wind directions. Output from the program is a tabular summary of the calculations by the hour for each month. The program has the optional capability of recording the summarized data on tape for historical purposes. This tape contains 12 files of data, one for each month of the year. This historical tape may then be updated on a monthly basis by combining the current month's data with the previous year's monthly data. Statistical calculations are then performed with the updated summary information and the cumulative monthly statistics are output in tabular form.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE 635
PROGRAM SIZE: Approximately 358 source statements
PRICE: Program $370.00 Documentation $7.50
PROGRAM NUMBER: KSC-10425

Handbook For Estimating Toxic Fuel Hazards

This package consists of a program which calculates the drift and fall of air borne materials. It was developed to model concentration, dosage and settling of toxic fuels emitted in the atmosphere, but can be applied to pollution studies of any materials where atmospheric layer structures, position, concentration, diffusion parameters, velocity and distribution of particle size can be determined. The program initially was used for studies in the 0-5 kilometer region of the atmosphere, but has been used for materials at a height of 30 kilometers. Certain assumptions about meteorological conditions are necessary, but accompanying documentation illustrates how these assumptions have been made with a reasonable degree of accuracy. Input parameters are of type types, meteorological inputs required to model atmospheric conditions, and source inputs which incorporate characteristics of the air borne substance being studied. Both types of inputs may be used in a single equation. For example, material concentration is calculated by: Concentration=(Peak Concentration Term) X (Alongwind Term) X (Lateral Term) X (Vertical Term) X (Depletion Term) where (a) Peak Concentration is the concentration at a point defined by Gaussian Coordinates. (b) The alongwind term is defined by wind speed and time of cloud travel. (c) The Lateral term is defined by the position of the source material. (d) The Vertical term is defined by the height of the source material, and (e) The Depletion term is defined by material loss due to simple decay processes such as gravitational settling. The amount of material disposited on the ground surface is calculated by making three principal assumptions: (1) the rate of precipitation is constant over a large area; (2) precipitation originates at a level above the toxic cloud; and (3) precipitation time has a distinct relationship to horizontal cloud movement. The program consists of 22 subroutines and is written in ASA FORTRAN V, though currently written for UNIVAC it should execute under most high level FORTRAN compilers when the appropriate monitor control cards are used.

LANGUAGE: ASA FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 1,877 source statements
PRICE: Program $710.00 Documentation $52.50
PROGRAM NUMBER: MFS-21114

Four-Dimensional World Wide Atmospheric Models

This package consists of two programs, ANYPT and ANYRG, and a set of magnetic data base tapes which are input to the programs. The data base utilized by ANYPT contains one file for each month of the year. Each of these files contains records representing atmospheric parameter values at 3490 grid points over the globe. Each record contains the pressure means and variances, the temperature means and variances, the moisture means and variances and the density means and variances for any height from 0 to 25 km a 1 km intervals. Using this global data set, ANYPT will generate for any month unique meteorological profiles consisting of tables of monthly means and variances for pressure, temperature, absolute humidity and density for any latitude, longitude and level up to 25 km. Where data for a selected grid point is not available, ANYPT will take existing data and, using horizontal interpolation schemes, apply it to any location on the globe. In addition, ANYPT contains the option of curve fitting the profiles generated for any data point so that meteorological parameter values may be extrapolated to any height in the range 0 to 25 km. Program ANYRG accepts as input data curve fit coefficients for each meteorological parameter averaged over each month and selected grid points within 45 homogenous moisture regions defined across the globe. ANYRG then generates meteorological profiles at specific times and locations from the coefficients of the curve fitted region data. The values produced are not unique for each latitude and longitude for they are constant throughout a homogenous moisture region. However, the execution efficiency of ANYRG relative to ANYPT, recommends ANYRG in those applications where lesser precision in generated profiles can be tolerated.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 1,960 source statements. Approximately 41,000 data records (4-2400 ft. magnetic tapes)
PRICE: Program $420.00 Documentation $30.00
PROGRAM NUMBER: MFS-22838

A Program for Computing the Brightness Temperature of a Clear Atmosphere From Radiosonde Data

In the spring of 1971, the losses in the antennas, waveguides, and radomes of the Multi-Frequency Microwave Radiometer (MFMR) were being determined by measurements made at Table Mountain, California. In these determinations, the brightness temperature of the sky must be known. The purpose of this computer program is to calculate the angular distribution of sky brightness temperature at microwave frequencies from radiosonde data. A radiosonde is a balloonborne device that measures pressure, temperature, and relative humidity. Soundings of these quantities are obtained during the ascent of the radiosonde from the surface to an altitude at which the balloon breaks. The following must be considered in making the angular distribution of sky brightness temperature at microwave frequencies from radiosonde data: (1) The radiosonde data and its shortcomings; (2) The radioactive transfer problem; and (3) The relationship between the radioactive and meterological properties of the atmosphere. After selecting a set of mathematical expressions to describe the microwave transfer process, these equations are then programmed in a format compatible with the input data and the needs of the data reduction program. The atmosphere is assumed to be

composed of a number of homogenous, spherical shells overlying a spherical surface that has a radius four-thirds that of the earth. The meteorological properties of each shell are taken to be the arithmetic means of the values of these properties at the boundary of the shell as given by the radiosonde data. No liquid water is assumed to exist in the atmosphere.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 396 source statements
PRICE: Program $190.00 Documentation $6.50
PROGRAM NUMBER: MSC-14093

AIRPOL—Wind Trajectory Tracing for Air Pollution Studies

This program performs the task of tracing the path of an air parcel as a function of time. The value of this program is that (1) it can provide data on the areas affected by an air pollution source or (2) if a monitoring station detects a pollutant, the upstream path of the air can be traced, and the potential pollution sources can be narrowed considerably. The program is a non-real time program. The program takes, as input data, wind vectors, wind station parameters, and the locations of the desired starting points. The program computes and lists the air parcel locations in half hour steps, either for the duration of time span requested, or until no wind vector date is available. The program traces a non-dispersing wind parcel either forward or backward in time and does so in two dimensions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,168 source statements
PRICE: Program $370.00 Documentation $7.50
PROGRAM NUMBER: NPO-11892

QUAL 1 - Simulation of Water Quality in Streams and Canals

A computer program, QUAL-1, is one of two computer programs developed by the Texas Water Development Board for use in stream quality simulation studies. QUAL-1 was developed to simulate the spatial and temporal variations of several specific water quality parameters in streams and canals. These parameters are: (1) Temperature; (2) Biochemical Oxygen Demand/Dissolved Oxygen (BOD/DO), and (3) Conservative Minerals. The program routes these parameters through a system of streams and canals on an hourly basis. It assumes that the major transport mechanisms, advection and dispersion, are significant only along the main direction of flow (longitudinal axis of the stream or canal). It allows for multiple waste discharges, withdrawls, tributary flows, and incremental runoff. It also has the capability to compute required dilution flows for flow augmentation to meet any prespecified dissolved oxygen level. The program is designed to begin the routing calculations from the points farthest upstream (headwaters) of a stream or canal system. As incremental flows and waste inputs or withdrawals are encountered, they are entered into the calculations. The result at the end of the system is a set of simultaneous equations equal in number to the number of computational elements in the system. This set of equations is solved, thus advancing the solution forward in time. This procedure is repeated until steady state conditions are reached, which is approximately the time required for a water particle at the uppermost point in the system to reach an end of the system. The user has seven (7) options to choose from: (1) Route temperature, BOD/DO, and conservative minerals; (2) Route temperature and BOD-/DO; (3) Route BOD/DO; (4) Route conservative minerals and temperature; (5) Route temperature; (6) Route BOD/DO and conservative minerals; and (7) Route conservative minerals. The user has the option to determine flow augmentation requirements based on preselected minimum allowable dissolved oxygen concentrations if he so desires. The program has the following restrictions: (1) Maximum number of reaches = 25; (2) Maximum number of waste inputs = 25; (3) Maximum number of headwaters = 5; (4) Maximum number of junctions = 5; and (5) Maximum number of computational elements = 500.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Can be run on any computer with a FORTRAN IV compiler if minor modifications are made. The program has been operational on the RCA SPECTRA 70/45, the CEC-6400 and 6600, and the UNIVAC-1108
PROGRAM SIZE: Approximately 2,134 source statements
PRICE: Program $680.00 Documentation $16.50
PROGRAM NUMBER: UGA-02333

DOSAG 1 - Simulation of Water Quality in Streams and Canals

A computer program, DOSAG-1, is one of two computer programs developed by the Texas Water Development Board for use in stream quality simulation studies. DOSAG-1 is used to simulate the spatial and temporal variations in biochemical oxygen demand (BOD) and dissolved oxygen concentration (DO) under various conditions of temperature and headwater flow. Its principal use is for rapid evaluation of a number of varying stream conditions. The purpose of the model is to calculate the BOD/DO in a particular stream system. If desired, the minimum DO in the stream system may be checked against a pre specified target level DO. If the minimum DO level is below the target DO, the program will compute the required amount of flow augmentation to bring the DO level up to the target level in the entire system. The user specifies the locations within the stream system at which dilution water is available for flow augmentation. The program is designed to be run for varying climactic and hydrologic conditions during a twelve month period. Thus, it is possible to enter up to twelve different temperatures and corresponding discharges to each of the headwaters within the stream being modeled. The output from a single run of the DOSAG 1 program will provide a complete description of the DO resources of the stream system investigated, and the required dilution water needed to bring the system up to the target level DO. An additional user option available is the ability to find the DO distributions for varying levels of treatment (waste treatment plants) in the simulated river basin. The program has the following restrictions: (1) Maximum number of headwater stretches = 10; (2) Maximum number of junctions = 20; (3) Maximum number of reaches = 50; (4) Maximum number of stretches = 20; (5) Maximum of twelve months of routing for temperature and headwater flows; a minimum of one month must be used. (6) Maximum number of dissolved oxygen targets = 4, with a minimum of one specified, which could be negative if no flow augmentation is desired. (7) Maximum of five degrees of treatment for both carbonaceous and nitrogenous wastes, with a minimum of one specified. The user does not have to exercise this option.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Could be run on any computer that has a FORTRAN IV compiler

PROGRAM SIZE: Approximately 1,132 source statements
PRICE: Program $670.00 Documentation $9.00
PROGRAM NUMBER: UGA-02340

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Could be run on any computer that has a FORTRAN IV compiler

PROGRAM SIZE: Approximately 1,132 source statements
PRICE: Program $670.00 Documentation $9.00
PROGRAM NUMBER: UGA-02340

INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; sensors and transducers; photography (including optical, aerial, and radar photography); infrared technology; display systems; data recording and processing.

Optical Systems Ray Tracing

This program traces rays of light through optical systems consisting of up to 65 different optical surfaces and computes the aberrations. For design purposes, paraxial tracings with astigmatism and third order tracings are provided. The procedure accounts for various tilts of the surfaces with respect to the optical axis which are introduced either by design or by manufacturing tolerances. Five different types of optical surfaces are treated, and provision is made to test for each type. Also, the computations are carried out for three different values of the refractive index. Provision is made for introducing new surfaces, or variations of the original ones, into the system after the computations for the original have been made. The input of all variables is on cards. The basic coordinate system used is a right handed Cartesian system with the positive Z axis directed along the optical axis, the Y axis directed positive vertically, with the X axis completing the right handed system. An option to run several types of systems at once is available, which gives the advantage of computing large numbers of experiments in only one pass on the computer.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE 635
PROGRAM SIZE: Approximately 1,677 source statements
PRICE: Program $440.00 Documentation $13.50
PROGRAM NUMBER: FRC-10017

OSRT1 - Optical Systems Ray Tracing Computer Program

A computer program has been written which provides efficient handling of optical analysis equations from both the general skew and paraxial ray standpoints, yet is sufficiently general in approach as to accept a wide variety of systems introduced in a convenient form. Meaningful diagnostic messages are generated to help the user pinpoint any inconsistencies of the system definition. The program uses standard optical system analysis equations as outlined in such publications as the "Military Standardization Handbook of Optical Design." It is designed to trace the exact paths of up to 800 representative rays through any number of symmetric or asymmetric optical systems. Rays may also be traced through a paraxial ray trace, two rays at a time. The functions of the program are segmented enough so that, while each segment is not autonomous, the functions contained within each segment are well defined to facilitate conversion to other computers or other languages, and to enable changes in method to be incorporated easily. The program is sufficiently general in approach to accept a large spectrum of systems defined by normal, tilted, or decentered planar surfaces. Rotationally symmetric quadric, aspheric and deformed spheric and conic surfaces may be input in any combination up to 22 surfaces per system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 3000L
PROGRAM SIZE: Approximately 2,811 source statements
PRICE: Program $540.00 Documentation $14.50
PROGRAM NUMBER: GSC-11393

SMIPS - Small Interactive Image Processing System

The Small Interactive Image Processing System is designed to facilitate the acquisition, digital processing, and recording of image data as well as pattern recognition in an interactive mode. The system contains approximately 104 routines and application programs designed for ease of communication with the computer by personnel who are not expert programmers, fast response to requests for information on pictures, complete error recovery, and simplification of future programming efforts for extension of the system. SMIPS is intended as an experimental system allowing a quick familiarization with the characteristics of the image data rather than a production system. It can, however, be used for production work and its full compatability with the VICAR System allows access to numerous image processing programs in the VICAR library. Because of its modular design, new interactive capabilities can be easily included and SMIPS could be used as an experimental tool to gain further experience for the design of larger and more sophisticated interactive image processing systems. Digital image processing involves the pictorial or numerical display of raw image data, the restoration or enhancement of images, the display of results as maps or photographs and the

detection of objects. This requires examination of the image data from many different view points and the SMIPS system has been developed to give the user flexible and convienent control of a variety of image-processing methods. SMIPS serves for: (1) Fast display of parts of pictorial data on the screen of an IBM 2250 display device either numerically or as a character representation. (2) Computation and display of histograms. (3) Convenient specification of a variety of image processing tasks for restoration, enhancement and detection. (4) Output of numerical results and pictures as graphs, maps and photographs.

LANGUAGE: ASSEMBLER (60%) FORTRAN IV (40%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 46,690 source statements
PRICE: Program $2,180.00 Documentation $18.00
PROGRAM NUMBER: GSC-12079

CONVERT - Technique and Computer Program for Calculating Photographic Film Density Variations

This computer program converts digitized film densities of aerial photographs into a number representing the film density difference between the unexposed film border and a point on the photograph. The program contains several subroutines which allow the calculation of the angle off the principal axis of the camera lens so that a correction can be made for vignetting and atmospheric backscattering. The program also plots the computed values as a function of position on the photograph so that a three dimensional picture is produced. Ranges of density difference can be predetermined, and the program will place each data point into its corresponding range so that the percentage of points in each range can be calculated. There are seven steps in calculating the film density difference: (1) the average density of the unexposed film border is calculated (AVERAGE); (2) the density difference between AVERAGE and the density for a specific data point is calculated; (3) the vertical pen distance traveled by the recording plotter pen is calculated; (4) the angle off the principle axis of the camera lens is calculated; (5) a correction factor is calculated; (6) the corrected vertical pen distance is calculated. (7) the film density difference value is calculated. The lens principle axis is assumed to be the same as the perpendicular vertical intersecting the center point of the photograph. The program has utility in the area of remote sensing and was developed to remotely determine water quality. The program operates in batch mode, uses the Calcomp plotter and is presently running under the Scope 3.0 operating system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 399 source statements
PRICE: Program $370.00 Documentation 8.00
PROGRAM NUMBER: LAR-11873

Instrumentation Reliability Analysis Program

This program is used for instrumentation reliability analysis. This history tape can be added, deleted, and modified, all in one job. Analysis only jobs can be processed using the same program deck with no increase in computer time or change in input format. Used properly, this program will reveal faulty equipment, improper recall period, or some other failure condition. Output consists of twelve categories: (1) Listing of all instruments that failed, (2) Mean time in weeks to failure of population, (3) Mean time in weeks to failure of population, consisting of those instruments that failed, (4) Percentage of failure of population, (5) Average repair time per instrument, (6) Total number of instruments analyzed, (7) Period in weeks over which entire population is analyzed, (8) Component and failure mode correlation, (9) Frequency analysis of component parts, (10) Equipment failure symptoms analysis, (11) Component failure symptoms analysis, and (12) Failure cause analysis.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 690 source statements
PRICE: Program $160.00 Documentation $4.50
PROGRAM NUMBER: MFS-18483

Digital Image Registration Method Based Upon Binary Boundary Maps

This program uses binary boundary maps to register ground scene images from remotely sensed earth observation data. In change detection, data is acquired from the same ground scene at different time intervals; therefore, registration is a necessary part in determining changes that occur in the ground scenes.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 375 source statements
PRICE: Program $50.00 Documentation $6.50
PROGRAM NUMBER: MFS-23033

ASTEP - Algorithm Simulation Test and Evaluation Program

This package represents a data analysis program used to examine statistical properties of multispectral scanner data. It serves as a tool to perform experiments to gain understanding of the problems associated with processing multispectral earth resources data and to test and evaluate processing algorithms. Examples of the experiments of this type include the following investigations: (1) quantitatively determining the variation in spectral signatures for a given situation, (2) determining if there are patterns in the signature variation, either spectrally or spatially, (3) determining the statistical homogeneity of typical ground truth sites, (4) determining if the statistical assumptions required for maximum likelihood processing of typical areas are satisfied, (5) evaluating the performance of various clustering techniques, and (6) comparing the performance of clustering and maximum likelihood algorithms. Since the last version of ASTEP, a number of new capabilities have been added. Some of these were made to improve the overall efficiency of the program and will be transparent to the user, others include changes in input option and some new options. A main feature of this updated version is that it can accept input data in LARSC1, LARSC2, ERTS, and Universal formats, and output processed image or data tapes in Universal format. Also an error recovery capability has been added to prevent the program from terminating when errors are made in the namelist input. The program now consists of two basic parts, a driver and a set of application modules. The driver serves several functions. It is the holder of the common storage areas and transfers control to the appropriate applications module. The application modules consist of data classification and display algorithms; data statistical analysis subroutines; feature selection; utility options; and program information options. ASTEP consists of over a hundred subroutines and operates in either interactive or batch mode.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series EXEC 8
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR Formatted Tape
PRICE: Program $970.00 Documentation $35.00
PROGRAM NUMBER: MSC-14690

LARSYS III - Multispectral Data Analysis System, Release 3.1

The LARSYS software system is designed for remote sensing research. The system uses pattern recognition and interactive data handling techniques applied to remotely sensed multispectral and/or multitemporal data. The primary input data to LARSYS is multispectral data in image orientation. Such data has been obtained from aircraft or spacecraft multispectral scanners. These images of the earth's surface are either recorded in or converted to digital data for input to LARSYS. LARSYS has found application in the areas of agriculture, geology, hydrology, and geography, but LARSYS facilitates the application of remote sensing for researchers in other disciplines as well. The basic analysis concept of LARSYS consists of locating data points which are believed to be representive of classes of interest. A class of interest may be certain crops, beaches, woods, geological features, etc. Gaussian statistics of these data points (a key assumption made in several LARSYS algorithms is that distributions are Gaussian) are calculated and data sets are classified by spectral similarity. Next, the classification results are evaluated. Thus, there are four basic concepts to the analysis: (1) location of data points, (2) statistical calculations, (3) classification, and (4) process evaluation. LARSYS will operate in batch, interactive or disconnect mode, and as distributed is implementable on IBM 360 machines. The current configuration includes 512K bytes of main storage, about 200 million bytes of auxiliary direct access storage, 10 tape drives, 2 card readers, 2 printers, 1 card punch, 10 remote typewriter terminals, 3 remote reader-printer-punch high speed terminals, and an IBM 4507 Digital Display System developed especially for LARSYS. LARSYS options allow for the installation of the software on a configuration which represents only a subset of the present hardware system. The operating system environment includes the IBM supplied Control Program-67; the Cambridge Monitoring System (for virtual machine operation); a FORTRAN IV compiler identical to the OS G-level compiler; and the OS 360 Assembler. Documentation for LARSYS consists of four different manuals. Multiple documentation prices are available for LARSYS. The LARSYS Users Manual contains a comprehensive description of the functional organization of the system, the processing functions provided, and the manner in which the functions are invoked and controlled. The LARSYS System Manual is directed primarily to programmers and analysts who maintain or revise the system or write new functions that must be interfaced with LARSYS. The LARSYS System Program Modules Manual contains the documentation of each FORTRAN and Assembler routine and each Cambridge Monitoring System Executive routine in LARSYS. The LARSYS Test Procedure Manual is the basic document to be used for verifying the proper functioning of the LARSYS Program System as defined in the Users Manual and the Systems Manual. The LARSYS program product is available by lease only for a one time initial fee of $1,000 to domestic U.S. lessees and $2,000 to foreign lessees. The leased program product delivered includes one complete set of supporting documentation, however, additional documentation may be purchased separately at any time (Prices available from COSMIC on request).

LANGUAGE: IBM FORTRAN IV (G) and IBM Assembler
MACHINE REQUIREMENTS: IBM 360
DISTRIBUTION MEDIA: 9 Track, 800 BPI Magnetic Tape
PROGRAM NUMBER: MSC-14023

FOLDP—FORTRAN Optical Lens Design Program

This program utilizes the principles of geometric optics to design optical systems containing up to 100 plane, conic or polynomial aspheric surfaces, 7 object points, 6 colors and 200 rays. Any number of cases can be processed in a single computer run. The program is made up of 48 subroutines. In the design phase, it uses a linearized least squares technique to iteratively reduce the magnitude of the merit function by automatically adjusting system parameters. The merit function is made up of the sum of the squares of the user-weighted aberrations of the system. The ray trace capabilities of the program can be used individually, by option, to find focal point, focal length, back focus, f number and exit pupil location for every color.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/SC 4020 plotter
PROGRAM SIZE: Approximately 7,077 source statements
PRICE: Program $680.00 Documentation $52.00
PROGRAM NUMBER: NPO-10603

VICAR: Vicar Image Communication and Retrieval System

The VICAR system consists of an expandable library of application programs and a supervisory control program and is designed to facilitate the acquisition, digital processing, and recording of image data. The application programs perform the various image processing functions of picture comparison, expansion, two dimensional convolution filtering, geometric transformation, and other image enhancement functions. The image analyst using VICAR calls for the automatic execution of one or more of the library programs, including the requisite image data management services, through a set of command instructions supplied to the control program which serves as a communication medium beteen the user and the program library and is always resident in central memory. Because the library programs are written to be flexible in application, the analyst supplies the parameters specific to a particular application at execution time through command language operands. Utilization of the VICAR command language to accomplish picture processing requires a minimum of programming knowledge and data inputs from the analyst. The system also utilizes and provides efficient special purpose input/output routines designed for image data transfer which reduce library and central memory storage requirements as well as obviating the necessity for writing these for each processing program. Currently the application program library contains in excess of 200 processing programs which may be easily augmented with additional programs using standard VICAR support facilities. Two versions of the VICAR system are available through COSMIC differing only in the host computer operating system requirements. One version (NPO-13415) requires the IBM 360/44 Programming System (44-PS) monitor while the other (GSC-12706) is implementable under the IBM 360/370 OS monitor.

LANGUAGE: FORTRAN (60%), ASSEMBLER (40%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 82,000 source statements
PRICE: Program $1,670.00 Documentation $88.00
PROGRAM NUMBER: NPO-13415, GSC-12076

MACHINE ELEMENTS AND PROCESSES

Includes bearings and gears, seals, pumps, vacuum technology; lubrication and lubricants; friction and wear; materials fabrication; numerically controlled machining; manufacturing processes and quality control; structures and component reliability analysis.

Systems Identification Using A Modified Newton-Raphson Method

A digital computer program written in FORTRAN is offered which computes a maximum-likelihood estimate of the parameters of a linear, state space model. For the case considered, the maximum-likelihood estimate can be identical to one which minimizes simultaneously the weighted mean-square difference between the computed and measured response of a system, and the weighted square of the difference between the estimated and a priori parameter values. A modified Newton-Raphson or quasilinearization method is used to perform the minimization which typically requires several iterations. The modification of the Newton-Raphson method was made in the interest of reduced computation and program simplicity. A starting technique is used which insures convergence for any initial values of the unknown parameters. A Cramer-Rao bound is used to indicate the variance of the estimated parameter values. Although the primary application of the program has been to determine aircraft stability derivatives from flight data, it is directly applicable to identification of any system which can be described by a linear, constant-coefficient model. The intent of this paper is to describe the program and its operation in sufficient detail to enable the user to apply the program to his particular problem with a minimum of difficulty.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 700 source statements
PRICE: Program $380.00 Documentation $12.00
PROGRAM NUMBER: LAR-11251

Investigation of Isothermal Compressible Flow Across a Rotating Sealing Dam

This computer program analyzes by means of a mathematical model the flow across a parallel sealing dam of a shaft face seal. The analysis is for steady, laminar, subsonic, isothermal compressible flow with rotation of one of the sealing dam surfaces. The effect of rotation on mass flow, pressure distribution, and other physical parameters is determined. Some power plants, such as advanced jet engines, exceed the operating limits of face contact seals. As a result, noncontact face seals are becoming necessary if high leakage associated with labyrinth seals is to be avoided. The effects of relative rotation of the sealing dam surfaces on the radial pressure flow does not presently exist in the literature. To achieve a good design, it is desirable to study the effect of the variation of a large number of parameters; thus, the automatic calculation and printout of physical variables facilitates design. The program requires the following input variables: the dimensions of the seal, pressure boundary conditions, and molecular weight and physical properties of the gas. The output includes mass flow rate, pressure and velocity distribution, Mach number, force, center of pressure, rotational flow Reynolds number, pressure flow Reynolds number, power loss, torque, and approximate temperature rise due to viscous shearing for specified film thicknesses.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 II/7044 or 7040 DCS under IBSYS Version 13 using ALTIO
PROGRAM SIZE: Approximately 891 source statements
PRICE: Program $280.00 Documentation $12.00
PROGRAM NUMBER: LEW-11032

Computer Program for Calculating the Temperature Field of Face Seals

This program was developed for the calculation of the temperature field of shaft-seals, but it is general and can be applied to a variety of steady-state thermal problems. Shaft seals are composed basically of axisymmetric bodies. The circumferential temperature gradient approaches zero for most applications, thus the cylindrical coordinate system is used as a basis for analysis. Various convection and radiation boundary conditions which can be used are given in the developed mathematical formulations. The program is designed to permit ready substitution or addition of other boundary conditions or other expressions for the heat transfer coefficients. The calculation procedure requires that the axisymmetric

bodies be divided into an arbitrary finite number of axisymmetric volume elements or nodes which need not be equal in cross-section. The program takes into account contact resistance at the interface between nodes and material properties that vary from node to node. Provisions are made to handle varying gas temperatures along the seal boundaries and internal viscous heat generation within the fluid at the boundaries. A subroutine, normally vendor supplied, is missing from this program and must be furnished by the purchaser. The subroutine name is TIMEI.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 1,716 source statements
PRICE: Program $200.00 Documentation $13.00
PROGRAM NUMBER: LEW-11110

Evaluation of Rotating Incompressibly Lubricated Pressurized Thrust Bearings

An analysis and computer program have been developed which permit the rapid evaluation of pressurized thrust bearing designs using an incompressible lubricant. Included in the analysis are the effects of two self-acting journal bearings which may be used to provide a radial load capacity. Bearing load, torque, lubricant flow rate, and other quantities of interest can be calculated. Either orifice or capillary restrictors may be used and effects of bearing rotation are included. A review of the literature indicates that there is no published information on rotating, compensated, pressurized thrust bearings using incompressible lubricants. The program was used to evaluate a series-hybrid, fluid-film ball bearing. For the fluid-film bearing, an orifice compensated pressurized thrust bearing in conjunction with a self-acting journal bearing was used. Oil viscosities corresponding to experimentally measured ball bearing outer-race temperatures were used in the computer program. Points for the analytical curve were obtained from plots using measured bearing torque. The analysis indicated that when the supply pressure became high enough to lift off the fluid-film thrust bearing, the intermediate speed dropped abruptly. After lift-off, the intermediate speed would rise at a slightly lower rate than shaft speed. Results of the computer program agreed well with experimental data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 or others with FORTRAN IV compiler
PROGRAM SIZE: Approximately 250 source statements
PRICE: Program $250.00 Documentation $5.00
PROGRAM NUMBER: LEW-11511

FORTRAN Programs for the Design of Liquid-to-Liquid Jet Pumps

Five computer programs have been written, based on one-dimensional equations, for the selection and design of liquid-to-liquid jet pumps for noncavitating and cavitating flow. Each program operates on a specific combination of input parameters and provides a set of output parameters which enable a designer to choose a pump. There are five programs because there are five common design situations, each carrying a unique set of "known" parameters and requiring another set of output parameters to specify a design. The five design programs have the following input and output elements: P1=Primary total inlet pressure; P2=Secondary total inlet pressure; PD=Outlet total pressure; W1=Primary fluid weight flow; W2=Secondary fluid weight flow; M=Flow Ratio, W1/W2; An=Area of primary nozzle exit plane; At=Area of throat; and R=Area Ratio, An/At. The major advantages to each program are: Program I-Design chart development; Program II-Known throat diameter; Program III-Marginal cavitation limits; Program IV-Known flow rate and pump pressure rise; and Program V-Off-design performance from known pump geometry. The programs may be used for any liquid for which the physical properties are known. Calculations for noncavitating and cavitating performance were combined, permitting a calculation of cavitation limits within the program. Design charts may be developed without the manual iteration which is common to existing design methods. The programs are adaptable in use. Single-pass design-point calculations may be made if the design requirements are fully specified. Or, if some of the parameters are variable, one or more programs may be used to construct elaborate design charts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 420 source statements
PRICE: Program $340.00 Documentation $7.50
PROGRAM NUMBER: LEW-11679

Computer Program for Calculating Critical Speeds of Rotating Shafts

This computer program has been written to calculate the critical speeds of rotating shafts. The shaft may include bearings, couplings, extra masses (nonshaft mass), and disks for the gyroscopic effect. Shear deflection is also taken into account and provision is made in the program for sections of the shaft that are tapered. The boundary conditions at the ends of the shaft can be fixed (deflection and slope equal zero) or free (shear and moment equal zero). The fixed end condition enables the program to calculate the natural frequencies of cantilever beams. The program uses continuous integration of the differential equations of beam flexure across different shaft sections. In the program output a plotter is used to produce a drawing of the shaft with superimposed deflection curves at the critical speeds together with all pertinent information related to the shaft.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 866 source statements
PRICE: Program $370.00 Documentation $9.50
PROGRAM NUMBER: LEW-11910

Program for Calculating Total Efficiency - Specific-Speed Characteristics of Centrifugal Compressors

A computer program has been developed for predicting design point specific speed-efficiency characteristics of centrifugal compressors. Compressor efficiency has been shown to be a function of specific speed. Specific speed is a characteristic that relates compressor inlet volume flow rate, rotation speed, and ideal enthalpy rise. Generally, high efficiencies are associated with high specific speeds, and low efficiencies are associated with low specific speeds. Compressor design point geometries that produce maximum attainable efficiency are also functions of specific speed. Knowing the variation in optimum design point geometric variables with specific speed permits rapid selection of high efficiency configurations. This computer program uses a one-dimensional mean streamline analysis conducted at fixed stagnation conditions. Seven specific losses are calculated for each set of compressor geometric variables and inlet velocity diagram characteristics studied. These are inlet guide vane, blade

loading, skin friction, disk friction, recirculation, vaneless diffuser, and vaned diffuser losses. Each of these individual losses is expressed as a decrement in compressor total efficiency. The effect of these losses is then related to overall compressor total efficiency. The effect of these losses is then related to overall compressor performance and specific speed. By examining the program output, the user can select values of inducer hub-tip diameter ratio, inducer tip-exit diameter ratio, impeller blade exit backsweep, impeller exit blade height-diameter ratio, and impeller exit absolute flow angle that will result in maximum total efficiency for the chosen application. For given inlet stagnation conditions, the user can generate efficiency, pressure ratio, specific speed, and relative loss distribution data corresponding to various combinations of impeller inlet velocity diagram characteristics and impeller overall geometries. By examening the output data, a compressor geometry can be chosen which will yield maximum efficiency under the constraints imposed. The following categories are used as input information: (1) compressor geometry, (2) thermodynamic properties of the working fluid, (3) velocity diagram characteristics, and (4) iteration limits. The prewhirl used in this analysis is solid-body vortex. For iterations on inducer tip absolute critical velocity ratio, the inducer tip speed is adjusted to preserve inlet velocity triangle similarity with that determined by the first pair of input inducer tip speed and inducer tip absolute critical velocity ratio. That is, the absolute and relative flow angles are held constant for successive iterations. For each iteration, the following c itput information is tabulated: compressor geometry, velocity diagram characteristics and compressor performance characteristics. The program can be used for working fluids other than air which approximates ideal gas behavior since the thermodynamic properties needed for the equations solved in the programs are specified inputs. If a working fluid other than air is used in the analysis, an empirical equation expressing the dynamic viscosity as a function of temperature must be substituted.

LANGUAGE: FORTRAN (83), MAP (17)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 460 source statements
PRICE: Program $370.00 Documentation $7.50
PROGRAM NUMBER: LEW-12008

Bellows Calculation Program, IBM 360 Version

This program employs empirical and analytical derived design equations on various metal bellows of different sizes in order to calculate various properties of bellows used in ducting systems. Arithmetic operations are performed in double precision. Calculations are restricted to four single bellows movements and two double bellows movements. One subroutine and one data deck are required with the main program. The main program and the subroutine calculate bellows spring rates, bulging, bending, and hoop stresses. Cycle life is calculated by the data deck. With known bellows dimensions and type of movements supplied as data, the main program and subroutine calculate spring rate, actuating force, squirming pressure, stress, bellows weight, resonant frequency, fatigue, life and convolution clearing.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 371 source statements
PRICE: Program $160.00 Documentation $2.50
PROGRAM NUMBER: MFS-12641

RAM—Reliability Analysis Model

The reliability Analysis Model (RAM) Program is an integrated Systems Design Analysis Program whose primary purpose is to combine the results of various Saturn V analyses into a single effective and comprehensive program. The RAM Program can be readily applied to determine the probability of success for one or more given objectives for any complex system. RAM can be applied to analyze complex transportation systems and traffic control systems and can be used in designing more reliable and safer automobiles. The Reliability Analysis Model Program is also applicable to urban planning, the air pollution problem, weather prediction, the water pollution problem, oceanographic exploration, in determining the effect of the weather on the environment, and in determining the effect of human factors on reliability. The RAM program includes failure mode and effects, criticality and reliability analyses, and some aspects of operations, safety, flight technology, systems, design engineering, and configuration analyses. The unique advantage of this methodology and its associated programs is that the results of all these analyses are fed into a single data bank in terms of impact on mission objectives, so that comparison, correlation, and trade-offs may be made between the results of the various analyses. The basic output of the RAM program is the identification of those components that are critical to primary flight mission (no abort), vehicle integrity (no physical destruction of the vehicle), and crew safety. In addition to identifying those components that are critical to a specific objective, this program can rank them in order of importance (probability of causing loss). The program also provides estimates of the probability of primary flight mission success, vehicle integrity, and crew safety - both as an overall number and as a profile with respect to mission time. The criticality determination technique (CD technique) used in conjunction with RAM is a more general method than those currently used. By this new method, criticality numbers can be assigned to components, subsystems, systems, stages, missions and crews for any given failure distribution, such as the exponential, Weibull, Gamma, or truncated normal, where applicable.

LANGUAGE: COBOL (100)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 18,150 source statements
PRICE: Program $2,410.00 Documentation $21.00
PROGRAM NUMBER: MFS-14513

Exact Minimal Path and Minimal Cut Techniques for Determining System Reliability

This is a generalization of a family of techniques for determining by exact methods the probability of successfully operating a system using tree type logical analysis of the configuration of the elements. The system is deemed to be successful if a path of unbroken strings of connected branches corresponding to operating elements and assemblies can be traced from one end of the tree to another. The minimal paths are a subset of the paths and generate all the others; the minimal cuts are the subset of the failure states that generate all the others. The reliability of the system is the probability that at least one path obtains. The unique feature of these techniques is that one can find the system reliability if only either set of minimal states are known. By a recursive process, a system reliability (or unreliability) equation is generated as a function of the reliabilities (unreliabilities) of the elements using the complete set of minimal paths (cuts). The

system reliability (unreliability) is formed by substitution into this equation.

LANGUAGE: FORTRAN IV (73%); ASSEMBLER (27%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,889 source statements
PRICE: Program $440.00 Documentation $6.00
PROGRAM NUMBER: MFS-16499

APRDCT - Apportionment/Prediction

This is a general program which utilizes weighting, failure rates, time, reliability equations, and system contractual stage goals to establish phase predicted indices and phase apportioned reliabilities at the component, subsystem and system levels. The weighting factors used in this apportionment reflect Thurstone-Mosteller weightings derived from analyses of components with respect to conditions of use, phase stress conditions, and item capabilities. The phase reliability equations are determined from phase reliability networks by a computer program called MFS-24484.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 4,648 source statements
PRICE: Program $560.00 Documentation $12.00
PROGRAM NUMBER: MFS-24034

ERSION 3 Reliability Goal Status

The ERSION program is basically a prediction-type program which allows the user to input component level reliability indices and compute overall reliability values at the subsystem, system and unit level. Basically, the program substitutes the input indices in the SCOPE (MFS-16410) generated equation for the subsystem to obtain a subsystem reliability. A set of subsystem level indices are obtained in this manner and are substituted in the associated system SCOPE equation determined by system/subsystem ID code to obtain a system reliability index. Finally, after a complete set of system level reliability indices are generated, numbers are substituted in the SCOPE equation to produce the overall unit reliability. The program allows the user to update a previously generated data set if the only difference between what is needed and what is available from the previous data set is in the component reliabilities. In this case, the user merely codes the number of differences on the system or subsystem control card and places the new reliabilities after the basic subsystem set. The component code identifies the component to be changed and the program will apportion the new reliability to the phases of operation in the same proportion as the old values were apportioned. Since phase reliabilities are assumed independent, the overall reliability is the product of the phase reliabilities.

LANGUAGE: FORTRAN IV, H COMPILER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 4,007 source statements
PRICE: Program $250.00 Documentation $12.50
PROGRAM NUMBER: MFS-24121

SCOPE - System for Computing Operational Probability Equations

SCOPE (System for Computing Operational Probability Equations) is a system for determining the probability of success or failure for a given network. SCOPE computes from a logical block diagram, success or failure modes, success or failure equations and probability of success or failure probability indices. SCOPE will merge a pert type path generator with an algorithm for combining failure or success modes to obtain failure or success equations. This allows the user to analyze a system's reliability. The mathematical model for the SCOPE program is based on the Fundamental Law for the Addition of Probabilities and its extension to cases of more than two events. This program could be used in industry to determine the reliability of any large network or system where the functioning of the system is dependent on each step.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,351 source statements
PRICE: Program $760.00 Documentation $16.50
PROGRAM NUMBER: MFS-24484

Digital Servo Analyzer

A computer program which enables post test analysis of digitized servomechanism responses on a Hewlett-Packard Model 9100A Desk Computer is offered. The primary function of the program is to compute amplitude and phase angle differences between servomechanism sinusoidal stimuli and response measurements. In addition, the program may be used to perform Harmonic and Fourier analysis of periodic phenomena. This program does not have a program card listing. The documentation and source program are offered only as a complete package.

LANGUAGE: Not Applicable
MACHINE REQUIREMENTS: Hewlett-Packard 9100A
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17552

Optimization Of Fluid Line Sizes With Pumping Power Penalty

A computer program has been developed to calculate and total the weights for tubing, fluid in the tubing, and weight of a fuel cell power source necessary to power a pump based on flow rate and pressure drop. The larger the tube diameter the greater the weight of tube and fluid weight. For a fixed fluid flow rate, the larger the tube diameter the lower the fluid pressure drop and consequently the lower the pumping power and weight of electrical power supply. The greater the flow rate the higher the pressure drop and related pumping power required and weight of power source. Using different stainless steel tubing sizes and flow rates, the systems rates have been calculated for a Shuttle Orbiter water and Freon 21 system. Two different power penalties for pumping power were used in the calculations for all conditions. The optimum water system line size was ¼ to ⅜ inch diameter for a flow rate of 500 lb/hr. The optimum Freon 21 system line size was approximately ⅜ to ½ inch diameter for a flow rate of 1800 lb/hr. This program can be used for any fluid system used in any type of application aircraft, spacecraft, trucks, ships, refineries, and chemical processing plants. The weight and the pumping power of the plumbing system can be equated to cost. The line size can then be optimized relative to weight or cost.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 33 source statements
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17930

Reinforced Carbon-Carbon Mass Loss

This package is a series of desk top computer routines for calculating mass loss from Reinforced Carbon Carbon (RCC) materials used in the Space Shuttle missions. The system will calculate and plot mass loss rates and accumulated mass loss for critical locations where temperature and pressure profiles have been determined. The system should be useful in forecasting operating life of materials in high temperature cycling.

LANGUAGE: Instructions and data are entered at the time of processing
MACHINE REQUIREMENTS: Hewlett Packard 9820A
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19494

TRACE - Fault Tree Computer Code Analyzes Large and Complex Systems to Identify and Eliminate Combinations of Malfunctions, Failures, and Hazards

TRACE, a computer simulation technique, has been developed to analyze a fault-tree, estimate the probability of tree failure, and identify the most probable causes. The fault tree concept, originated at Bell Telephone Laboratories, provides a systematic and logical procedure for representing the structure of a system and gives an orderly description of the various combinations of possible occurrences within a system that can result in a failure. TRACE applies the technique of importance sampling to reduce computer time requirements. The power rule is utilized for the importance sampling. This program performs a Monte Carlo simulation to identify the minimal cutsets and critical paths of a fault tree and to estimate probabilities of fault tree failure. The basic input events to a tree are primary and secondary component failures. The time-to failure for a component is assumed to be a random variable with an exponential distribution. Various types of logic gates are permitted.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,637 source statements
PRICE: Program $390.00 Documentation $12.00
PROGRAM NUMBER: NUC-10402

MATHEMATICS

Includes numerical analysis techniques such as error analysis, function evaluation, numerical integration and differentiation, differential and integral equation solution; combinatorial and discrete mathematics; mathematical programming; mathematical statistics and probability.

Spearman Rho Multiple Rank Order Correlation Program

This program ranks raw data, selects one variable at a time, pairs it with another variable and computes a rank-order correlation. This process is repeated until each variable has been correlated separately with every other variable. Each variable is ranked by assigning the rank of 1.0 to the highest value, 2.0 to the next highest, etc. Ties in the raw data values are adjusted by computing an average rank and assigning that rank to each of the tied data. After all data have been ranked, one set of ranks is subtracted from the other, the differences are squared, and the rank-order correlation coefficient is computed. This procedure may be used (1) for small samples of data, (2) to obtain the relationship between two variables, one or both of which cannot be measured objectively, but which may be ranked subjectively, or (3) when other assumptions for parametric statistics cannot be met. The program will process up to 100 cases for up to 30 variables. No data point may be larger than 999,998.9 nor less than 0.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 77 source statements
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: ARC-10165

AESOP - Automated Engineering and Scientific Optimization Program

This program solves a wide range of multivariable parameter optimization problems by providing search techniques for the optimization of non-linear parametrically defined systems. The program has the ability to solve constrained optimization problems involving up to one hundred parameters. Nine search techniques are available for problem solutions; they are: Sectioning, Adaptive Creeping, Steepest-Descent, Quadratic Search, Davidon's Method, Random Point Search, Random Ray Search, Pattern, and Magnification. The searches may be employed separately or in any sequential combination. The optimization program may be rapidly coupled with a wide class of parameter optimization problems, including systems which have previously been synthesized as digital computer programs.

LANGUAGE: FORTRAN IV (80%); ASSEMBLER (20%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 3,571 source statements
PRICE: Program $680.00 Documentation $41.50
PROGRAM NUMBER: ARC-10168

Finding An Extremum of a Bounded Multivariable Function without Determination of the Derivatives

This program searches a local extremum (maximum or minimum) of a function, analytical or computed indirectly, of which it is impossible or difficult to obtain the derivatives. Any inequality constraints on the variables or functions of the variables may be included. The evaluation of the function values is performed in a subroutine given by the user. The constraints are introduced in this subroutine and hence may be nonlinear and can be changed during the search procedure. By a coordinate transformation the search is accomplished in the optimal direction. During the convergence to the optimal point this main direction in the vector-space is continuously adjusted by trials in the remaining secondary directions computed to be orthogonal to the main search direction. By this procedure the algorithm is able to follow accurately shape irregular ridges or deep-curved valleys. The speed of convergence is increased by predicting the near-optimal point long a line with a second order extrapolation—or interpolation method. It is possible to treat multidimensional problems involving variables which may present considerable differences in magnitude, this due to an automatic adjustment of the step-sizes along each direction.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 172 source statements
PRICE: $120.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: ARC-10577

CONMIN - A Fortran Program for Constrained Function Minimization

CONMIN is a program, in subroutine form, for the solution of linear or non-linear constrained optimization problems. The basic optimization algorithm is the Method of Feasible Directions. The user must provide a main calling program and an external routine to evaluate the objective and constraint functions and to provide gradient information. If analytic gradients of the objective of constraint functions are not available, this information is calculated by finite difference. While the program is intended primarily for efficient solution of constrained problems, unconstrained function minimization problems may also be solved, and the conjugate direction method of Fletcher and Reeves is used for this purpose. The program can be used without special knowledge of optimization techniques.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Any machine with a FORTRAN IV compiler
PROGRAM SIZE: Approximately 1,948 source statements
PRICE: Program $740.00 Documentation $10.50
PROGRAM NUMBER: ARC-10836

TIDEDA - Time Dependent Data Analyzer

TIDEDA is a computer program for collecting, collating, checking, correcting, and analyzing time dependent data. The program was designed for processing time dependent data in general, and riverflow data in particular. TIDEDA deals with data that is naturally recorded as sequences in time. For example, the daily or seasonal cycles of air temperature. The program has a wide precision range, it is able to establish trends over decades and at the same time resolve events that change from second to second. The TIDEDA program is designed with: (1) binary coded files for computational efficiency; (2) a command language for interactive processing; (3) simply identified elements for easy editing; (4) unequal time steps and rating options to allow non-interpretive filing; (5) automatic interpolation linked to the IBM Continuous System Modelling Program for emulating an analog computer. The program assumes that a series of discrete values are joined by straight lines and so may always be graphed as a curve against time. Thus, air temperature can be represented as a line on graph paper which indicates the temperature level as it varies continuously with time. Typically the data requires a single value which describes temperature, for example, but sometimes requires a number of values like the three components of velocity. The program operates in interactive mode, uses the IBM Continuous System Modelling Program, and Calcomp plotter.
LANGUAGE: FORTRAN (88%); ASSEMBLER (12%)
MACHINE REQUIREMENTS: IBM 370
PROGRAM SIZE: Approximately 9,485 source statements
DISTRIBUTION MEDIA: 9 Track 800 BPI Magnetic Tape
PRICE: Program $900.00 Documentation $27.00
PROGRAM NUMBER: COS-02530

SIGPAC - Significance Arithmetic Experimental Package

SIGPAC is a software system which permits a user of Standard FORTRAN to test actual error propagation in numerical calculations. The process is almost completely mechanistic so that, with little human resequencing required or permitted, a "numerical procedure debugging" tool is made available. SIGPAC consists, in effect, of a compiler from FORTRAN source language into an artificial object language in which arithmetic operations produce, in addition to numerical results, a measure of the current significance of each result operand.

The purpose of SIGPAC is to provide to the scientific and engineering users of the IBM 360 95 computing facility a convenient, effective, and quite general means for testing and indicating the accuracy of computer calculations. This work has two primary goals: (a) To permit the testing and localizing of weaknesses within numerical procedures for abnormal error propagation from generated (primarily truncation) errors; and (b) To provide an objective basis for determining when single precision gives adequate significance or when double precision should be used.

LANGUAGE: FORTRAN IV (72%); ASSEMBLER (28%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 6,820 source statements
PRICE: Program $420.00 Documentation $10.50
PROGRAM NUMBER: GSC-11499

NUMING - Numeric Integration by Gaussian Quadrature

This program package consists of ten subroutines which apply the Guassian quadrature formula to numerical integration techniques. It has been shown that Gaussian quadrature is superior to ordinary Simpson's Rule for a wide class of functions. An increase in computing speed by a factor from 4.7 to 91 times has been shown for Gaussian quadrature routing over similar Simpson's Rule programs. Since the majority of numerical integrations performed at large computing centers treat far less pathological integrands than those for which Simpson's Rule programs were designed, it is advantageous to use the more rapid Gaussian quadratures whenever possible. However, Simpson's Rule programs provide an excellent means of determining an optimum number for a given accuracy with Gaussian quadratures. The program operates in batch mode and the subroutines are written in both single and double precision.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,760 source statements
PRICE: Program $440.00 Documentation $9.00
PROGRAM NUMBER: GSC-11950

PAP - Parametric Analysis Program

PAP provides a systematic approach to Parametric Analysis of systems whose characteristics (dependent variables) are continuous functions of the system parameters (independent variables). It is designed to explore the parameter space of a system using as few system evaluations as possible. This is achieved by: (1) Program design features which reduce the number of approaches to the computer required to obtain a given degree of coverage of the parameter space; (2) Algorithms specifically designed to minimize the number of system evaluations; (3) Extensive use of interpolation and extrapolation; and (4) The provision of a flexible contour plotting capability. The approach taken by PAP is to apply n-2 (n is the number of system parameters) constraints to the parameter space for fixed values of the remaining two parameters. Determine solutions to this nonlinear constraint problem and map the solutions found to the points of a grid determined by the domains of the two parameters previously fixed. This gives rise to a number of functions of two variables defined at discrete points which represent the behavior of the constrained system. PAP provides an interpolation scheme to generate contours of these functions and a flexible plotting capability so that they may be displayed in various combinations.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 2,500 source statements
PRICE: Program $310.00 Documentation $9.00
PROGRAM NUMBER: HQN-10649

Bellcomm's Approximation Library

This is a package of six subroutines designed to calculate the value of various functions. The subroutines and their functions are: (1) BARN—random number generator, (2) CISI—evaluates sine and cosine integrals, (3) ELIP—computes complete and incomplete elliptic integrals, (4) NEWTON—finds the real root of some real-valued functions of a single real variable by the Newton-Raphson method, and (5 & 6) NUMBERS and RMIDPT—these subroutines compute the numerical solutions to a system of simultaneous ordinary differential equations. NUMBERS uses a fourth order variable step size predictor corrector integration. RMIDPT uses an extension of the trapezoidal rule to approximate the integral of a function and incorporate Euler's revised method to enable it to solve differential equation.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 1,309 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program $260.00 Documentation $4.50
PROGRAM NUMBER: HQN-10735

Bellcomm Linear Algebra Library

This library of programs is Bellcomm's Linear Algebra Library. The programs are on magnetic tape and consist of eight separate files. The files have the following functions: File #1—EGNVEC—The complete eigenvalue problem for general real matrices; File #2—GAUSS—Solution of a system of linear equations; File #3—HESH—Program-Hessenberg-Householder Reduction, TRNVEC-Vector transformation; File #4—CHOLESKY—Used Cholesky (or square root method) for computing and inverting matrices; File #5—MAP—Find some or all the frequencies and orthogonal mode shapes of any linear discrete system which is governed by a generalized eigenvalue equation; File #6—QR—Eigenvalues and eigenvectors of symmetric matrices; File #7—SIREIG—Used for the solution of a linear generalized real symmetric positive definite eigenproblem; and File #8—SGEIG—Used for solving the real symmetric algebraic eigenproblem. The documentation for the programs consists of brief write-ups and or abstracts giving the function and uses of the routine(s) within the various files.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108, EXEC-VIII
PROGRAM SIZE: Approximately 10,000 source statements
PRICE: Program $600.00 Documentation $14.50
PROGRAM NUMBER: HQN-10738

LPII - LaGrange Three Point Interpolation Computer Program

This program generates equally incremented interpolated data, using the LaGrange interpolation formula for equal or unequal intervals of data. Input to the program consists of the input data set and the following parameters: number of functions to be interpolated, the first and last arguments to be interpolated, and the output options. The input data set may be on cards or tape; the output data set and the interpolated values may be on tape, cards, and or the printer. Each record of the input data set consists of an argument followed by as many as 19 functions to be interpolated. Three data points are used to calculate each interpolated point. The points to be interpolated are always maintained between the first and second of three data points, except for the extrapolated regions. Extrapolation before the data set may be forced by setting the first argument to be interpolated less than the first argument of the data. Extrapolation beyond the available data may be forced by setting the last argument to be interpolated greater than the last argument of the data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 115 source statements
PRICE: $55.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: KSC-10418

FORTRAN IV Program for Symbolic Solution of Up to 20 Simultaneous Equations

This program is basically a symbolic manipulator which provides a means for obtaining an algebraic

solution to a set of up to 20 simultaneous equations. The algebraic (as opposed to the numeric) solution is useful in understanding the influence of the coefficients on the solution and in determining formulas which can be used in further analyses. In general, the program operates by reading in the linear equations in matrix form as the matrix equation $A_{ij} X_j = B_{ij} Y_j$ where the X's are the dependent variables, the Y's are the independent variables, and the A's and B's are the constant coefficients of the equations. Also read in is the list of X solutions desired since it is not usually required to solve for all X's. The program then operates on the matrices to develop the matrix equation $X_j = B_{ij} Y_j$ during which operation the particular X solutions requested are obtained.

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 7044 DCS
PROGRAM SIZE: Approximately 404 source statements
PRICE: Program $290.00 Documentation $2.50
PROGRAM NUMBER: LEW-10439

MATAR - Conversational Approach to Matrix Calculations

This is a computer program which enables users to do matrix computations without knowledge of computers or programming languages. Potential users can easily learn the command language recognized by the program. The program, called MATAR, interacts with users in a conversational manner. It is now running under a time-sharing system. MATAR provides for simple input output of matrices, matrix arithmetic, and several other operations. These include formations of the transpose, inverse, determinant, and eigenvalues and exponentiation. The program can issue specific complaints about input it cannot process. For example, if the user tries to use a matrix not previously defined, the program tells him that the matrix is unknown and therefore that particular calculation must be cancelled. The user can promptly see and rectify his errors.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,338 source statements
PRICE: Program $440.00 Documentation $3.50
PROGRAM NUMBER: LEW-10830

Computer Program for Spline Fit Curves

The spline fit curve is a convenient method for fitting a curve through a given set of points. This program will calculate the spline fit curve, with function values, first and second derivatives, and curvature at any desired interpolated points. If a set of function values corresponding to a set of arguments is given, there are several ways a curve can be fitted through these values so as to approximate the original function with these values. The classical way is by an nth degree polynomial for n+1 points. However, this may not be satisfactory for a large number of points. Other methods include Least Squares and the Four-Point Lagrangian interpolation. But these methods have short comings over come by the spline fit or piecewise cubic fit method. The spline fit curve gives a simple method of determining an approximating analytical curve which can be used in place of the original curve for interpolation, determining first and second derivatives, curvature, or integration.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 85 source statements
PRICE: $80.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: LEW-10317

RAPIER - FORTRAN IV Program for Multiple Linear Regression Analysis Providing Internally Evaluated Remodeling

RAPIER is a very flexible, easy to use, sophisticated multiple linear regression program; its major asset is its comprehensiveness of calculations and options. With the aid of a few control cards, the program can be used readily for a wide range of applications which can vary from a simple least-squares curve-fitting problem to a complete regression analysis. It can provide the variance-covariance matrix of independent variables, regression coefficients, individual t-statistics with their significance levels, analysis of variance tables for significance of regression, special useage of replicated data to estimate the error due to lack-of-fit, any one of three pooling procedures which may be used to estimate the error variance, tests for normality of distribution of the residuals, weighted regression, and the use of more than one dependent variable. The mathematical analysis of the computations and their reliability is aided further by the option of obtaining an eigenvector decomposition of both the variance-covariance matrix and the correlation matrix of the independent variables. The program also provides an option to perform a backward rejection regression at any given level of significance. Despite its sophistication, RAPIER is relatively easy to use, but it presupposes that the user has at least a basic knowledge and or experience in the application of statistical techniques.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 II 7044 DCS under IBSXS Version 13 using ALTIO
PROGRAM SIZE: Approximately 2,217 source statements
PRICE: Program $370.00 Documentation $10.50
PROGRAM NUMBER: LEW-11062

GIPTRAN - General Input Probability Translator

The program package entitled GIPTRAN is actually two programs, (GIPTRAN and STORM) which provide mathematical routines for statistical analysis in one computer run. The GIPTRAN program generates a FORTRAN deck from a higher level language (called GIPTRAN). The data is then treated by STORM to give frequency distribution; probability distribution; cumulative probability distribution; sample size; mean value; standard deviation; sample range; goodness-of-fit tests; arithmetic combinations of probability dis-

tributions; and tolerance intervals. The GIPTRAN language is documented in the program package but a knowledge of FORTRAN is a prerequisite to understanding this language. STORM (Statistical Operations on Random Measurements) computes statistics and probabilities (mentioned above) of n independent continuous random variables. The programs are applicable only when the size of each input sample is large; the accuracy of the results is seriously eroded when any of the input bodies of data has less than 100 observations. A maximum of 3000 sample measurements for any one random variable may be input. The package is designed to be used as a probabilistic approach to the solution of engineering problems. It was developed to compute statistical parameters (random variables) which are simple functions of many other input parameters (also random variables). The most important feature of STORM is the ability to combine independent continuous random variables in basic arithmetic operations. The program can solve $f=|(a \cdot b)\ c|-d$ where a, b, c and d are independent, continuous random variables and f is continuous random variable dependent upon a, b, c and d. It accomplishes this by classifying input data into intervals and then computing probabilities corresponding to the interval midpoints.

LANGUAGE: FORTRAN (98%); COMPASS (2%)
MACHINE REQUIREMENTS: CDC 6000 Series (with FORTRAN RUN compiler)
PROGRAM SIZE: Approximately 3,860 source statements
PRICE: Program $820.00 Documentation $17.00
PROGRAM NUMBER: LEW-11452

FITLOS—FORTRAN Program for Fitting Low-Order Polynomial Splines by the Method of Least Squares

FITLOS is a computer program which implements a new curvefitting technique. This technique consists of (1) dividing the set of data points into subsets, (2) fitting a polynomial of degree two or three to each subset, and (3) smoothing the total curve by assuring that the first derivatives in the case of second degree polynomials, or the first and second derivatives in the case of third degree polynomials, are equal at the break points of each segment of the curve. These continuity constraints are imposed by use of Lagrangian multipliers. This method can be useful in cases (1) where the data contains random errors such that the application of any known methods of interpolation would lead to undesirable errors, (2) where the use of polynomials of sufficiently high degree, to provide formally small errors, would result in computation difficulty because of the occurrence of large coefficients of opposite signs, and (3) where a reasonable initial value guess is desired for some iterative computation. The main program, FITLOS, reads the input data, calls the appropriate subroutines for the curve-fitting, calculates a statistical analysis, and writes the output data. The modular structure of this program allows a potential user to incorporate this procedure into another computer program since the curve-fitting requires only three subroutines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 7044 DCS
PROGRAM SIZE: Approximately 1,765 source statements
PRICE: Program $480.00 Documentation $11.50
PROGRAM NUMBER: LEW-11651

NEWRAP - An Improved Multiple Linear Regression and Data Analysis Computer Program

A digital computer program (NEWRAP) has been developed which can be used with ease to perform extensive regression analyses or a simple least-squares curve fit. The major value of the program is the comprehensiveness of its calculations and options. NEWRAP computes the variance-covariance matrix of the independent variables, regression coefficients, t-statistics for individual tests, and analysis of variance tables for overall testing of regression. There is a provision for a choice of three strategies for the variance estimate to be used in computing t-statistics. Also, more than one set of responses of dependent variables can be analyzed for the same set of independent variables. A backward rejection option method based on the first dependent variable may be used to delete nonsignificant terms from the model. In this case, a critical significance level is supplied as input. The least significant independent variable is deleted and the regression recomputed. This process is repeated until all remaining variables have significantly non-zero coefficients. The NEWRAP program uses the triangular form of symmetric matrices throughout. It allows also for the use of weighted regression, computation of predicted values at any combination of independent variables, a table of residuals, and plots of residuals. By use of CRESPIT, a separate program, a preregression analysis may be performed which may aid in the choice of model to use the NEWRAP. This program accepts the same raw data in the same format and computes the variance-covariance matrix and correlation matrix of all the variables and an eigenvector decomposition of the variance-covariance matrix corresponding to the independent variables. Microfilm plots are then printed of specified pairs of variables. Punched output of residuals and predicted values from NEWRAP can also be used for more complicated residual plots than the direct use of the plotting option NEWRAP permits. When a quadratic response function has been estimated (as for example in optimum-seeking experimentation) CREDUC, another separate program, may be used to obtain all information necessary for a canonical analysis of the function. The three programs together provide a useful data analysis package that can be applied to a large variety of common research and development situations.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 7044
PROGRAM SIZE: Approximately 2,726 source statements
PRICE: Program $460.00 Documentation $11.00
PROGRAM NUMBER: LEW-11842

AMINT - Adams Moulton Integration Subroutine

This subroutine will numerically integrate a set of n simultaneous first order ordinary differential equa-

tions, by either the Adams-Moulton method of the fourth order Runge-Kutta method. It has been checked against several known solutions, and in all cases the errors were approximately equal to their expected values. There were no indications that round-off errors accumulate rapidly. This subroutine offers the user an option of using one of the following methods to solve first-order differential equations: 1. A fourth-order Runge-Kutta method with a fixed step size, 2. Adams-Moulton method with a variable step size, and 3. Adams-Moulton method with a fixed step size.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 154 source statements
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-00465

Cutlier Technique Program

This program identifies questionable values in an array of numbers. The program is based on a method which is called the "Full Normal Plot". A description follows: (1) let $a_{i,n}$ be a typical value for the ith ordered observation in a sample of size n from a unit normal distribution. The choice $a_{i,n} = \mathrm{GUA}^{-1}\left(\frac{3i-1}{3n+1}\right)$ where $P = \mathrm{GUA}(y)$ is the cumulative normal, is an adequate approximation to what is claimed to be optimum and is easy to compute. (2) Order the sample of size n to be examined such that $y_1 \leq y_2 \leq \ldots \leq y_n$. Let y' be the median of the y's. (3) For the top third and the bottom third of the ordered array, compute the quantity $Z_i = (y_i - y')\, a_{i,n}$. The i's with $(1/3)n \leq i \leq (1\ 3)(2n)$ are from the formation of Z_i's both because the small values of $a_{i,n}$ promote instability and because Z_i's for such i's seem unrevealing. (4) Approximately (1 3) (2n) of the Z values have been computed. Calculate the median, Z', of the Z's. (5) Special attention should be given to Z values for which both $(y_i - y') > AZ'$ and $Z_i > BZ'$ where A and B are prechosen constant values. (6) If some or several Z_i values are selected from the above, the Zj's with j more extreme than a selected i also deserve special attention. This is particularly true if the n is small.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 139 source statements
PRICE: $45.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-01128

Calculation of Eigenvalues and Eigenvectors of Arbitrary Matrices

This program uses a modification of the Greenstadt method to calculate the eigenvalues and eigenvectors of an arbitrary complex material. Basically, the matrix is reduced to upper triangular form. Elements in the lower triangle (called the pivot elements) are driven to zero through the application of a sequence of unitary transformations. The sequence of operations upon the set of pivot elements is called a pass. The algorithm continues until a specified maximum number of passes has been made or until the average modulus of the set of pivot elements has been reduced to a particular value. The maximum order of the input matrix is 40. The triangularized matrix (labeled "Eigenvalue Matrix") is output in two parts, the real part and the imaginary part. The eigenvalues appear on the main diagonal, real part and imaginary part. The vector matrix of the triangularized system (in similar format) follows. Finally, the eigenvector matrix of the original system is output.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 298 source statements
PRICE: Program $140.00 Documentation $4.00
PROGRAM NUMBER: MFS-02358

Point Transformation-Orthographic to Perspective, FORTRAN H Version for 360 System Use

This is a general purpose subroutine to transform orthographic points to perspective points, and present a perspective picture of an object described by orthographic dimensions. Transformation is performed by means of algebraic formulas. In addition to the coordinates to be transformed, the user specifies in the call statement the viewing angle from which the view is to be taken, the distance from which the view is to be taken, the height from which the view is to be taken, and the projection length for the perspective points.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 54 source statements
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-02486

Solution of Large Sets of Simultaneous Linear Equations with Banded Symmetric Matrices

A digital computer program has been written to solve large systems of simultaneous, linear equations having banded, symmetric matrices. The problems that are considered by the program are limited to those which have a bandwidth that is less than the number of equations. The core storage needed by the program is independent of the number of equations, and hence, the program is not limited directly by the order of the matrix. Flexibility in applying the program is realized by variably dimensioned arrays and by user selection of auxiliary storage devices. As many as 10,000 equations have been solved in twelve minutes with this program. Results accurate to nine significant figures were obtained. Subroutines, callable from a FORTRAN program, to read a FORTRAN-produced tape backwards are a feature of the program that could be used elsewhere to reduce execution time.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360 65
PROGRAM SIZE: Approximately 558 source statements
PRICE: Program $160.00 Documentation $3.00
PROGRAM NUMBER: MFS-12947

RKADAM - Subroutine to Solve Differential Equations

Subroutine RKADAM gives a stepwise solution to a system of N first order differential equations of the form, $y_i' = f_i(x;y_1,y_2,\ldots,y_n)$, i=1 to N. The user has the option of selecting one of the following methods to perform the integration: (a) Single step 4th order Runge-Kutta method with fixed increment; (b) Adams method with third differences and fixed increments; and (c) Adams-Moulton method with third differences and variable increments.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 225 source statements
PRICE: $90.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-12981

DENORD - Solution of Differential Equations Using the Nordsieck Method

This subroutine solves an Nth order system of first order ordinary differential equations using the method described in the following: "On Numerical Integration of Ordinary Differential Equations", Arnold Nordsieck, **Mathematics of Computation** 16 (1962), pp. 22-49. This method, which is stable under all circumstances, incorporates automatic starting with automatic choice and revision of integration step size. In addition, the amount of computation for a specified accuracy is approximately minimized. All arithmetic calculations are performed in double precision. This technique may be applied to any system of differential equations with derivatives which are either continuous or piecewise continuous with finite jumps.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 204 source statements
PRICE: $90.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-13122

FORIER - Subroutines for Lens Design Program

This subroutine computes the coefficients a_i and b_i of the real Fourier series for a given tabulated real function f. The series is then evaluated for real arguments. The method of calculation, based on a real Fourier analysis, is described in two textbooks referenced in the program documentation. All arithmetic calculations are performed in double precision, and the calling sequence requires double precision arguments. The function to be approximated is assumed to be periodic with respect to the given interval, and the given set of functional values is assumed to be equally spaced with respect to the given interval. It is assumed that the initial functional value is located at the left-most point of the interval.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 123 source statements
PRICE: $90.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-18565

Method for Nonlinear Exponential Regression Analysis

The investigation of physical processes frequently require the use of models that simulate or describe the processes. A model is often chosen so that certain variables interact in the model according to physical theories associated with the particular process. A model equation contains identified independent variables and unknown parameters. Regression analysis is the statistical tool used to determine the unknown parameters which provide an analytical representation of the experimental data. The general procedure in regression analysis is to take partial derivatives of a specific model-dependent minimizing function. These partial derivatives are taken with respect to each of the unknown model parameters. If the set of equations obtained by setting these partial derivatives equal to zero can be solved by the usual algebraic methods, the fitting or analytical representation is accomplished. However, if these equations are transcendental in one or more of the unknown parameters, they cannot be solved by the usual algebraic methods. The processes of particular interest in this program are those that can be described by decaying exponential forms. A mathematical model that contains more than one exponential term results in a set of transcendental normal equations if conventional forms of regression analysis are used. Thus, one usually resorts to iterative methods that require initial estimates for the parameters. The method used in this program is the least squares procedure, whereby, the nonlinear problem is linearized by expanding in a Taylor series. In the iterative method, one develops a starting nominal guess for the model parameters. A correction matrix is derived and then applied to the nominal guess to produce an improved set of model parameters. This procedure is continued until some predetermined criterion is satisfied. The number of iterations necessary for convergence is closely related to this criterion, the initial estimates, and the form of exponential model. Two general types of exponential model programs were developed to implement the theory for exponential regression analysis. One concerns a single exponential and the sum of exponentials without a constant, and the other concerns the sum of exponentials with a constant included. Each program contains double-precision capability and the SC-4020 plotting procedures.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020 Plotter

PROGRAM SIZE: Approximately 2,159 source statements
PRICE: Program $510.00 Documentation $10.00
PROGRAM NUMBER: MFS-21855

Selection of Approximating Functions for Tabulated Numerical Data

This computer program selects, from a list of candidate functions, the approximating functions and associated coefficients which result in the "best curve fit" of a given set of numerical data. The approach used in the development of this program yields several advantages over other "best fit" programs. Some advantages offered by this approach are that multivariable approximations can be performed and there is a degree of flexibility with respect to the type of approximation used. The program is designed to choose the "best" terms to be used in the approximation from an arbitrary list of possible terms so that little knowledge of the proper approximating form is required. Elementary matrix operations and vector methods are the techniques used to determine the recursion relations which are used in determining the coefficients of approximating functions. This reduces the computer execution time of the program. This program is missing three minor subroutines that must be supplied by the purchaser, if a computer plot is needed.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 760 source statements
PRICE: Program $340.00 Documentation $17.50
PROGRAM NUMBER: MFS-22136

A Computer Program for Standard Statistical Distributions

A computer program that will provide efficient procedures for determining theoretical statistical models for empirical data is presented as three options, A, B, and C. Option A, a theoretical approach, is the Pearson System of frequency distributions developed by Karl Pearson. Option A also provides sample statistics including central and non-central moments, appropriate variances and standard errors of theoretical parameters, and the cumulative probability function. Options B and C of the program provide a straightforward empirical approach to the problem. Known standard statistical distributions are presented as prospective models for the sample input. Option B includes continuous distributions, and option C includes discrete models. Statistical tests for "goodness of fit" are included for making objective decisions in regard to rejection or non-rejection of hypothetical models selected.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360, UNIVAC 1100 series
PROGRAM SIZE: Approximately 846 source statements
PRICE: Program $410.00 Documentation $11.50
PROGRAM NUMBER: MFS-22894 (IBM Vers.), MFS-21456 (UNIVAC Vers.)

TEMPO - Technique For Evaluating Multiple Probability Occurrences

This program was written to automate a statistical process by which subjective responses in the form of paired comparisons are quantitatively evaluated to produce relative probabilities. The program is useful in any analysis which requires a ranking to be established for a set of elements for which there is little available data. The program has been extensively used in prediction and apportionment for the S-II Stage of the Saturn Rocket. To illustrate the use of this program, suppose three systems must be ranked as to their relative probability of success and that previous data is not available on these systems since they are in the preliminary design phase. To get the best possible ranking of these systems, rating matrices are prepared according to prescribed instructions. The program then averages all the rating matrix entries and every entry is transformed into a Normalized Preference Matrix. This transformation makes all of the entries positive and less than one, hence they can be associated with a probability distribution.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360 65
PROGRAM SIZE: Approximately 250 source statements
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-24100

Polynomial Matrix Equation Solver

Given the matrices A and C whose elements are polynomials or order 2 or less, A being N by N and C being N by M, this program obtains the inverse of A in terms of A- adjoint and the determinant, P. It then obtains the solution matrix, X, of the matrix equation $Ax=C$. If desired, it obtains any specified linear combination of the elements of X. In addition, all roots of the polynomials which are the determinant and the numerators of selected elements of X are printed out in a manner to highlight frequency and damping factors. For matrix inversion, Leverrier's method is used. In this inversion, software-extended precision equivalent to about 31 decimals is used, afforded by the Q-Precision System supplied by C. L. Lawson of JPL. Eleswhere, hardware double-precision is used freely. This mixture is adequate to avoid confusing spurious roots which are without physical significance. N is limited to 14 or less. Unless N is 12 or less, M is limited to 1. This program can be used in control problems where the Laplace transform is applied to a set of simultaneous algebraic equations with polynomials as coefficients. The solution of this system will yield the system transfer functions as elements of the inverse matrix, and also the Laplace transform of the system response to a given forcing function. The same mathematical structure is found in other applications such as the analysis and synthesis of networks; feedback circuits, and design of digital band pass filters.

LANGUAGE: FORTRAN V (95%); SLEUTH (9%)
MACHINE REQUIREMENTS: UNIVAC-1108

PROGRAM SIZE: Approximately 1,828 source statements
PRICE: Program $260.00 Documentation $9.00
PROGRAM NUMBER: MSC-14094

UHELP - University of Houston Easy Linear Programming System

There are a number of linear programming routines available to the computer user. However, to use these standard routines effectively, the user must have a basic knowledge of computer programming and computer vocabulary. The formats in which data has to be punched for some of these routines are quite complex. Moreover, the output can be rather confusing to the occasional user. Some of the routines available are coded in more than one language, which presents a problem in implementation. Alteration of these existing routines is practically impossible even for an experienced programmer. To overcome these difficulties an interpretive type of language is presented with the acronym UHELP (University of Houston Easy Linear Programming). The language enables the user to input his data in the same form as he would write his linear programming problem on paper. The interpreter is coded in FORTRAN IV and hence can easily be converted to almost any computer system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 1,267 source statements
PRICE: Program $200.00 Documentation $6.00
PROGRAM NUMBER: MSC-14147

Algorithm for Matrix Bandwidth Reduction

For a great many structural problems, particularly using the finite element method, the mathematical model that must be solved is a set of linear simultaneous equations. Among the fastest methods for solving this class of mathematical problems are the elimination techniques which involve two main steps: (1) decomposition and (2) backsubstitution. The amount of time required to perform the technique is a function of the size and the bandwidth of the coefficient matrix. For a matrix of a given size, the time required to solve the system is directly proportional to the square of the bandwidth. Bandwidth is defined as the maximum size (in terms of column indices) between the main diagonal and any non-zero element in that row. A computer program was developed to solve a system of simultaneous linear equations by the bandwidth reduction method. Bandwidth reduction is needed in order to reduce the time and cost of computing answers for systems of equations. For example, a reduction in bandwidth of 50% represents a reduction in solution time of 75%. The method used for the present program is a simple and straightforward procedure which systematically moves rows closer together that are far apart and coupled. A comparison of this bandwidth reduction method with existing algorithms is presented in the documentation. Also results obtained by using this method on ten different topologies are given.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 138 source statements
PRICE: $85.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17550

Addition Convolution Computer Program for Cost Risk Analysis

In cost risk studies probability density functions are determined judgmentally by subsystem engineers and cost analysts working together. These functions express probability of cost for subsystem elements. The subsystem functions then have to be combined to determine a total system cost probability function. In many cases the addition convolution theorem is applicable, which allows the determination of density functions for sums of random variables through evaluation of a convolution integral. The present computer program performs this integration numerically, two functions at a time successively, from input density functions defined by sets of coordinate pairs. The program was written to provide a simpler, faster, and less expensive working tool for risk studies than the programs which use Beta functions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 52 source statements
PRICE: $95.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19078

Routines for 3-D Vector Computations

Frequently used 3-dimensional vector operations have been programmed, to serve as a mathematical convenience by providing a coordinated set of routines normally used in various sequential order. The solution of 3 dimensional geometric problems which have been mainly solved graphically in the past can now be programmed for computers.

LANGUAGE: N A
MACHINE REQUIREMENTS: Hewlett-Packard 9100A
PROGRAM SIZE: Not Applicable
PRICE: $55.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separate from the program listing.
PROGRAM NUMBER: MSC-19289

Statistical Table Value Estimation (t and Chi Square)

This package of desk-top computer procedures estimates values (probabilities and percentage points) for two frequently used statistical tables, t and X^2 distributions, using the standardized normal distribution table.

LANGUAGE: Instructions and data are entered at the time of processing.

MACHINE REQUIREMENTS: Compucorp 145E
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19475

VERGE - Computer Subroutine to Accelerate the Convergence of Iterative Processes

VERGE is a general-purpose FORTRAN IV routine which is designed to accelerate the convergence of iterative processes and can be used to solve the many equations encountered in the numerical solution of engineering problems which do not permit explicit solutions for certain variables. Iteration is often the only effective means of solving non-linear algebraic and transcendental equations. Therefore, the general class of problems which is of interest is that which may be written in the form x=f(x). The routine is based on the convergence algorithm of Wegstein. The method accelerates the rate of convergence if the iteration converges, and it induces convergence if the basic iteration process tends to diverge. The convergence is quadratic which means that asymptomatically the number of correct decimal places is doubled at each step. The method is analogous to the graphical procedure of finding the intersection of curves y=x and y=f(x), except that the process is automated. Iteration is started with a guess, from which the subroutine derives an improved estimate, and the process continues until the difference between successive estimates, and the process continues until the difference between successive estimates is arbitrarily small. In addition, underflow protection is provided so a search for roots close to the origin will not violate machine limits.

LANGUAGE: CDC FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 70 source statements
PRICE: $95.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: NPO-10614

SPLINT - Parabolic Spline Interpolation Subroutine

The SPLINT program performs interpolation and differentiation using the parabolic spline. This spline fit, while not as accurate as the cubic or higher order splines, can be generated by a closed-form expression. The method is analytically equivalent to taking four consecutive tabular points and fitting a parabola through the first three points and a parabola through the last three. The parabolic spline between the two middle points of the set is determined by linearly interpolating between the two parabolas. Continuity of the first derivative of the fitted curve is preserved. A new search scheme was devised to permit the use of tabular data where the independent variable is either monotonically increasing or decreasing. This feature allows the subroutine to handle inverse interpolation directly, with the restriction that Y=F (x) and the inverse operation X=G (y) are both single valued. Also, in the interest of generality, a special indexing scheme is used to facilitate multidimensional interpolation. Endpoints and extrapolations are handled by letting the first three tabular points, or the last three, determine a parabola which defines the fit at the extremities of the table.

LANGUAGE: CDC FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 249 source statements
PRICE: $55.00
NOTE: The price includes the documentation and the program listing only. The documentation is not sold separately from the program.
PROGRAM NUMBER: NPO-10786

Random Number Generator

This package consists of six routines which perform random number generations from various types of populations. UNIFRM generates floating point numbers from a uniformly distributed population with a sample space defined by the open interval (0, 1). The routine uses a multiplicative, congruential pseudo-random number generator. GAUSS, on the other hand, uses Bell's algorithm which is a modification of the method of Box and Muller to generate floating point numbers from a normally distributed population with a zero mean and unit variance. NPOISN uses Snow's algorithm to generate integers from a population which has a Poisson distribution. The algorithm of Ralston and Wilf is used by EXPONT to generate floating point numbers from a population which satisfied an exponential distribution on the interval (0,). If the population has a Rayleigh distribution, RAYLEI is used to generate floating point numbers. Finally, GVEC generates random vectors from a multivariate normal population with specified mean vector and variance-covariance matrix.

LANGUAGE: FORTRAN V (91.7%); SLEUTH (8.3%)
MACHINE REQUIREMENTS: UNIVAC 1108, EXEC VIII
PROGRAM SIZE: Approximately 451 source statements
PRICE: $75.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: NPO-11528

RFT1 - One-Dimensional Real Fourier Transform

This subroutine computes one-dimensional Fourier transforms for real data using the Cooley-Tukey Fast Fourier Transform (FFT). Applications include: (1) Finite Fourier analysis, (2) The calculation of Fourier transforms, (3) Calculating convolutions and lagged products (e.g. digital filtering), (4) The calculation of power spectra, and (5) The inversion of Laplace transforms.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 456 source statements
PRICE: Program $340.00 Documentation $6.50
PROGRAM NUMBER: NPO-11649

CFT - Multi-Dimensional Complex Fourier Transform

This subroutine computes multi-dimensional complex Fourier transforms in up to six dimensions using the Cooley-Tukey Fast Fourier Transform (FFT). Applications of this program include: (1) Finite Fourier analysis, (2) The calculation of Fourier transforms, (3) Calculating convolutions and lagged products (e.g. digital filtering), (4) The calculation of power spectra, and (5) The inversion of Laplace transforms.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 416 source statements
PRICE: Program $340.00 Documentation $5.50
PROGRAM NUMBER: NPO-11651

ROMBS - Modified Single Precision Romberg Quadrature Subroutine

This program package consists of two subroutines for evaluation of a single integral and a group of three subroutines for the evaluation of multiple integrals. ROMBD and ROMBS are double and single precision subroutines respectively for numerical quadrature, using a modified Romberg procedure with a variable step size. This package also contains subroutines RMB1, RMB2, and RMB3 for the evaluation of multiple integrals. ROMBS is used as the basic integration technique. These routines represent a "state of the art" in their field. They have been thoroughly tested and found to be equal or better than any comparable routines. The programs have been compared to SQUANK of J. Lyness (see ACM Journal, Volume 16, July, 1969, "Notes on the Adaptive Simpson Quadrature Routine") and found to be more reliable and better able to solve a larger class of problems. Although these routines are designed to serve as a library "standard" to evaluate most definite integrals, it is necessary to realize that with singularities and certain discontinuities in the integrand, Gaussian quadrature or other methods may be more appropriate.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 1,213 source statements
PRICE: Program $260.00 Documentation $10.50
PROGRAM NUMBER: NPO-11718

STURM - Eigenvalue Routine by Sturm Sequence Method

This computer program has been generated for the efficient solution of certain broad classes of eigenvalue problems. Extensive applications of the procedure are envisaged in the analysis of many engineering problems such as natural frequency and stability analysis of practical structures discretized by the finite element technique. The procedure used in this program fully exploits the banded nature of the associated matrices and further enables the user to compute either all the roots or any specific ones as desired. Thus once the range of values for the roots are specified, the routine computes the first required NR roots lying within the range. The routine also computes repeated roots as well as the eigenvectors. Storage requirements are modest, since only one working store of moderate dimension is needed for the solution. Further special storage options enable storing mostly nonzero elements only of the associated main matrix of the eigenvalue problem.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 867 source statements
PRICE: Program $430.00 Documentation $2.50
PROGRAM NUMBER: NPO-11805

Reliability Computation from Reliability Block Diagrams

This program package consists of a probability calculation program used to calculate the probability of system success from an arbitrary reliability block diagram. The class of reliability block diagrams that can be handled include any active standby combination of redundancy, and the computations include the effects of dormancy and switching in any standby redundancy. The program is based on an algorithm which extends probability tree usefulness to standby systems. Four factors to be considered in calculations of this type are active block redundancy, standby block redundancy, partial redundancy and the presence of equivalent blocks in the diagram. The probability of successful operation for a system involving active redundancy is found using the probability tree method. The principle that is used in computing standby redundancy is simple but difficulty occurs in applying the principle to complex circuits; methods and equations are presented in the program documentation. Partial redundancy is handled by manually setting up the problem in terms of equivalent blocks. Equivalent blocks occur when the same piece of physical hardware appears more than once in the reliability block diagram. When this happens, the program assumes that if the block worked in one occurrence, it will work in the other and vice versa. To accommodate storage capacity (on the UNIVAC 1108), the following program limitations exist: (1) maximum of 50 blocks to a block diagram, (2) maximum of 200 success paths, (3) there can only be one output block, and (4) maximum of 14 inputs and 14 outputs per block (The first three restrictions can be overcome by grouping blocks and or success paths; by routing output blocks through one final success block). The program is written to be used on a UNIVAC 1108 time-sharing system with 65K core storage and a UNIVAC 1108 FORTRAN V compiler. The program can be run in either batch or interactive mode.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series EXEC 8
PROGRAM SIZE: Approximately 4,756 source statements
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR Formatted Tape
PRICE: Program $950.00 Documentation $6.50
PROGRAM NUMBER: NPO-13304

SPIN - Spining Structures Eigenproblem Solver

This computer program may be conveniently utilized for the accurate solution of a wide range of practical eigenvalue problems. Important applications of the present work are envisaged in the natural frequency analysis of spinning structures discretized by the finite element technique, and in the determination of transfer functions associated with the dynamic blocks of control systems of spacecraft utilizing gas jets or reaction wheels for attitude control, as well as of spin-stabilized and dual-spin-stabilized satellites. The validity of the Sturm sequence property is first established for the related matrix formulation involving Hermitian and real symmetric, positive-definite matrices, both being usually of highly banded configuration. A numerically stable algorithm based on the Sturm sequence method is then developed which fully exploits the banded form of the associated matrices. The related computer program proved to be extremely fast and economical in comparison to other existing methods of such analysis.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 695 source statements
PRICE: Program $430.00 Documentation $2.50
PROGRAM NUMBER: NPO-13244

STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue studies for structures and components; stress (including thermal) calculation and analysis of structures; analysis of vibration and damping in structures; analysis of shell structures including stresses, loads, buckling and vibration.

MASFLAY - Finite Element Mesh Generation Program

This program was written to perform finite element data preparation. It is to be used as an auxiliary program for finite element analysis and it prepares the input data on cards for programs which utilize the generated and controlled mesh. The mesh is generated for plane figures (two-dimensional or axisymmetric bodies) which are to be subdivided into quadrilateral and triangular elements for finite element analyses (structural, heat transfer, etc). The program has four steps of operation: (1) Missing data generation—(a) Generation of nodal point numbers, coordinates, and temperatures, and (b) Generation of element numbers, connectivities and material numbers. (2) Input data control—The program controls both the nodal point and the element numbers sequence. Calculation of the maximum difference in nodal point numbers belonging to an element is performed and printed. This information is often required to limit the stiffness matrix bandwidth in finite element analyses. (3) Control plot of mesh—The plots are provided using the line printer. (a) The nodal number is printed in correspondence of nodal coordinates in selectable scales, and (b) The element number at the element centroid is printed out in a plot with the same scales as that used in the node position plot. (4) Data cards are punched—Data cards are punched according to FORMATS chosen by the user if the option for punched data cards is chosen.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 360 source statements
PRICE: Program $260.00 Documentation $3.50
PROGRAM NUMBER: COS-02350

Isometric Piping System Drawing and Material Takeoff Program

The Isometric Piping Drawing System was designed to allow the engineer to have a fully dimensional isometric drawing produced for him. The system is comprised of five main parts. (1) Isometric Piping Drawing—This produces an isometric drawing of the piping system viewed from any positive Y quadrant. It also produces a printed report describing all input data to the drawing system. (2) Isometric Symbol Drawing—This inserts pipe fitting symbols onto the piping drawing. (3) Material Report—Produces a plotted report listing index, description, length and stockcode number for each item in the system. (4) Instrument Point Report—Produces a plotted report which lists index, instrument number, description, stockcode number, and angular location pressure instrument branch connections, sample connections and temperature instrument thermowells, in the system. (5) Drawing Dimensions—Dimensions the piping system with extension lines. It takes into account the problems of readability and dimension placement optimization. There are several favorable input features incorporated in this system. Each line of piping may be comprised of a number of elementary sections of pipe, which may either be straight lines or circular arcs, pipe fitting symbols may be inserted between any two consecutive points in the system. Instrument points may be inserted at any point in the system, and the physical properties of the piping material may change at any input data point in the system. The input for the computer program are data points necessary to define the piping system. The necessary inputs are: (1) Beginning points for a pipe line or segment, (2) Terminal points for a pipe line or segment, (3) Points of intersection of the tangents of the end of each circular bend in the pipe line, (4) Points at which the line changes direction without a circular bend, (5) Points at which a piping symbol is located, (6) Points at which pipe supports are located, (7) Points at which instrument point information is required. When a drawing run is completed, information consisting of input data, calculated values, and error messages are printed. The drawing is produced on a magnetic tape to be plotted by a Calcomp plotter.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: Univac 1108
PROGRAM SIZE: Approximately 8,230 source statements
PRICE: Program $970.00 Documentation $32.00
PROGRAM NUMBER: COS-02410

BANDIT - Structural Matrix Bandwidth Reduction Computer Program

BANDIT is a data preprocessor for use with the NASTRAN structural analysis computer program which automatically resequences the grid point numbers associated with structural matrices in order to reduce the band width of these matrices, i.e., produce a clustering about the main diagonal of the non-zero elements in the matrices with a resultant improvement in computational efficiency for NASTRAN. Although the structural matrices assembled by NASTRAN as a finite element based system are typically sparse and while many of the routines used by NASTRAN for the solution of linear equations and extraction of eigenvalues are designed to operate most efficiently when the bandwidths of the structural matrices are minimum, NASTRAN currently places the burden on the user to number the structure so as to provide such a bandwidth. The inherent difficulties in sequencing nodal labels manually can make this a burdensome task for the analyst. The current public release of BANDIT, Version 5.2., automatically resequences grid points using two different enumerative strategies, the Cuthill and McKee (CM) method and the Gibbs, Poole, and Stockmeyer (GPS) method. By default both strategies are invoked with the resequencing method selected being that which produces the minimal bandwidth. Alternatively, the user may specify that only one resequencing strategy to be used. Instead of bandwidth, the user may optionally select to reduce matrix profile, matrix wavefront, or row wavefront variance. BANDIT Version 5.2 is compatible with NASTRAN release levels 15.9 and below and recognizes the finite elements available in NASA NASTRAN Level 15.9, MSC NASTRAN and NAVY NASTRAN.

LANGUAGE: FORTRAN (5% ASSEMBLER CDC Version)
MACHINE REQUIREMENTS: CDC 6000 Series, IBM 360 370 Series, UNIVAC 1100 Series, Honeywell 6000 Series
PROGRAM SIZE: Approximately 3,800 source statements
PRICE: Program $460.00 Documentation $7.00
PROGRAM NUMBER: DOD-00033 (CDC), DOD-00034 (IBM), DOD-00035 (UNIVAC), DOD-00054 (Honeywell)

MEC21 - Pipe Flexibility Analysis Program

This is a program using tensor analysis methods to analyze the flexibility of multiple branch and closed-loop piping systems subject to thermal, uniform, and concentrated loadings, and is also applicable on cryogenic piping systems. All computations are performed in accordance with the requirements of ASA B31. 1-1955 American Standard Code for Pressure Piping. As an incidental feature, the program is also able to solve certain structural problems. The maximum problem size is 99 branches, 99 branch-intersection-points, and or 999 data points. Each data point may describe one to three elements. Machine time varies between 0.02 and 0.05 minute per element, depending on the complexity of the system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series, UNIVAC 1100 Series
PROGRAM SIZE: Approximately 5,220 source statements
PRICE: Program $630.00 Documentation $25.50
PROGRAM NUMBER: DOD-00024 (IBM Vers.), DOD-00025 (UNIVAC Vers.), DOD-00026 (CDC Vers.)

MEL40 - Piping Flexibility Analysis Program

MEL-40 is a computer program using tensor analysis methods to analyze the flexibility of multiple branch and closed-loop piping systems subject to pressure variations, temperature variations, anchor movements, weight, and or other prescribed loading conditions. All computations may be performed in accordance with the requirements of USA Standard Code for Pressure Piping. As an incidental feature, the program is also able to solve certain structural problems.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360 370 Series
PROGRAM SIZE: Approximately 5,273 source statements
PRICE: Program $340.00 Documentation $26.50
PROGRAM NUMBER: DOD-00027

SHCP - Ship Hull Characteristics Program

These are a series of programs that calculate ship areas, volumes, and centers. They operate on a data base which is applicable to almost any ship hull form. The programs have been sufficiently checked and tested to give reasonable assurance of valid answers. SHCP is composed of modular routines, each operating at one of three basic levels. **Level 1**—A miniscule executive (or monitor) routine which reads an identification card and a list of the work to be done, then supervises the performance of this work. **Level 2**—Output programs which read their own sets of data, perform their distinct types of calculations with the aid of Level 3 routines, print out their answers and return control to the executive. The first of these reads various combinations of design parameters, calculates the missing parameters, performs initializations and prints out design information. The remainder of the Level 2 programs are those which perform basic naval architectural calculations. They are: (1) Hydrostatics, (2) Trim Lines, (3) Longitudinal Strength, (4) Floodable Length, (5) Limiting Drafts, (6) Intact Stability, (7) Damaged Stability. These programs have stand alone capability; none need be aware of the existence of any of the others. **Level 3**—Working level, or calculation routines which perform all integrations, interpolations, and iterations.

LANGUAGE: LOW-LEVEL FORTRAN IV
MACHINE REQUIREMENTS: Any system with FORTRAN IV compiler. Examples: IBM-1130, IBM-360, IBM-7090 7094, RCA Spectra 70, Burroughs B5500, UNIVAC-1108, CDC-3000 and 6000 Series
PROGRAM SIZE: Approximately 5,365 source statements
PRICE: Program $970.00 Documentation $16.50
PROGRAM NUMBER: DOD-00030

TOWER12 - Guyed Tower Analysis Computer Program

The program is based on a method of analysis which includes such secondary effects as external moments produced by the guys at each level and those produced by beam-column action. Effects of ice loads and insulators on the guys are also included. Within the limitations described below, the program will determine deflections, reactions, moments, and vertical loads for towers subject to loads which cause it to bend in one or in two directions. In addition, for triangular towers, stresses in all members can be determined for the following wind directions: (1) Wind directly into a face; Wind A, (2) Wind directly into an apex; Wind B, and (3) Wind parallel to a face; Wind C. If the guys at all levels are symmetric with the wind direction and there are no external loads in a direction other than the wind, Winds A and B load the tower symmetrically and the tower will deflect in the wind direction only. Wind C will cause the tower to bend in two directions because of dissymmetry. If the tower bends in one direction only, machine run time can be reduced by inserting the proper value for KS on the pertinent data card as described hereafter. Pull-off loading is assumed to be at the top of the cantilevered span. If there is no cantilevered span, the pull-off loading is assumed to be at the top guy level. This loading consists of a horizontal load, a vertical load, and a moment produced by the vertical load acting at some distance from the center of gravity of the tower. If there are no pull-off loads, the fields for such data are left blank.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,600 source statements
PRICE: Program $530.00 Documentation $8.00
PROGRAM NUMBER: DOD-00036

Midship Section Design for Naval Ships

This computer program will design the longitudinal scantlings of a midship section. Any practical combinations of decks, platforms, and longitudinal bulkheads for the midship section configuration may be used. Options to include an inner bottom structure and to perform a nuclear air blast analysis of shell and upper strength deck structure are provided. The program contains the decisions necessary to determine an initial set of minimum weight scantlings for the shell, deck bulkhead, and inner bottom segments, test them to determine compliance with the design criteria as defined by the Naval Ship Engineering Center, and then increase the scantlings if the criteria are not satisfied. Modification of scantlings continues until the scantlings developed do not change the primary stress assignment. If the midship section has a primary stress deficiency at the deck and or keel fibers, the program will automatically adjust the material at these fibers and iterate the design process until scantlings are found that are of minimum weight and structurally adequate. This program requires approximately 220K of memory in order to execute.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 10,000 source statements
PRICE: Program $500.00 Documentation $27.00
PROGRAM NUMBER: DOD-00041

GRID2D - IGFES: Two Dimensional Grid Generator and Terminal Control System

This software package represents a structural design program which generates two dimensional finite element grids. The package contains the GRID2D program, which is one of the programs comprising the Interactive Graphics Finite Element Systems; and also contains the Terminal Control System (TCS), which is a package of computer graphics routines designed to free applications programmers from graphics device dependent considerations. TCS interfaces GRID2D to graphic devices. The GRID2D program allows the user to define and display two dimensional structure, and supports the NASTRAN program. The grid generation process runs under control of a monitor. The user informs the monitor which phase of generation is to be performed. The phases are boundary definition, region definition, and monitor manipulation. By making multiple passes through each of these phases the user has the capability of regenerating regions many times using different nodal densities and element types. The restriction that opposite sides of the region must have an equal number of nodes is basic to the generation process. Internally each grid region is represented as a matrix. Thirteen NASTRAN elements are supported by GRID2D including the Twist element and the Axisymmetric trapezoidal ring element. The program operates in batch and interactive mode; currently runs in 80K bytes on an IBM 360 44 running OS MFT and 24K word PDP 11 40 under DOS BATCH; and uses the Calcomp plotter.

LANGUAGE: FORTRAN (95%); ASSEMBLER (5%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,078 source statements
PRICE: Program $480.00 Documentation $15.50
PROGRAM NUMBER: DOD-00050

Automated Input Data Preparation for NASTRAN

This program package consists of five computer programs which are available to aid the structural engineer in preparing input data for the NASTRAN structural analysis program. The first three programs —AXIS, SHELBY, and COONS—are coded in FORTRAN IV for operation on the IBM-7094 or the IBM-360 computer; while the last two programs—BANDAID and MOVE—are coded in PL-1 for operation on the IBM-360 computer. Each program may be briefly described as follows: AXIS generates data for shells described by the rotation of a plane curve about an axis. SHELBY generates data for shells described by the translation of a plane curve along an arbitrary axis in space. The scale factor may vary along the length of the axis. COONS generates data for free-form shell structures based on the description of four bounding curves. BANDAID automatically resequences the grid points of a structural problem to achieve a reduced

bandwidth in the stiffness matrix, given the NASTRAN data deck for the problem. MOVE generates data for structures having a number of identical segments, given the NASTRAN bulk data for one of the segments.

LANGUAGE: FORTRAN IV (59.6%); PL-1 (40.4%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,078 source statements
PRICE: Program $490.00 Documentation $8.00
PROGRAM NUMBER: GSC-11039

Advanced Structure Geometry Studies

This report explains one method of subdividing a polyhedron into triangular facets and "exploding" it onto the surface of a sphere. A structure is thereby given which may be used in spherical form. The tetrahedron, octahedron or icosahedron are the fundamental geometrical configurations of the structure. A further subdivision of the configuration chosen is accomplished by subdividing each principle side of each principal polyhedral triangle into any number of segments. The order of subdivision is determined by subdividing the triangle and the origin (or center) of the polyhedron into equal angle segments, using the origin as the vertice for subdivision. The points of intersection of the equal angle segments with the principle side determines the subdivision along the principle side of the principle polyhedral triangle. The points of subdivision on each side of the Principle polyhedral triangle are connected with line segments which are parallel to the two remaining sides of the principle polyhedral triangle under consideration. They intersect at a number of points which define a triangular grid of subdivision. Due to the method of subdivision, small triangular "windows" occur in the grid. The centers of these windows are found by one of two methods and are used as the vertices of a triangular grid of subdivision of the principle polyhedral face and are then transformed to the surface of the sphere which circumscribes the polyhedron. The cords that connect these transformed vertices thus define the structural grid that comprise the structural configuration desired. A mathematical model has been determined which explains the geometry used in subdividing and transforming the polyhedron into the structural configuration desired. From this model a computer program has been written which gives the necessary information needed for construction and analysis of the structure. As a further aid in investigation of the various forms, a plot routine was developed to give a graphical output of each of the structural forms.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094, Calcomp Plotter Model 740
PROGRAM SIZE: Not Applicable
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: HQN-10677

Structural Synthesis of a Stiffened Cylinder

This program designs minimum weight ring and stringer-stiffened cylinders which are subject to axial and lateral pressure loadings. The basic approach is to regard weight as a merit function in the design variable space and then to determine the minimum weight by mathematical programming techniques. The program adjusts seven design variables: the thickness of the skin, and the thickness, depth, and spacing of solid, rectangular, integral rings and stringers; adjustments continue until the design of minimum weight is obtained. Cylinders are designed to prevent general and local buckling, and to prevent the skin and stiffener from yielding under prescribed loading conditions. The linear membrane prebuckling state is the stress state examined for buckling and yielding. The program considers stiffener eccentricity, provides for minimum gage limitations, and designs for multiple load conditions. The buckling and yielding failure conditions constitute constraints in the design variable space for the optimization problem. A penalty function method is used to convert the constrained problems which are solved by a gradient method.

LANGUAGE: CDC FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,700 source statements
PRICE: Program $460.00 Documentation $16.50
PROGRAM NUMBER: LAR-10473

Geometrically Nonlinear Analysis of Arbitrarily Loaded Shells of Revolution

A digital computer program for the geometrically nonlinear analysis of thin elastic shells of revolution subjected to arbitrary load and temperature distributions has been developed to predict snap buckling of shell structures due to asymmetric loads. The analysis is based on Sander's nonlinear shell theory for the condition of small strains and moderately small rotations. During execution, the program solves a set of nondimensional linearized equations for each Fourier coefficient of the actual load, plus an estimated pseudo load from the nonlinear terms, using a finite difference formulation with a Gaussian elimination. The operational parameters of the program and the boundary conditions are read in on cards, but the geometry of the shell, the inplane and bending stiffness, and the pressure and thermal loads are introduced through user-prepared subroutines. The input and output data may be in either dimensional form or non-dimensional form. The program can be compiled in any order, and no special tapes, discs, or routines are required.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,111 source statements
PRICE: Program $480.00 Documentation $16.00
PROGRAM NUMBER: LAR-10736

Geometrically Nonlinear Static and Dynamic Analysis of Arbitrarily Loaded Shells of Revolution

The design of many shell structures is influenced by the geometrically nonlinear response of the shell when subjected to static and or dynamic loads. As a

consequence, a number of investigations have been devoted to the study of the buckling phenomenon exhibited by shells. Most early works examine the behavior of the shallow spherical cap, the truncated cone, and the cylinder under axisymmetric loads. Due to the lack of information on the axisymmetric response of shells with other meridional geometries and on the response of shells subjected to asymmetric loads, a computer program for the geometrically nonlinear static and dynamic response of arbitrarily loaded shells of revolution has been developed. The program can be used to analyze any shell of revolution for which the following conditions hold: (1) The geometric and material properties of the shell are axisymmetric, but may vary along the shell meridian; (2) The applied pressure and temperature distributions and initial conditions are symmetric about a datum meridional plane. (3) The shell material is isotropic, but the modulus of elasticity may vary through the thickness. Poisson's ratio is constant. (4) The boundaries of the shell may be closed, free, fixed, or elastically restrained. The governing partial differential equations are based upon Sanders' nonlinear thin shell theory for the condition of small strains and moderately small rotations. At each load or time step, an estimate of the solution is obtained by extrapolation from the solutions at the previous load or time steps. The sets of algebraic equations are repeatedly solved using Potter's form of Gaussian elimination, and the pseudo loads are recomputed, until the solution converges. An automatic variable load incrementing routine is included in the program for the static analysis. Post-buckling behavior cannot be determined in the static analysis because of the method of solution employed. The documentation contains a description of the theory, the method of solution, instructions for preparing the input data, and two sample problems to illustrate the data preparation and output format.

LANGUAGE: FORTRAN IV, Level H
MACHINE REQUIREMENTS: IBM-360 370
PROGRAM SIZE: Approximately 2,337 source statements
PRICE: Program $720.00 Documentation $11.50
PROGRAM NUMBER: LAR-11109

Computer Program for Stress, Vibration, and Buckling Characteristics of General Shells of Revolution

The SRA system of programs is composed of six compatible computer programs for structural analysis of axisymmetric shell structures. The theory and method upon which these programs are based are presented in the documentation. They apply to a common structural model, but analyze different modes of structural response. They may be classified according to their function into three groups, designated here as the 100, 200, and 300-series. In particular, they are: SRA 100—Linear static response under asymmetric loads, SRA 101—Buckling of linear states under asymmetric loads, SRA 200—Nonlinear static responses under axisymmetric loads, SRA 201—Buckling of nonlinear states under axisymmetric loads, SRA 202—Imperfection sensitivity of buckling modes under axisymmetric loads, and SRA 300—Vibrations about nonlinear states under axisymmetric loads. These programs treat branched shells of revolution with an arbitrary arrangement of a large number of open branches, but with at most one closed branch. Current dimensioning allows for seven branch points, each of which may have as many as five branches emanating from it. Branches which close at the axis of revolution; i.e., dome closures, are not considered to be closed branches. A maximum of 23 dome closures or other shell edges is allowed. At each meridional station, the shell wall may consist of as many as five orthotropic layers, in each of which elastic properties may vary only in the meridional direction. At each material point, the shell is assumed to possess orthotropic principal axes in meridional and circumferential directions. All geometric and mechanical properties of the structure are assumed to be axisymmetric, but may have arbitrary meridional variation. A continuous reference surface, arbitrarily located within or near the shell wall is treated. The shell may be stiffened by: (1) up to 34 discrete isotropic rings, (2) stringers, whose stiffness is circumferentially distributed, and (3) an elastic foundation attached to the shell wall. The effect of thermal loads and live pressure fields are included.

LANGUAGE: FORTRAN IV (99%); COMPASS (1%)
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 18,109 source statements
PRICE: Program $650.00 Documentation $34.00
PROGRAM NUMBER: LAR-11359

SNAP - Dynamic Structural Network Analysis Program, CDC 6000 Series Version

SNAP Dynamics is applicable to the same class of large linear finite element networks as the basic static analysis version of SNAP (LAR-11330). Undamped vibrational modes and frequencies of free or constrained systems are computed using an iterative procedure analogous to the stodola method of beam analysis. SNAP Dynamics executes a Rayleigh-Ritz analysis to obtain initial approximations of the first N modes and frequencies of the system (N is specified by the user). Generalized functions used in the Rayleigh-Ritz analysis are whole-structure static displacement functions computed by the program, based on a sequence of static loadings defined by the user. To assure that good approximations of the first N modes are obtained, 2N to 3N generalized functions are normally used. After the initial approximations of the modes have been computed, the program executes an iterative procedure to compute initially the first (lowest frequency) mode, then the second mode, and so forth. Beginning with the initial approximation of a mode, an 'equivalent inertia loading' acting on the structure is evaluated. The static deformation corresponding to the inertia loading is computed, providing an improved approximation of the mode. This procedure is executed repeatedly until convergence is obtained. In computing higher modes, a process based on orthogonality relations is used to 'sweep out' low-frequency components of each modal approximation. Routines from the basic static analysis version of SNAP are used to compute the successions of modal

approximations. These routines take full advantage of system stiffness matrix sparsity to reduce computer costs to a virtual minimum. Advantage is also taken of system mass matrix sparsity in computing kinetic energy terms, equivalent inertia loadings, etc. Three optional methods of representing inertia effects are provided: (1) A diagonal system mass matrix may be used. In this case, the program automatically performs the necessary 'lumping' of distributed structural and non-structural mass. This method results in minimum computer costs and should be used if the finite element model reasonably supports a lumped mass approach. (2) Consistent mass matrice may be used for beams and certain membrane elements. (3) A 'Pseudo-Consistent Mass Matrix' method may be used. This method in effect assumes linear displacements for all elements, for purposes of kinetic energy and inertia force calculations. Input data includes: (A) A definition of the geometrical and physical properties of the structure (eg position coordinates of the structural 'Joints' at which the elements are interconnected, material constants, element section properties, etc.). (B) Constraint conditions. (C) Definitions of the static loadings from which displacement functions are computed for use in the initial Rayleigh-Ritz analysis. (D) Control parameters enabling the analyst to exercise an array of options governing modes of operation, output content, etc. Output data includes the following: (A) Frequencies and mode shapes. (B) Detailed comprehensive checks of numerical accuracy. (C) SC-4020 plots of both undeformed and deformed structure, generated by a very general system of automatic plotting routines. (D) 'Restart' tapes enabling problem solutions to be resumed, as required, without repeating preliminary steps such as formation and reduction of the system stiffness matrix. (E) Solution data output tapes for use in other programs. These tapes contain the system mass matrix, modes, and frequencies.

LANGUAGE: FORTRAN IV (98%); COMPASS (2%)
MACHINE REQUIREMENTS: CDC 6000 Series, SC 4020 Plotter
PROGRAM SIZE: Approximately 17,000 source statements
DISTRIBUTION MEDIA: 7-Track SCOPE Formatted Magnetic Tape
PRICE: Program $650.00 Documentation $16.00
PROGRAM NUMBER: LAR-11529

SNAP - Static Structural Network Analysis Program, CDC 6000 Series Version

SNAP V70J is a finite element structural analysis system for executing linear analyses of large statically loaded networks of beam and shell elements. A companion program, SNAP Dynamics (LAR-11529) may be used for dynamic analysis of structures. The system consists of a main computational program called SNAP which executes basic solutions and an array of associated analytical and graphics display processor programs. Allowed loadings include point forces and moments at joints, non-zero specified joint motions (in oblique directions, if required), and thermal loadings. Output solution data includes joint motions (displacement and rotation components), element stresses and or stress resultants, element nodal forces and strain energies, reactions, and automatic plotting of both undeformed and deformed structures. A sparse matrix solution procedure is used in SNAP Statics which in many large-scale practical applications affords very substantial savings in computer execution cost and data storage requirements, compared with band matrix, 'active column' or partitioning methods. The basic solution routines—'decomposition' of the stiffness matrix and forward backward solution for joint motions can approach the minimum computer costs theoretically obtainable using direct solution procedures (symmetric Gaussian elimination, Cholesky, etc.) Multi-dimensional 'network generators' of input data for element definitions, position coordinates, constraint, etc., are provided. The data input routines also make extensive use of 'libraries' of beam and shell section properties, material constants, etc., in generating problem definitions. This method can reduce the amount of manual effort (and probability of error) in preparing data decks for large structures. For example, the section properties of a beam are 'defined' by referring to the applicable set of data in one of the libraries. Accordingly, the detailed definition of each unique section appears in the input data only once, regardless of how many elements have that particular section. The force-deformation relations of individual elements are represented within the program by 'intrinsic stiffness matrices' expressing force-deflection characteristics relative to intrinsic (moving) reference frames imbedded in the elements. A general set or routines evaluate element dimensions, orientation, etc., and compute contributions to individual elements to the complete system stiffness matrix. After system joint motions have been evaluated, other general routines (i.e. routines independent of the sources of the intrinsic stiffness matrices) compute element deformations relative to their embedded intrinsic frames, stresses, etc. This apparatus allows for the addition of new element formulations to the program, since it is necessary only to construct subroutines for computing the corresponding intrinsic stiffness and stress matrices, with element dimensions and section properties supplied through the calling sequence from the general routines. Plate shell membrane and bending element formulations based on 'hybrid' variational methods are included, providing substantial improvements in the accuracy of displacements and stresses. Options are retained for using other well-known element formulations for comparison. Beam elements include effects of shear center centroid offsets, transverse shear deflection, and non-uniform torsion. Section properties (moments of inertia, area, shear deflection constants, torsion constants, principal axis orientation, shear center location, etc.) may be input directly or the program will compute them for many types of sections (wide-flanges, boxes, tube, angles, zees, channels, tees), given only the section dimensions as input. Detailed checks of numerical accuracy are automatically executed. In performing these checks the program returns to the basic problem definition; that is, the checks reflect not only the error accumulated in the 'factoring' and displacement evaluation procedures, but also the effects of round-off in assembling the system stiffness matrix (which, in most applications, is the primary

source of error). There are three checks, (1) a strain energy external work comparison, (2) a total applied force reaction comparison, and (3) an equilibrium check at all joints. An option is included for automatically executing an iterative accuracy improvement procedure. If, in its accuracy checks, the program detects numerical error in excess of a given tolerance (input by the user), this procedure is implemented which can result in 'salvaging' solutions that would otherwise be unacceptably inaccurate. The program is also structured for easy conversion to double-precision arithmetic as an alternative method of overcoming accuracy problems. Other user options available with SNAP Statics include: (a) Provision for temporary internal re-sequencing of joint numbers, to allow maximum advantage to be taken on SNAP's sparse-matrix solution procedure. (b) Generation of 'restart tapes' enabling problem solutions to be resumed, as required, without repeating preliminary steps such as formation and reduction of the system stiffness matrix. (c) Partial executions principally for use in initial data debugging. (d) Reduction of the system stiffness matrix in double precision. (e) Automation of symmetry anti-symmetry constraint specifications. (f) Provision for rigid links offsetting beam element end points from the joints to which they are connected. (g) Reading of input data in 'block' formats for element definitions, joint position coordinates, and beam and shell section properties allowing local reference frames and local joint numbering arrangements to be used in various parts of the structure. This procedure allows data decks generated for individual parts of the structure to be merged with minimum effort to form a deck defining the complete structure.
LANGUAGE: FORTRAN IV (97%); COMPASS (3%)
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 20,000 source statements
DISTRIBUTION MEDIA: 7-Track CDC SCOPE Formatted Magnetic Tape
PRICE: Program $650.00 Documentation $21.00
PROGRAM NUMBER: LAR-11530

SALORS - Structural Analysis of Layered Orthotropic Ring Stiffened Shells of Revolution, Linear Stress Analysis Option

A computer program is presented for the linear static analysis of asymmetrically loaded, thin, elastic shells of revolution. The program is equipped to handle segmented, laminar, orthotropic shells with discrete rings. Provisions are made for handling meridional variations in material properties, temperatures, and wall thickness. The program also allows linear variations of temperature through each layer of the shell wall. Meridional discontinuities in geometry, temperature, and material properties and the actual load path through the joint at a discontinuity are accounted for. The effects of longitudinal stiffening (stringers) are automatically distributed circumferentially. Circumferential variations of loads and temperatures are handled by Fourier series expansion.
LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 3,000 source statements
PRICE: Program $200.00 Documentation $15.50
PROGRAM NUMBER: LAR-11559

BUCLAP2——A Computer Program for Instability Analysis of Laminated Long Plates Subjected to Combined Inplane Loads

This is a structurel analysis package containing approximately eight programs and thirty-one subroutines to predict theoretical buckling loads of long, rectangular flat and curved laminated plates with arbitrary orientation of orthotropic axes in each lamina. Few results are available in the literature for laminated curved plates. Thus, BUCLAP2 is expected to aid in achieving a better understanding of the buckling behavior of these curved plates, in addition to supplementing the available results for laminated flat plates. A structure and its displacement is represented by polar coordinates and strains are represented using the Kirchoff-Love hypothesis so that stress-strain equations for a lamina are in matrix form. The stability equations for laminated curved plates subjected to combined inplane normal and shear loads are derived by variational methods. Linear theory is used in buckling analysis. The solution is applicable to (1) finite length plates, when the plate is specially orthotropic and the combined inplane external loads do not include shear, and (2) infinitely long plates for all other cases. The buckling analysis considers rectangular flat or curved general laminates subjected to combined inplane normal and shear loads. Analysis oriented restrictions are as follows: (1) Linear thin shell buckling theory is used; (2) Prebuckling deformations are ignored; (3) Only inplane applied loads are considered; (4) The included angle of the curved plate is limited to 180°. The program operates in batch mode and presently runs under SCOPE 3.1 of KRONOS 2.0. All system subroutines used are standard CDC release. With the exception of three special purpose subroutines (PAC, UNPACK, and VIPDR in COMPASS) all source routines are coded in CDC FORTRAN IV. The overlay loading feature is used.
LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 7,400 source statements
PRICE: Program $760.000 Documentation $25.50
PROGRAM NUMBER: LAR-11686

Torsional Vibration Natural Frequencies Program

This program computes the torsional vibration natural frequencies and corresponding mode shapes of a physical system under free vibration, that can be idealized to N lumped mass polar moments of inertia, connected by weightless shafts possessing torsional stiffness. Both free-free and free-fixed and fixities can be accommodated. The method combines the best features of two techniques: the Holzer method and the Stodola method. The latter method obtains the highest frequency which is used for convergence of the Holzer iteration in a reasonable amount of time.
LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 474 source statements
PRICE: Program $230.00 Documentation $3.50
PROGRAM NUMBER: MFS-01488

Column Analysis Complex

This is a FORTRAN IV digital computer program to evaluate the stability analysis of complex columns in the field of structures. Lateral deflection, internal moments, magnitude, position of the maximum ANC-5 interaction value, and the minimum margin of safety on each side of a pin-ended column are determined by this program. The effects of secondary bending assume external end moments cause bending in only one plane and that the axial loads act parallel to a straight line between the ends of the column. The centroidal axis is assumed straight before loading, but it may have a small parabolic warp which must lie in the plane of bending. The three general types of problems which can be analyzed by this program are: (a) To determine the stresses, deflections, interactions, etc. for a specific column due to a single loading condition; (b) To determine the stresses, deflections, interactions, etc. for a specific column due to a constant end moment and an axial load which increases to the critical value of load or stress; and (c) To determine the stresses, deflections, interactions, etc. for a column of varying length with a constant end moment and a varying axial load.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 213 source statements
PRICE: $105.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-02227

Kellogg Piping Analysis Program, IBM-360 Version

This program uses the Kellogg General Analytical Method to facilitate the flexibility analysis of rocket engine propellant lines. A stiffness-matrix approach is used since it lends itself naturally to complex configurations in three dimensions. The program accomodates up to 50 curved members and/or straight segments of single runs of piping. Flexibility and stiffness coefficients relating loads and deflections at the free-end are determined. Internal and free-end reactions due to specific free-end deflections can be found, as can internal reactions and free-end deflections due to specific free-end loads.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 850 source statements
PRICE: Program $350.00 Documentation $2.50
PROGRAM NUMBER: MFS-12622

Stress Analysis of Belleville Springs Program

This program computes deflections, membrane forces, bending moments, stress, and the load-deflection history for conical shells (Belleville Springs) of uniform thickness. The program uses a large deflection theory, and is not restricted to the range in which deflection is proportional to the load. Program limitations are: (1) the shell must be thin and shallow, (2) symmetric axial loads must be applied and reacted at the edges of the shell, and (3) no axial, radial, or rotational constraints can be enforced at either boundary. Significant errors were found in the results of computation using prior methods. These errors have been overcome by this program.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 376 source statements
PRICE: Program $50.00 Documentation $2.50
PROGRAM NUMBER: MFS-13217

SAMECS—Structural Analysis Method for Evaluating Complex Structures

The purpose of this program is to analyze large complex structures under various types of loading. The structure is described in rectangular coordinates by a set of control points (nodes) connected by plates and beams. Each node is assigned six degrees of freedom: rotations about each of the coordinate axes as well as displacements in the directions of the coordinate axes. Plates may be either triangular or quadrilateral, and beams may be either straight or curved and may have uniform or non-uniform section properties. Loads may be described as nodal or element loads. The assumptions normally made in structural analysis are assumed, i.e.: (1) The material is perfectly elastic; (2) The deflections are sufficiently small compared to the size of the structure that secondary deflections caused by interaction between the applied forces and primary deflections are negligible. Further it is assumed the structure can be adequately described as plates and beams. This program is limited to the evaluation of structures which can be adequately described by no more than 2,000 nodes. The total number of plates and/or beams is limited only by this restriction. Further, the nodes are grouped into partitions, and the maximum number of rows of partitions is 200, with a maximum of ten nodes per partition. The total number of partitions in the stiffness matrix is limited to 800.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108 EXEC VIII
PROGRAM SIZE: Approximately 6,397 source statements
PRICE: Program $420.00 Documentation $11.50
PROGRAM NUMBER: MFS-15302

Torsion Analysis of Open Sections

An open section is a section in which the centerline of the wall does not form a closed curve. Channels, angles, I-beams, and wide-flange sections are among many common structural shapes characterized by combinations of thin-walled rectangular elements; a variety of thin-walled curved sections is used in aircraft and missile structures. The basic characteristic of these sections is that the thickness of the component element is small in comparison with other dimensions. This program performs the torsional analysis of thin walled open sections for both unrestrained and restrained torsion sections. Torsional shear stress, angle of twist, and warping deformations are determined for unrestrained torsion. Torsional shear stress, warping shear stress, warping normal stress, angle of twist, and the first, second, and third derivatives of angle of twist are determined for restrained torsion

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 836 source statements
PRICE: Program $140.00 Documentation $10.50
PROGRAM NUMBER: MFS-20648

Vibrational Transfer Functions for Base Excited Systems

A general computer program, GD203, has been developed for computing vibrational transfer functions for complex structures excited by a base motion. In the design of complex structures the governing vibrational environ-

ment is generally specified in terms of either a sinusoidal or random base environment. In either case the response of the subject structure can be evaluated through the use of vibrational transfer functions. The primary input to the program are modal properties of the system. The program is capable of handling modal properties developed through modal coupling techniques with a maximum of 162 degrees-of-freedom per structure and up to 150 substructures. The program capability includes plotting of the computer transfer functions. The program could be utilized by the aircraft industry where induced vibration environments and structural response to these environments are used in the design of critical structure. Further application could include the automotive industry in computing response of vehicles to specified road environments.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 771 source statements
PRICE: Program $350.00 Documentation $6.50
PROGRAM NUMBER: MFS-21432

FORMA—Synthesis Of Dynamic Systems Using FORTRAN Matrix Analysis

A library of computer programs called FORTRAN Matrix Analysis (FORMA) has been developed in order to find efficient solutions of small and medium size structural dynamics problems of up to 150 degrees of freedom. The library consists of 86 subroutines that may be combined in the form of "building blocks" that may be used to solve a large variety of structural dynamic problems. The obvious advantage of the "building block" approach is that the only programming and checkout time required is putting the necessary blocks together in the proper order. The FORMA library includes routines for beam mass matrix calculations, beam stiffness matrix calculations, eigenvalue-vector solutions, time response solutions as well as the basic matrix algebra subroutines. The FORMA method has advantageous features such as: (1) Method will work on any computer with a FORTRAN IV compiler. With minor modifications it has been used on the IBM-7044/7094/360, GE 625/635, CDC 6400/6500, and UNIVAC 1108; (2) Computer times are reasonable; (3) Incorporation of new subroutines is no problem; (4) Basic FORTRAN statements may be used to give extreme flexibility in writing a program. (5) An analyst can program relatively complex problems with very little programming experience; (6) The method of programming is closely related to the manner of the mathematical formulation of the physical problem; and (7) Subroutines in the library have been used extensively for many years and as a result are well checked out and debugged. The documentation for FORMA consists of four volumes: Methodology; Programming Manual; Subroutine Explanation; and Subroutine Listings.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Any computer with FORTRAN IV Compiler (present version, UNIVAC-1108)
PROGRAM SIZE: Approximately 15,000 source statements
PRICE: Program $1,500.00 Documentation $32.50 (volumes 1, 2, 3 only)
PROGRAM NUMBER: MFS-21490

SNAP—Dynamic Structural Network Analysis Program, UNIVAC 1108 Version

SNAP, Dynamics is a computer program written to calculate the normal modes of an arbitrary structure from a finite element mathematical model. The strong feature of the finite element technique is its suitability for accurately characterizing extremely complicated structures for which determination of exact analytical solutions are impossible. The basic version of SNAP is an extremely general program for linear analysis of statically-loaded linear finite element networks. The computer execution costs achieved by the basic static solution routines are very close to the minimum that can possibly be attained using direct solution procedures, generally affording substantial savings when compared with the costs associated with constant or variable-width band matrix, active column, or partitioning solution methods used in other programs. This can be extremely important in analyzing large complicated structures. SNAP's allowable number of degrees of freedom is extremely large. Structures having over 15,000 elements and 12,000 degrees of freedom have been solved, and much larger problems can easily be handled. The sparse matrix solution technique entirely eliminates stiffness matrix band width restrictions. Very efficient use is made of both core and secondary data storage resources. Dynamic allocation of core storage is automatically implemented by the program to optimize size capacity and execution efficiency for each individual analysis. An option is included for automatically executing an iterative accuracy improvement procedure. If, in its accuracy checks, the program detects numerical error in excess of a given tolerance, this procedure is implemented. The computer execution cost is very small, and often results in salvaging solutions that would otherwise be unacceptably inaccurate. Optionally, double precision arithmetic may be used as an additional means of overcoming accuracy problems.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020 Plotter
PROGRAM SIZE: Approximately 17,000 source statements
PRICE: Program $1,750.00 Documentation $33.50
PROGRAM NUMBER: MFS-21531

ASTROS—Automated Shell Theory for Rotating Structures

The ASTROS computer program can be used to analyze any disk or shell of revolution of arbitrary cross section under inertial loads caused by rotation about the shell axis and various static loads, including thermal gradients. The geometric shapes incorporated in the program are ellipsoidal, spherical, ogival, toroidal, conical, circular plate, cylindrical, and parabolic. The program was developed because of a need for an easy-to-use and accurate computer program that is oriented directly toward solving for the stresses and deformations in rotating disks and shells of revolution such as those encountered in rocket engine turbomachinery. This program has advantages over other similar programs in that it uses larger segments of the structure than when the finite difference method is used. Therefore, the input to the program is minimized resulting in a larger program capability and more accurate results. Four classifications of information are used as program input: (1) Geometry Data - the geometric description of each segment of the disk or shell of revolution. (2) Material Data - thickness and material properties of the segment. (3) Topology Data - the manner in which all the segments are interconnected to form a structure. (4) Load Data - temperature and loading data, both concentrated and distributed, and angular velocity. Many features of this program such as treatment of the branched shells, stiffened wall construc-

tion, and thermal gradients are retained from a computer program named STARS II (Shell Theory Automated for Rotational Structures II) which was developed by the Grumman Aircraft Engineering Corporation.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 5,000 including 3,000 data cards
PRICE: Program $750.00 Documentation $27.00
PROGRAM NUMBER: MFS-21970

STARS2S - Shell Theory Automated for Rotational Structures (Statics)

These programs use the Love-Reissner first order shell theory method to assist in the numerical analysis of the shells of revolution and can analyze orthotropic thin shells of revolution subjected to unsymmetric distributed loading or concentrated line loads and thermal strains, or they can perform stability or vibration analysis of thin shells of revolution subjected to axisymmetric distributed loading or concentrated line loads and thermal strains. The shell wall cross section used can be a sheet, sandwich, reinforced sheet or reinforced sandwich. The reinforcement can consist of rings and/or stringers, a waffle construction rotated at any angle to the principle coordinates, or an isogrid construction. The reinforcement material properties can differ from those of the main shell, and a temperature variation can cause different properties in the two face sheets of the sandwich shell. The basic approach to the problem is to cut the structure into several shell segments, each being free to have its own geometric shape, provided the shape falls into one of the categories mentioned below. Stiffness matrices obtained for each segment are coupled by standard matrix methods to obtain region stiffness, which, after being reduced in size, are in turn coupled to form the total shell structure under analysis. The shells that can be analyzed with these programs can consist of any combination of the following geometric shapes: (1) Ellipsoidal - spherical, (2) Ogival - toroidal, (3) Modified ellipse shape, (4) Conical - circular plate, (5) Cylindrical, (6) General point input geometry, (7) Dummy geometry slot to be filled by the user, (8) Discrete ring, and (9) Elastic support.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series, Exec 8
PROGRAM SIZE: Approximately 25,000 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program $2,410.00 Documentation $131.50
PROGRAM NUMBER: MFS-23027

PANES - Program for Analysis of Nonlinear Equilibrium and Stability

This program was developed to utilize improved techniques for analysis of structures with material and geometric nonlinearities, including the limit point and bifurcation behavior which occurs in buckling and collapse problems. The methods used in this program are "incremental loading," Newton Raphson iteration and its modifications, involving periodic updating of the Jacobian matrix and higher order methods including various orders of predictor and corrector algorithms. In order to make current methods applicable to cases of large strain and arbitrary nonlinear materials, the equation generation process is accomplished in the present work by a finite difference expansion procedure. It is found that generation of the nonlinear equations by this means within a perturbation context provides a unifying basis for definition of the nonlinear solution terms, including as special cases the first-order Newton Raphson and incremental loading methods, as well as almost an unlimited variety of higher-order solution techniques. The perturbation procedures have the advantage of a sound theoretical basis in classical developments, and lend themselves readily to both limit point and postbuckling problems as well as to simple nonlinear behavior without critical points.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 2,554 source statements
PRICE: Program $200.00 Documentation $14.00
PROGRAM NUMBER: MFS-23172

Remote Access Terminal Circular Frame Computer Program

This program calculates the internal moment axial, and shear loads on a rigid 'circular' frame. Inner and outer cap stresses are also included in the output. The program uses a minimum energy solution. The applied loads are first balanced, yielding the balanced static loads. The balanced static loads and the redundant loads are then related, using energy equations to determine the final internal loads. The program's main application is for preliminary analysis of circular frames for rocket vehicle and aircraft structures, although it is also applicable to other industries using circular frames. The program's main advantage is that it eliminates the time delay and cost of running a large production program for frames with less than forty section cuts.

LANGUAGE: FORTRAN IV, IBM Assembler
MACHINE REQUIREMENTS: IBM 360 RAX Terminal System
PROGRAM SIZE: Approximately 793 source statements
PRICE: Program $50.00 Documentation $3.50
PROGRAM NUMBER: MFS-24042

FRAP - Pressurized Structure Optimization

This program was developed to optimize the weight of orthotropic cylinders with stiffeners and rings subjected to axial compression. The program computes (a) skin panel buckling stresses and load levels; (b) compressive running load capabilities (skin stringer column buckling) and associated stress levels of pressurized and non-pressurized structures (short column effects are included); (c) gross and effective section properties of the cylinder wall; (d) optimum ring frame geometry, and (e) equivalent thicknesses of the cylinders under consideration.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360 RAX System
PROGRAM SIZE: Approximately 260 source statements
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-24043

CAPR - Compression Allowable Plotting Routine

This program is written for plotting design stress strain, effective modules (Et and Es), compression buckling (Fcr), and compression crippling (Fcc) curves for new materials or materials for which these curves are not available. The input of the program requires the three Remberg Osgood

parameters (n, E, and F0.7) which mathematically describe the material stress-strain curve, the design yield strength (Fcy), and Poisson's ratio (u).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 1130
PROGRAM SIZE: Approximately 550 source statements
PRICE: $45.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-12705

Fracture Mechanics of Apollo Spacecraft Pressure Vessels

This computer program performs a fracture mechanics evaluation of Ti 6Al-4V pressure vessel cyclic pressure histories using techniques that conform to NASA specifications. Evaluation results for each pressure vessel are defined in terms of maximum potential flaw depth based on its cyclic pressure history. This flaw depth is then interpreted as remaining allowable pressure cycles to a selected evaluation pressure and also interpreted where applicable as maximum allowable temperature when pressurized to the selected evaluation pressure. The input to the program consists of tank parameter data, tables used for interpolation of certain variables, and pressure cycle data. The output consists of desired tank condition parameters such as temperature, maximum expected flaw size and number of pressure cycles that can safely be applied to the tank. The present program is limited to cylindrical or spherical Ti-6Al-4V pressure vessels. The program could be generaled to allow an assessment of pressure vessels of any type of material. The constants input for any particular material would have to be determined from experimental data on that material.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 292 source statements
PRICE: Program $160.00 Documentation $5.50
PROGRAM NUMBER: MSC-13995

SOR—Shells of Revolution

Stiffness and Mass Matrices (SAMMSOR) - Stiffness and Mass Matrices for Shells of Revolution are generated utilizing this program. This program accepts a description of the structure in terms of the coordinates and slopes of the nodes and the properties of the elements joining the nodes. For shells with simple geometries (such as cylinders, shallow caps, hemispheres, etc.) the shell geometry can be internally generated. Utilizing the element properties, the structural stiffness and mass matrices are generated for as many as twenty harmonics and stored in magnetic tape. This program generates the input data to be used by other stiffness of revolution programs. Our advantage of creating the stiffness and mass matrices in a separate program is that a variety of analyses can be performed on the same shell configuration without having to create the matrices more than once.

Dynamic Nonlinear Analysis (DYNASOR) - The equations of motion of the shell are solved using Houbolt's numerical procedure with the nonlinear terms being moved to the right-hand side of the equilibrium equations and again treated as generalized loads. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated using this program. Solutions can be obtained for highly nonlinear problems in reasonable periods of time on the computer utilizing as many as five of the harmonics generated in SAMMSOR. A restart capability is incorporated in this code which allows the user to restart the program at a specified time without having to expend the computer time necessary to generate the prior response.

Frequencies and Modes (FAMSOR) - Using the stiffness matrix generated by SAMMSOR and a lumped mass representative developed from the consistent mass matrix generated by SAMMSOR, a specified number of natural frequencies (beginning with the lowest or fundamental frequency) are obtained using the inverse iteration method. The mode shapes for each of the frequencies are also obtained. The natural frequencies and mode shapes can be found in reasonable periods of computer time utilizing this code.

Static Nonlinear Analysis (SNASOR) - The Static Nonlinear Analysis of Shells of Revolution (SNASOR II) subjected to arbitrary mechanical and thermal loading is performed using this computer program. Utilizing the stiffness matrices generated by SAMMSOR and the loading conditions and boundary conditions input to SNASOR II, the equilibrium equations for the structure are generated. The nonlinear strain energy terms result in pseudo generalized forces (as functions of the displacements) which are combined with the applied generalized forces. The resulting set of nonlinear algebraic equilibrium equations is solved by one of several methods: Newton-Raphson type iteration, incremental stiffness method, and modified incremental stiffness method. In general, the Newton Raphson procedure is the best and yields accurate results for highly nonlinear problems in a reasonable computer time. Symmetrical and asymmetrical large deflection problems have been solved using this code. Buckling loads for symmetrically and asymmetrically loaded shells (with moderately large prebuckling deflection) have been obtained and checked with other solutions.

LANGUAGE: FORTRAN IV
PROGRAM SIZE: Approximately 7,000 source statements
PRICE: Program $840.00 Documentation $53.50
PROGRAM NUMBER: MSC-14748 (CDC 6000 Version), MSC-14749 (IBM 360 Version)

Geometry Processor, Mesh Topology and Nodal Point Generator

In order to create the mesh topology and nodal point coordinates for a finite element stiffness method model for a large structure, large amounts of data must be generated. Generating this data requires large manpower expenditures; input errors are numerous and expensive to debug. In order to minimize these problems, the Geometry Processor computer program calculates cartesian coordinates and defines structural elements from such basic values as radius and angles for cylindrical or cone type structures. The coordinates and elements are graphically displayed by CRT plots and punched in BCD format. The program also contains a "Table of Equivalent" which relabels the coordinates or elements identification.

LANGUAGE: FORTRAN IV (65%), ASSEMBLER (35%)
MACHINE REQUIREMENTS: IBM 360, SC 4020 plotter
PROGRAM SIZE: Approximately 2,573 source statements
PRICE: Program $420.00 Documentation $13.00
PROGRAM NUMBER: MSC-17031

FMA - Frame Modal Analysis

FMA is a computer program that was initially developed for the dynamic analysis of the S-11 program but has since been modified and capabilities added in order to make vibration analyses of many structures, primarily during preliminary design. The primary purpose of the program is to calculate the natural frequencies and modal displacements of three-dimensional frame structures. In addition, the program may be used to generate the stiffness and mass matrices of frame structures for use in subsequent analyses. A general beam element and consistent mass matrices are employed in the idealization. If required by problem size, the structure may be divided into several structures or sections prior to calculation of modal characteristics. Considerable flexibility in the arrangement of structural degrees of freedom is provided to the user. Input data includes member sectional properties and weights plus coordinates of the node points at which the members join. Stiffness matrices for each beam member are generated and combined to form the structure stiffness matrix using the direct stiffness method. A consistent mass matrix is formed using the stiffness information and the weight input data. Node shapes and frequencies are then calculated by the Jacobi method using the mass matrix and stiffness matrix. The stiffness matrix, and/or nodes may be saved on magnetic tape for future use.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 852 source statements
PRICE: Program $160.00 Documentation $12.50
PROGRAM NUMBER: MSC-17562

Program to Reduce the Size of Structural Matrices

There are programs available to reduce the size of stiffness matrices, but none to reduce both stiffness and mass matrices. This program was developed to reduce both the mass and stiffness matrices to a size that will enable the modal program to calculate mode shapes and frequencies. The reduction is accomplished by eliminating degrees of freedom using the Cholesky decomposition. The program performs a Guyan (consistent mass) reduction on any structural mass and stiffness matrices. This reduction allows calculation of Eigenvalues of a smaller matrix than would otherwise be required. Assuming sufficient auxiliary storage (on tape, disk, or similar device), the matrix sizes that may be reduced are essentially limited only by the cost. Three double precision arrays and two integer arrays (each of the length of one row of the matrix) are required to be in core at any one time. Efficiency is greatly improved, however, if more core is provided since the program automatically utilizes all available core. Accuracy is dependent upon the conditioning of the input matrices and the accuracy with which the input matrices were formulated.

LANGUAGE: FORTRAN G and H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 704 source statements
PRICE: Program $140.00 Documentation $5.50
PROGRAM NUMBER: MSC-17619

STRESS - Structural Thermal Rapid Evaluation - Stresses and Strains

A computer program was written to determine the internal stresses and strains resulting from thermal gradients. In prior analyses either the problem was solved longhand which was very time consuming, or a general purpose finite element program was used with a large amount of input data which was also time consuming. The STRESS program has simple input data and provides rapid turnaround which leads to parametric studies and "quick-look" evaluations. This program has been used to evaluate the thermal protective systems on the space shuttle by the North American Rockwell, Space Division.

LANGUAGE: FORTRAN G
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 132 source statements
PRICE: $75.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17931

SAMIS - Structural Analysis and Matrix Interpretive System

SAMIS is designed to solve problems involving matrix arithmetic, with particular emphasis on structural applications. The program can execute, either exclusively or sequentially, two basic operations. From input data that define an idealization of a structure, the generation phase of the program generates structural matrices for any type of element available in the program element library. This phase is based upon the structural concepts of the finite element method, in particular, the stiffness or displacement method. To enable the program to analyze a range of structural types (truss, plate, sheil, composite shell beam, etc.), several elements are programmed and cataloged in the program element library. Contained in the library are the general line element suitable for representing axial, bending, and torsion deformations, and the triangular plate element which models membrane and bending deformations. The second basic operation is termed the manipulative phase, in which either generated or input matrices are manipulated according to the rules of linear algebra. In structural problems, the matrix manipulations may be sequenced to compute displacements, stresses, reaction faces, or mode shapes and frequencies. The ability to compute these quantities for structural systems which are described by a large number of simultaneous equations requires greater than in-core data access and storage capacity. Because of this requirement, the program was developed as a chain system. Based mainly upon the constraint of computer running time, the SAMIS program operates efficiently with matrices ranging from the 100th to 2500th order.

LANGUAGE: FORTRAN (2% Assembler UNIVAC Version)
MACHINE REQUIREMENTS: CDC-6000 Series, UNIVAC 1100 Series
PROGRAM SIZE: Approximately 19,000 source statements (CDC Version), Approximately 18,000 source statements (UNIVAC Version)
PRICE: CDC Version - Program $2,060.00 Documentation $51.00 UNIVAC Version - Program $1,590.00 Documentation $48.50
PROGRAM NUMBER: CDC Version - LAR-10050
UNIVAC Version - NPO-11319

ELAS8—A General Purpose Digital Computer Program for the Equilibrium Problems of Linear Structures

ELAS8 is a general purpose digital computer program that can handle the equilibrium problems of linear structures of one-, two-, or three-dimensional continuum.

The program requires as input (1) the coordinates, in an over-all coordinate system, of the mesh points of a random one-, two-, or three-dimensional mesh established in the material volume of the structure of one-, two-, or three-dimensional continuum, respectively; (2) the geometrical, topological, material, and loading characteristics of the mesh elements; (3) the list of prescribed deflections and forces at the mesh points; and (4) a few program control parameters. As output they provide (1) the deflections at the mesh points, (2) the stresses at the mesh points, and (3) the listings of the input data. The solution is obtained by means of the displacement method and the finite element technique. Almost any geometry and structure may be handled because of the availability of linear, triangular and quadrilateral, tetrahedral, hexahedral, conical, and triangular and quadrilateral torus elements. The piecewise linear deflection distribution assumption, which is used, insures monotonic convergence of the deflections from the stiffer side with decreasing mesh size. The stresses are provided by the best-fit strain tensors in the least-squares sense at the mesh points where the deflections are given. The selection of local coordinate systems whenever necessary is automatic. The core memory is efficiently used by means of dynamic memory allocation, an optional mesh point relabelling scheme, imposition of the boundary conditions during the assembly time, and the straight line storage of the rows of the stiffness matrix within variable bandwidth and the main diagonal. The number of unsuppressed degrees of freedom that can be handled in a given problem is 500 to 600 for a typical structure, but might far exceed these average values for special types of problems. Options available to users include: (1) The ability to change the size of the labeled COMMON to fit the problem being solved without recompilation. (2) Production of a tape file containing all the output, which may be processed at a later time by means of the ELAS-PLOT program to obtain mesh, curve or contour plots of various quantities. (3) Minimum Output (INP=0) line size of either 72 or 120 characters.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 6,955 source statements
PRICE: Program $680.00 Documentation $32.50
PROGRAM NUMBER: NPO-11555

COMTANK - Structural Design and Stress Analysis Program for Advanced Composite Filament-Wound Axisymmetric Pressure Vessels

A computer program, COMTANK, has been developed to design and analyze advanced composite filament-wound axisymmetric pressure vessels. The purpose of the program is to enable the user to automatically develop a detailed vessel design and perform a complex stress analysis of the design in an efficient and cost-effective manner. The program has been specifically developed to handle planar-wound pressure vessels fabricated of either boron/epoxy or graphite/epoxy advanced composite material. The vessel may or may not contain a cylindrical midsection; i.e., the tank configuration may be that of a cylinder with dome closures or an oblate spheroid. In the former case, provision has been made to accept unequal boss openings in the forward and aft domes. In general, input to the program must be provided in three basic categories. (1) Tank description, consisting of geometry and material property data. (2) Design loading condition; and (3) Analysis loading conditions. The tank description consists of a definition of overall tank geometry and component geometry relating to the liner, bosses, and shirt attachments. The design loading condition consists of internal pressure only. The analysis loading conditions consist of internal pressure, boss line loadings, and temperature gradients through the tank wall. Items (2) and (3) above indicate that it is possible to analyze a pressure vessel design for loading conditions other than those for which it was designed. Given the proper input, COMTANK will perform computations to provide output that describes a detailed pressure vessel design and stress analysis. The vessel design consists of midsurface coordinates defining the entire tank and shirt support element geometry; element wall thicknesses throughout the structure, ply construction, enclosed volumes, weight breakdowns, and material property details relating to filament tape wrap angles of coefficients of thermal expansion. The stress analysis consists of the entire displacement field of the structure, element nodal forces, stress resultants and couples, and point stress analysis, giving a detailed breakdown of the longitudinal, transverse, and shear stress in each layer of the composite at the point of consideration. The program makes a call for subroutine TICK which calculates the CPU time of a particular run. The user will have to supply his own TICK subroutine or remove the small amount of logic that utilizes the CPU time.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 7,079 source statements
PRICE: Program $610.00 Documentation $7.00
PROGRAM NUMBER: NPO-11943

WAVEFRONT - Structural Stiffness Matrix WaveFront Resequencing Program

WAVEFRONT is a preprocessor computer program that resequences the nodes of the structural stiffness matrix by means of a wavefront reduction algorithm prior to entering a standard structural analysis computer program. The input and output are oriented to produce computational advantages and core-storage reductions particularly within the NASTRAN structural analysis program. The submitted version of WAVEFRONT will resequence a structure consisting of up to 600 nodes and 1,800 connection edges, using 36,000 words of core storage. The foregoing size definitions can be readily changed by updating one procedure element and recompiling (with no changes to the source elements) portions of the remaining program elements.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1108
program size: approximately 599 source statements
PRICE: Program $350.00 Documentation $5.00
PROGRAM NUMBER: NPO-13322

Finite Element Analysis of Compressible Solids With Nonlinear Material Properties

The program is designed to determine displacements and stresses within plane or axisymmetric solids with linear or nonlinear properties, using the finite element method. In the finite element approximation of solids, the continuous body is replaced by a finite number of discrete triangular or quadrilateral element[illegible]connected at joints or nodal points. Approximat[illegible]are developed relative to the behavior of any one element and applied to the solution of the continuous structure. Equilibrium

equations, in terms of unknown nodal point displacements, are developed at each nodal point and the solution of this set of equations constitutes a solution to the system. The stress in the solid is found from the displacements at the nodes. The options in the program include axisymmetric solids analysis, plane stress analysis, nonlinear (plastic) analysis, and equivalent stress and strain (according to the Von Mises yield condition). Advantages of the finite-element method compared to other numerical approaches are numerous. (1) The method is completely general with respect to geometry and material properties. (2) Complex bodies composed of many different materials are easily represented. (3) Since anisotropic materials are automatically included in the formulation, filament structures are readily handled. (4) Displacement or stress boundary conditions may be specified at any nodal point within the finite-element system. (5) Arbitrary thermal, mechanical, and accelerational loads are possible. (6) In addition, the finite element approach provides equilibrium equations which produce a symmetric, positive definite matrix which may be placed in a band form and solved with a minimum of computer storage and time.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 1,477 source statements
PRICE: Program $340.00 Documentation $11.00
PROGRAM NUMBER: NUC-10342

THERMODYNAMICS AND COMBUSTION

Includes thermodynamic and transport properties; combustion processes and analysis; thermal protection systems; heat transfer; and heat exchangers.

Subroutine for the Thermodynamic Properties of Steam and Water

SMTAB was developed to determine the thermodynamic properties of steam and water. The properties as determined by this program agree closely with the properties tabulated in the Keenan and Keyes tables. Table look-up was not used because of inefficiency and large amounts of core storage required. Instead, SMTAB makes use of Keenan and Keyes' equations, as well as curve-fitting and surface-fitting techniques, to determine the required properties.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7090
PROGRAM SIZE: Approximately 327 source statements
PRICE: Program $230.00 Documentation $8.50
PROGRAM NUMBER: DOD-00007

Nodal Network Thermal Balance Program

This program is an update to an earlier thermal balance program that covered all stages of spacecraft life, from launch to orbital dynamic steady state. Internal heat exchange by conduction and radiation is determined, given the appropriate conductances, radiation view factors, and effective emittances. The program employs an implicit solution method, inverting the matrix of linearized data by the Gauss elimination method. Recent improvements and additions to the program include features which extend the basic thermal computations. Additional thermal computation options include a feature for maintaining at any desired constant temperature those nodes designated as "isothermal," an algorithm for estimating the power input (or output) required to maintain any given node at any desired temperature, a means of imparting a variable emittance to any node, a new transient mode associated with an exponentially expanding time period, and an option for going into steady-state mode after the last transient period. The program generates an extensive table with a node-by-node energy balance for every node in the model, a table giving the node-by-node components of the heat leaks by key nodes, and a table summarizing nodal temperatures at successive time periods.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,679 source statements
PRICE: Program $440.00 Documentation $7.00
PROGRAM NUMBER: GSC-11158

General Transient Heat Transfer Computer Program for Thermally Thick Walls

This is a general heat-transfer program which employs a finite-difference method for the solution of temperature histories of one-dimensional, two-dimensional or spherical systems. Options are available for heat input given in tabular form, computed from a trajectory, or computed from a temperature history given for a special location. The types of heat exchange are: (1) conduction; (2) convection with (a) given heat input, (b) heating due to skin friction with Van Driest equations, (c) stagnation heating with Sibulkin, Detra-Kemp-Riddell, and Cohen equations; (3) radiation-out; (4) air-conduction; and (5) joint conduction. The system configuration is specified by an arbitrary number of discrete elements and their interrelationships.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 2,795 source statements
PRICE: Program $420.00 Documentation $17.00
PROGRAM NUMBER: LAR-10794

Program for the Transient Reponse of Ablating Axisymmetric Bodies Including the Effect of Shape Change

A computer program has been developed to analyze the transient response of an ablating axisymmetric body including the effect of shape change. The governing differential equation, the boundary conditions for the analysis on which the computer program is based, and the method of solution of the resulting finite-difference equations are discussed in the documentation. Some of the features of the analysis and the associated program are (1) the ablation material is considered to be orthotropic with temperature-dependent thermal properties; (2) the thermal response of the entire body is considered simultaneously; (3) the heat transfer and pressure distribution over the body are adjusted to the new geometry as ablation occurs; (4) the governing equations and several boundary-condition options are formulated in terms of generalized orthogonal coordinates for fixed points in a moving coordinate system; (5) the finite-difference equa-

tions are solved implicitly; and (6) other instantaneous body shapes can be displayed with a user supplied plotting routine. The physical problem to be modeled with the analysis is described by FORTRAN input variables. For example, the external body geometry is described in the W,Z coordinates; material density is given; and the stagnation cold-wall heating rate is given in a time-dependent array. Other input variables are required which control the solution, specify boundary conditions, and determine output from the program. The equations have been programmed so that either the International System of Units or the U.S. Customary Units may be used. Calculations from this program may be saved for plotting purposes but the user will have to supply his own plotting routines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,679 source statements
PRICE: Program $540.00 Documentation $11.00
PROGRAM NUMBER: LAR-11049

FORTRAN IV Program for Calculation of Thermodynamic Data

This program calculates ideal gas thermodynamic properties for any species for which molecular constant data are available. These thermodynamic properties can be calculated in several ways. For monatomic gases, three methods are given which differ in the technique used for truncating the partition function. Unobserved but predicted electronic energy levels may be included. For diatomic and polyatomic molecules, five methods are given which differ in the corrections for nonrigid rotation, anharmonicity and vibration-rotation interactions. Excited electronic states may be included. The initial thermodynamic functions calculated by the program are heat capacity, enthalpy, entropy, and free energy. These functions are fit to empirical equations and, as a function of temperature, heats of formation and equilibrium constants are calculated from assigned reference elements and/or from these elements in their atomic gaseous state.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 3,572 source statements
PRICE: Program $350.00 Documentation $13.00
PROGRAM NUMBER: LEW-10254

Computer Program for Calculating the Thermodynamic and Transport Properties for Eight Fluids - Helium, Methane, Neon, Nitrogen, Carbon Monoxide, Oxygen, Argon, Carbon Dioxide

A computer code, GASP, has been developed to provide thermodynamic and transport properties of the following fluids: argon, carbon dioxide, carbon monoxide, fluorine, helium, methane, neon, nitrogen, oxygen, and para hydrogen. The equation of state and transport coefficients are updated and other fluids added as new material becomes available. GASP accepts any two of pressure, temperature or density as input condition. In addition, pressure and either entropy or enthalpy are also allowable input variables. The properties available in any combination as output include temperature, density, pressure, entropy, enthalpy, specific heats, expansion coefficient, sonic velocity, viscosity, thermal conductivity and surface tension. A special technique is provided to estimate the thermal conductivity near the thermodynamic critical point. Properties are calculated at pressures from 0.1 to 200 atmospheres (to 100 atm. for helium) and at temperatures from near the triple point to 300 K for neon, to 500 K for argon, carbon dioxide, fluorine and para hydrogen, and from 5.2 to 500 K for helium (restricted use below 5.2 K). The GASP package was developed to be used with heat transfer and fluid flow calculations, and as such has broad application. It appears to be particularly useful in the many applications of cryogenic fluids. Some of the problems associated with liquification, storage and gassification of liquified natural gas and liquified petroleum gas can also be studied using GASP.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/7044 DCS
PROGRAM SIZE: Approximately 2,183 source statements
PRICE: Program $440.00 Documentation $9.00
PROGRAM NUMBER: LEW-11629

ACMA - Aerotherm Charring Materials Ablation Computer Program

The Aerotherm Charring Materials Ablation (ACMA) program is an implicit, finite difference computational procedure for computing the one-dimensional isotropic transient transport of thermal energy in a three dimensional isotropic material which can ablate from a front surface and which can decompose in depth. The ablating surface boundary conditions involve considerations of surface thermochemistry. In principle, these surface thermochemical calculations could be performed within the ACMA program; however, it has proved more expedient to do these calculations in a separate program and use the tabulated results in the ACMA program. A number of programs may be used to provide the surface thermochemistry information. One program specifically intended for this purpose and specifically designed to complement the ACMA program is the Aerotherm Chemical Equilibrium Program (ACE) (Reference: LEW 11722). The output from ACE can be used directly as input to the ACMA program.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 1,935 source statements
PRICE: Program $260.00 Documentation $14.00
PROGRAM NUMBER: LEW-11854

Regenerative Cooling Design and Analysis Computer Program

This computer program was written for the design and analysis of a regeneratively cooled rocket engine, however, the program may be used for any convectively heated and cooled device. The influences of heat transfer, stress and cycle life are evaluated. Coolant passages may be formed by tubes or channels with or without a gas side wall coating. These passages may be designed based on a specified gasside wall temperature, coolant side wall temperature, or coating temperature distribution. Also a design may be analyzed with a specified coolant passage size distribution to determine the resulting wall temperatures and the coolant pressure drop. Options contained in the computer program include a two dimensional thermal analysis model of a tube or channel cross section which uses a relaxation technique with a variable number of nodes. Also a transient thermal solution is provided by a quasi two dimensional thermal model for considering influences of engine start, shutdown or throttling. Another option is the determination of structural safety factor and the cycle life of a design.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 6,429 source statements
PRICE: Program $350.00 Documentation $25.00
PROGRAM NUMBER: LEW-12110

Computer Program for Calculating Water and Steam Properties

A computer subprogram Water and Steam Properties (WASP) was developed to calculate the thermodynamic and transport properties of water and steam. The temperature range is from the triple point to 1750 K (2690°F), and the pressure range is from 0.1 to 100 MN/m2 (1 to 1000 bars) for the thermodynamic properties and to 50 MN/m2 (500 bars) for thermal conductivity and to 80 MN/m^2 (800 bars) for viscosity. WASP accepts any two of pressure, temperature, and density as input conditions. In addition, pressure and either entropy or enthalpy are also allowable variables. This flexibility is especially useful in cycle analysis. The properties available in any combination as output include temperature, density, pressure, entropy, enthalpy, specific heats (Cp and Cv), sonic velocity, (OP/Op)t, (OP/OT)p, viscosity, thermal conductivity, surface tension, and the Laplace constant. The thermodynamic properties are based on calculations using the Helmholtz free-energy equation of Keyes, Keenan, Hill and Moore; the transport properties are calculated by using standard curve fits in regions where these equations exist and are interpolated elsewhere. Temperature and all the other properties can be obtained as a function of pressure and enthalpy (or pressure and entropy).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,629 source statements
PRICE: Program $610.00 Documentation $12.50
PROGRAM NUMBER: LEW-12206

BETA II - Boeing Engineering Thermal Analyzer

BETA II uses numerical methods to provide accurate heat transfer solutions to a wide variety of heat flow problems. This new version of the original BETA increases its capabilities and broadens its options as well as making the program available to second generation computers such as the IBM System 360. The program will solve steady-state and transient problems in almost any situation that can be presented by a resistance-capacitance network. The continuous physical system in question is replaced by a "lumped" network system analogous to a resistance-capacitance network. Numerical equations that represent this network exactly are then solved. The solution is accomplished in a step-by-step or iterative fashion. Given a network of temperatures at each node, the computer makes a pass through the network using the numerical equations to predict the temperature at each node a short time later. This process of predicting the new temperature from the old is repeated for many iterations until the problem is solved.

LANGUAGE: FORTRAN H (98%) BAL (2%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 10,564 source statements
PRICE: Program $1,000.00 Documentation $48.50
PROGRAM NUMBER: MFS-15055

Thermal Analysis of Fluid Flow in a Pipe

Differential equations governing the thermal transient of fluid and wall temperatures for flow in an exposed constant diameter pipe are developed. These equations are solved with an IBM-360/Model 67 computer to obtain fluid and wall temperatures for increments of pipe length at time increments during a thermal transient. The computer program has the capability of solving heat transfer problems for fluid flow systems with a variable external thermal environment for the pipe and variable inlet fluid temperature and flow rate. This item may be used for the heat transfer analysis of fluid flow systems with a variable external thermal environment for the pipe and variable inlet fluid temperature and flow rate. Possible extensions include the analysis of vacuum jacketed and insulated piping systems. The techniques used could also be extended to include the thermal analysis of exposed cryogenic piping systems during cooldown and frost formation.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 300 source statements
PRICE: Program $340.00 Documentation $16.00
PROGRAM NUMBER: MFS-15148

RAVFAC - Radiation View Factor Program

This program represents a new technique for calculating diffuse radiation view factors, using contour integrals. The technique is combined with the finite difference (double summation) technique to compose this program package. Two techniques for calculating radiation view factors were included in this program because the contour integral offers greater accuracy and the finite difference offers faster run times. A combination of the two provides accurate results and keeps the run time within reason. A technique was also incorporated into the program to account for the effects of shading by other surfaces. There is a routine that reduces run time by eliminating surfaces that cannot cause shading on the areas for which the view factors are being calculated. The program provides the heat transfer engineer with a tool for rapid and accurate calculation of radiation view factors between systems of complex surfaces. These view factors are necessary for calculation of surface temperature distributions of vehicles exposed to heat sources.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 2,170 source statements
PRICE: Program $260.00 Documentation $18.00
PROGRAM NUMBER: MFS-21075

FNG - Fluid Network Generator

This program uses the Fluid Network Generator to standardize and simplify environmental control system thermal modeling. The program reduces analyst time to set up a complex fluid system computer model from weeks to minutes and makes complex fluid system trade-off studies practical. The program automates the environmental control system modeling technique and is well suited for parametric studies, proposal efforts, preliminary design studies, and project thermal efforts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-600 Series
PROGRAM SIZE: Approximately 809 source statements
PRICE: Program $160.00 Documentation $10.50
PROGRAM NUMBER: MFS-21082

C-2

SINDA - Systems Improved Numerical Differencing Analyzer

This program is written to assist in the thermal analysis of spacecraft and other bodies. This is usually an empirical process that grows in complexity as the size of the body being analyzed gets larger. By combining the Kalman filter with an electrical network analogy, it becomes possible to describe the thermal distribution as the sum of conduction and radiation time functions. The parameters falling out of the analysis form the coefficients for conduction and radiation terms suitable for computerization. However, to obtain a true temperature profile of a body requires a large number of data points or nodes. It has been found that the upper limit for rapid computerization is 100 nodes, which would indicate the elimination of networks with, say, 1,500 nodes. An existing computer program called CINDA 3G (Reference: MSC-11653) has provided the basis for developing the SINDA program that can handle both the analysis of a 100 nodal areas the body may have to be divided into in order to obtain the required temperature profile. The new program is called SINDA - Systems Improved Numerical Differencing Analyzer. This highly modified version of CINDA 3G contains numerous subroutine additions. The major differences between SINDA and CINDA 3G are: (1) elimination wherever possible of assembly language coding, (2) additional mnemonic options to aid the program user in data input, (3) inclusion of a second pseudo compute sequence for evaluation of nonlinear network elements, and (4) additional subroutines such as STEP (sensitivity analysis) and KALORS KALFIL (Kalman filtering). The additional mnemonic options provide for a source data block, nodal capacitance as a composite, polynomial representation of temperature varying conductors, etc. Subroutines are used for thermal network correction. These subroutines use the Kalman filtering technique. SINDA program options offer the user a variety of methods for solution of thermal analog models presented in a network format. The network represents a one to one correspondence to both the physical and mathematical models. SINDA contains numerous subroutines for handling interrelated complex phenomena such as sublimation, diffuse radiation within an enclosure, simultaneous 1-D incompressible fluid flow including valving and transport delay effects, sensitivity analysis and thermal network corrections method.

LANGUAGE: FORTRAN V and SLEUTH (UNIVAC 1108 Machine Language)
MACHINE REQUIREMENTS: UNIVAC 1108, EXEC VIII system. Six tape and/or disc units required for operation.
PROGRAM SIZE: Approximately 10,700 source statements
PRICE: Program $7,410.00 Documentation $4,250
PROGRAM NUMBER: MSC-13805

General Heat Transfer Program

A simple transient heat transfer program has been written for use on the IBM 360 RAX system. The program includes conduction, convection, and radiation interchange. The program is capable of handling radiation to space, applied heat fluxes, and boundary temperatures. The heat fluxes and boundary temperatures may be input as functions of time. Multi-dimensional problems of up to 30 nodes may be considered.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360 System
PROGRAM SIZE: Approximately 1095 source statements
PRICE: $50.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17026

Phase Change Subroutine for Use with Finite Differencing Programs

Previously, phase changes which began or terminated during a time step of finite differencing programs resulted in heat balance errors. This subroutine eliminates errors due to finite time steps and greatly simplifies the inclusion of phase change type materials into thermal math models. The program employs interpolation methods which results in eliminating the accuracy dependency on time step durations. It allows any number of phase change nodes to be handled by one "drop in" subroutine. Any finite differencing technique that is used on systems employing phase change materials can use this subroutine.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 45 source statements
PRICE: $70.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19184

Determination of View Factors to Finite Surfaces Using the H-P Desk Computer

This program will calculate view factors from points to any surface bounded by straight line segments. The procedure is based on a Stokes theorem transformation of the basic view factor area integral to an equivalent contour integral. For areas not bounded by straight line segments, a result can be obtained by approximating the area with straight line segments.

LANGUAGE: Computations and data are entered at time of processing.
MACHINE REQUIREMENTS: HP 9820A
PROGRAM SIZE: Not Applicable
PRICE: $25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-19500

Computer Program for the Steady-State Temperature Analysis of Plane or Axisymmetric Bodies

This digital computer program using the finite element analysis technique has been developed to determine the steady state temperature distribution within plan or axisymmetric solids. The continuous body is replaced by a system of triangular or quadrilateral elements. Each element is numbered. Each nodal point of each element is identified by its X and Y coordinate. Input into the program consists of nodal point identification, temperature or heat flow at boundary nodal points, material identification of each element, conductivity of each material, and convective heat transfer coefficient and temperature at each boundary nodal point. Each quadrilateral element is divided into four triangular elements. The conductivity matrix for each triangle is formed and then combined to form a 5 x 5 conductive matrix with respect to the five points. The 5 x 5 matrix is then reduced to the 4 x 4

quadrilateral conductivity matrix by standard techniques. The quadrilateral conductivity matrix is then added to the conductivity matrix for the complete body. The nodal point temperatures are then found from the solution of the resulting matrix equations. Within the program this is accomplished by a large capacity matrix solver. All temperatures are then printed. A particular feature of this program is that it provides output which is compatible for input to available finite element stress analysis programs.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 736 source statements
PRICE: Program $280.00 Documentation $6.00
PROGRAM NUMBER: NUC-10049

TRACK - Computer Program for Transient and Steady State Coupled Fluid Flow and Heat Conduction Analysis

This program is designed to compute detailed transient and/or steady state fluid conditions (flow, fluid temperature and pressure distributions) and spatial material temperature distributions for reactor components and other types of heat exchange apparatus or components. The specified conditions are the geometric parameters of the flow system which consists of multiple, parallel fluid channels for cooling of the solid material, plena initial conditions, the solid body geometry which can be arbitrary in shape and internal nuclear heat generation rates of the solid materials, if any. The transient solution at the end of a time step is obtained by iterating the channel wall temperatures between the fluid flow and the heat conduction analysis. The procedure starts with a trial channel wall temperature distribution. The fluid flow calculation distributes the fluid between the various flow channels, calculates the convective heat transfer coefficients, the coolant temperature and pressure distributions along the channels. Either the total flow rate or the system overall pressure drop between inlet and outlet plenum may be specified. The coolant temperatures and the heat transfer coefficients thus obtained are applied as boundary conditions to the heat conduction computation. The resultant channel wall temperatures are compared to the trial channel wall temperatures used in the fluid flow calculation. Iterations continue until the channel wall temperatures are within a specified tolerance at the end of the time step. Computation then proceeds to the next time step. Similar procedures are used for steady state determination. A transient problem can be started after a steady state solution is obtained. The program utilizes a finite difference solution to solve the governing transient fluid flow and heat conduction equations. It can handle up to 46 parallel flow channels with various single phase fluids. The heat conduction model may be two or three dimensional and consist of different solid materials with temperature dependent properties.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 4,918 source statements
PRICE: Program $680.00 Documentation $11.50
PROGRAM NUMBER: NUC-10189

AUTOTEM - A Computer Program for Automated Geometry Meshing and Heat Conduction Calculation

In calculation of a temperature distribution for an arbitrary irregular body by a finite difference solution, the body must first be divided into a finite number of lumped masses or nodal points. AUTOTEM generates the majority of the input data required for the analysis (the description of the physical nodal system). The program generates this data automatically and calculates the temperature distribution for a two dimensional plane section in (x, y) coordinates or axially symmetrical irregular body in (r, z) coordinates. There are four major sections: (1) meshing of the peripheral nodes, (2) generating of the regular interior nodes and input data required by the temperature calculation codes, (3) calculating of the temperature distribution, and (4) plotting of the general nodal network and isotherms. The data generated from one section are stored on tape and are punched out on cards. The execution of the problem can be stopped at the end of any one section for examination. The AUTOTEM code can handle any two dimensional (constant in the third dimension) or axial symmetrical body consisting of a single material. Time dependent internal heat generation, temperature dependent material thermal properties and time dependent boundary conditions can be considered. This program is missing subroutines, TLFL and TIMEX, but these routines can be omitted without loss of executability.

LANGUAGE: FORTRAN IV (98.6%); ASSEMBLY (1.4%)
MACHINE REQUIREMENTS: CDC 6600, SC 4020 plotter
PROGRAM SIZE: Approximately 10,719 source statements
PRICE: Program $1,030.00 Documentation $9.50
PROGRAM NUMBER: NUC-10241

TAPA - Program for Computing Transient or Steady-State Temperature Distributions

This program solves problems involving transient and steady state heat transfer in multidimensional systems having arbitrary geometric configurations, boundary conditions, initial conditions and physical properties. It is capable of considering different modes of heat transfer and boundary conditions such as internal conduction and radiation, free and forced convection, radiation at external surfaces, specified time dependent surface temperatures, and specified time dependent surface heat fluxes. The program will also handle space and time dependent thermal conductivity and heat capacity. In addition, the external boundary (environmental) temperatures may be functions of time. Either explicit or implicit mathematical methods may be used to solve the difference equations. The implicit method uses an overall heat balance on the body being investigated as well as the usual temperature convergence criteria. While stability and convergence of the solution are automatically provided by the program, the user has control over the accuracy of the solution and the amount of output data produced.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6600
PROGRAM SIZE: Approximately 1,775 source statements
PRICE: Program $490.00 Documentation $16.00
PROGRAM NUMBER: NUC-10282

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