Application Program

1620-1311 Linear Programming System
(1620-CO-04X) Application Description

This is a general-purpose programming system providing sophisticated mathematical techniques to determine the most efficient use of various resources in carrying out alternative activities. A number of programs are stored on the 1311. Each routine is called into core storage by procedural control cards when it is to be executed. The sequence of control cards defines the solution procedure.

Linear programming is a mathematical technique for determining the optimum allocation of resources (such as capital, raw materials, manpower and plant or other facilities) to obtain a particular objective (such as minimum cost or maximum profit) when there are alternate uses for the resources. Linear programming can also be used to analyze the economics of alternate availability of resources, alternate objectives, etc. Applications include production allocation, blending, distribution and shipping, production planning, market research, and material handling.

The IBM 1620-1311 Linear Programming (LP) System optimizes an objective function subject to the constraints of a system of independent linear equations. The system will accept problems having up to 100 equations (including objective functions) and up to 1, 000 columns (including variables and right-hand sides) for the minimum 1620 configuration. The revised simplex algorithm with special features is used to obtain a two-phase solution. Source language for the system is IBM 1620 SPS II-D. This program operates under the control of 1620 Monitor I (1620 PR-025).

DEFINING THE SOLUTION PROCEDURE

The IBM 1620-1311 LP system is composed of programs which are stored on the disks. The programs are called by procedure control cards called agendum cards. The sequence of agendum cards defines the solution procedure by forming the processing agenda to tailor the input, solution and output as required for an application.

The agendum cards may be divided into five groups:

1. The basic agendum statements.

INPUT.	To read in the data from card or disk. Problems may contain alternate objective functions and alternate right-hand sides.
MAX...	To maximize the objective function. The user may specify an alternate objective function and/or alternate right-hand side.
MIN...	To minimize the objective function when it is expressed in terms of costs.
OUTPUT	To write out the solution on cards, printer or typewriter.
ENDJOB	To specify the end of linear programming processing and return control to the monitor.

2. The extended output agendum statements. These statements may be used to determine the stability of the solution and to supplement the solution output. To simplify data classification for analysis and distribution, several output type statements may be repeated specifying different subsets of the variables and the slacks (or rows). The number of integers and number of decimals of the output data may be specified by the user for each type of output datum. The output amounts will be rounded to the specified decimals.

DO. D/J	To determine what price change would cause a variable to enter the basis (reduced cost for variable). To determine the value of relaxing a restriction (marginal value for the slack of that row).
COST. R	To determine the price range for each basis variable which gives the same optimum solution.

3. The extensions to input, to provide disk maintenance of data files.

SAVE..	To save the solution or solution and inverse in disk storage.
ERASE.	To delete a saved disk file.
REVISE	To revise elements of data stored on disks (objective and constraint row elements of variable and right-hand sides).

4. The provision for priority interruption.

GETOFF	To punch a restart deck when processing is interrupted for priority applications.

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5. The extended control of processing and accuracy.

CHECK. To check solution accuracy. This agendum may also be used to obtain submatrix solution summaries — for example, in feed blending, to find the protein and fat totals due to vegetable ingredients, or, in a production allocation problem, to find the production hours (lathe, grinder, etc.) for the production of selected production models.

ASSIGN To assign or vary floating-point length and tolerances, assign output devices, and to limit processing (for inversion frequency and occurrence).

INVERT To obtain an inverse for the current basis, or to reinvert the current basis to improve accuracy.

FEATURES

Input is simple and flexible in use.

- Variables, right-hand sides, objective functions and constraints may be selected from card or disk input by item name.
- Data is maintained on disk in compact form.
- An entry may be revised at any time.
- Several problems may reference different subsets of the same card or disk data files.
- Automatic slack generation, optional basis specification.
- SHARE standard data (matrix) card format for data compatibility with other linear programming systems.

Advanced mathematical methods are used to increase processing speed and accuracy.

- Revised simplex (product form of inverse) with automatic or user control of inversions.
- Assignment and variation of floating-point length and tolerances during solution processing may be under automatic or user control.
- The bounded variable algorithm is applied to range ($\leq$ and $\geq$) constraints (and bounded variables). In alloy scheduling (blending), for example, the silicon composition of an alloy (product) may be constrained to the range of 5% to 7.5% by one range constraint.

Extensive output reports are available and under the control of the user.

- The output device, number of decimals of the output data, and output items (subsets of variables and slacks) may be designated.
- The optional output reports include:
  - Basis variables and slacks (the solution).
  - Reduced cost and marginal values.
  - Optimum price range for basis variables.
  - Submatrix solution summaries.
  - Iteration log.

Extensive checking features are incorporated.

- Input is checked for duplicate row identifications, split or duplicate columns and right-hand sides, and duplicate coefficient entries.
- Solution can be checked for computational accuracy.
- Extensive computation checking maintains optimization accuracy within error tolerance.

MACHINE CONFIGURATION

1620 Model 1 or 2
One or more 1311 Disk Storage Drives
Core storage of 20,000 digits (see below)
1622 Card Read Punch
Indirect Addressing
Automatic Divide
Additional instructions (strip, fill, move flag)
Automatic Floating Point Operations (optional)
Online printer (optional)

System Capacity

Core size	Maximum rows including objective rows	Maximum columns including right-hand sides
20,000	100	1000
40,000	250	2000
60,000	400 *	3000

*Requires multiple disks.

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