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Computer Applications at the Ecuadorian Institute of Standardization (INEN): Observations and Recommendations

Joseph Hilsenrath

Office of Standard Reference Data
National Bureau of Standards
Washington, D. C. 20234

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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COMPUTER APPLICATIONS AT THE INSTITUTO ECUATORIANO DE NORMALIZACION:
OBSERVATIONS AND RECOMMENDATIONS

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This report contains specific suggestions for computer applications at the Ecuadorian Bureau of Standards (INEN). The suggestions, based on observations and discussion during a 10-day visit by the author in Quito, Ecuador, cover editing and typesetting of Ecuadorian standards, data storage and retrieval, and statistical analysis of experimental data.

1. Introduction

During the week of October 7, 1974 this author had the privilege of visiting with the Director General and the staff of the Instituto Ecuatoriano de Normalizacion (INEN). This visit was part of an on-going program of cooperation and consultation between NBS and INEN under the USAID program. The NBS work is funded as a follow-up of the Survey of Standardization and Measurement Services in Ecuador¹ carried out under the direction of Ing. Raul Estrada A. Visits were also made to the Escuela Politecnica Nacional and the office of IBM del Ecuador, the Data Processing Center of the Mobilization Department.

The discussions with Ing. Raul Estrada, Director General of INEN and his staff served as an indoctrination into the present activities and expanding mission and responsibilities of INEN. It is in the latter connection (the authorized expansion of the staff and corresponding workload) that consideration of computer utilization is both pertinent and timely.

Discussions during the week covered not only problems internal to INEN, but a number of problems of more general concern to the government of Ecuador. These relate to the utilization of computers in all of Ecuador. This problem was brought into focus by Dr. Soto of the Junta de Planificacion who discussed, at some length, his comprehensive survey of computer installations and usage - both in the government and the private sectors. The survey shows a surprisingly low level of usage, a fact which is of considerable concern to the Junta de Planificacion. Since the full report will be published soon, it would be best to defer comment on that subject until that report is in hand.

A number of general questions were raised regarding quality control of measurements within the INEN and of products outside of INEN. These subjects are beyond the scope of this report as solutions to these problems are to be found primarily in precise measurement practices in the former case; and in the application of sound sampling techniques in the latter. Two related aspects can however be dealt with here. The first is to recommend suitable statistical and mathematical analysis programs, which we do in a later section. The second is to recommend for translation into Spanish, a number of U.S. publications in the area of precision of measurement and related statistical topics. Such a program of translation and publication, already under consideration at INEN, would provide an important supplement to the existing INEN program of diffusion of standards and precise measurement techniques in Ecuador as well as other Latin American Countries.

We suggest as a first candidate for translation, a small booklet of 125 pages by the late W.J. Youden entitled Experimentation and Measurement. This engaging booklet was prepared 13 or so years ago by Dr. Youden. It has been widely distributed by the National Science Teachers Association in their Vistas of Science Series, and its reprinting is currently under consideration at NBS. The present and previous Chief of our Statistical Engineering Laboratory concur in this recommendation. A sample copy has been forwarded under separate cover.

2. Computer Power in Quito

Until now INEN has not used digital computers in its work. In fact, until recently computer facilities in Quito were quite limited. Soon there will be two organizations in Quito that have modern digital computers with disc storage facilities and telecommunications of sufficient capacity to contemplate a program of automation of text processing, data storage and retrieval, and numerical and statistical data analysis. Time on both of the machines (IBM 370/125) can be made available to INEN. It is now readily evident from our meetings with Captain Manuel Yopez Moriera of the Direcion de Mobilizacion and with Dean Konti Hori of the Faculty of Electrical Engineering at the Escuela Politecnica Nacional that the computer facilities at these organizations will be available for use by INEN.

It was equally evident that in mid 1975 INEN will be able to access the computer at the Polytechnic from a terminal (2740) over telephone lines. This will enable INEN to enter jobs remotely but not to carry on on-line text editing. The degree to which the system at the Polytechnic can be made to support on-line interactive editing and retrieval will not be clear until more information is available here on the operating system and the software which will run on the 370/125. This subject is under investigation here and will be reported on in due course.

3. General Areas of Application

Among the activities internal to INEN where computer systems or techniques might well be applied, are the following:

- a. Operation of the INEN Library; especially in creation and maintenance of the catalogue of holdings of books and technical journals.
- b. The production of the Normas Tecnicas Ecuatorianas (Ecuadorian Standards).
- c. Creation of a data file for information retrieval on INEN standards and sources referenced therein.
- d. Mathematical and statistical analysis of measurements made within INEN and in industrial establishments under INEN guidance.
- e. Techniques for collection and analysis of data in various programs to be undertaken by INEN, as for example, the industrial accident reporting and prevention program.

We shall now take these topics up in turn.

3.1 Automation in the INEN Library

3.1.1 The Card Catalogue. At the present time the INEN Library maintains a 3x5 card file prepared by hand and cross referenced by author and subject. There will come a time when INEN will have had enough on-line experience to conclude that the library should also have a computer terminal. Until that time, it is possible for the library to build up a computerized file of its holdings (exclusive of standards) using either an MT/ST or a Key Punch.

Use of dual-cartridge MT/ST will permit the preparation of cross-referenced index cards for the card catalogue and provide also for the accumulation of a computer-based list of holdings. A paper by Robert I. Hirst² in Special Libraries describes how, with a single typing on an MT/ST, it is possible to produce all of the cards in a cross-referenced card catalogue. There are two added bonuses that accrue from this system:

- a. a duplicate set of cards can be made to be used in the annex recently rented by INEN:
- b. if a converter is purchased, the MT/ST tapes can be converted to magnetic tapes that can be used on the 370/125 computer. This will permit the gradual building up of a computerized catalogue of INEN library accessions.

The above scheme takes care of the new accessions only. When that portion of the job is well in hand, it will be time to decide whether an additional effort should be put forth to catch up with the earlier holdings. I believe that the use of the MT/ST to prepare a duplicate set of cards for the card index is labor saving even if there is no time to catch up with the older material or even if a converter is not available immediately.

A computerized catalogue of library holdings could, of course, be produced on a keypunch or on the terminal which will be connected to the computer at Polytechnic Institute. The technique described in the paper by Robert I. Hirst should be considered seriously for preparing library catalogue cards of new accessions because it will yield immediate results, and can be handled quite adequately by the existing library staff or at most with a little clerical help.

3.2. Where Can Automation Assist in Preparing INEN Standards?

When a decision is reached that a particular standard is needed, the appropriate advisory panel is selected, and an INEN staff member is assigned to prepare the standard, the ensuing activities are possible candidates for automation.

Among the activities that might be automated are the following:

- a. Gleaning from the library of thousands of existing ISO standards and from other countries, the dozen or so applicable standards which will provide guidance for the preparation of an INEN draft.
- b. Preparation of the draft standards for circulation, revision, and ultimate publication.
- c. Creation of a computerized data base of current INEN standards.
- d. Creation of a cross-reference file of INEN standards referred to in other related INEN standards.
- e. Creation of an index to current INEN standards on the basis of content and/or index terms or classification symbols.

We address ourselves now to each of these areas in turn.

3.2.1. Gleaning Source Material for INEN Standards. This problem is disposed of easily. Burdensome as it may be, the problem of finding, among thousands of existing standards, the dozen or so standards that are pertinent to the problem at hand, cannot be solved easily or quickly without diverting the staff from its major objective. The information in the standards library cannot be automated adequately without a large intellectual effort out of proportion to the benefits it will bring.

A preliminary automation is possible without a great deal of professional involvement if we restrict ourselves to listing only the titles and sources of the standards. This has been done in the World Index of Plastics Standards (NBS Special Publication 352)³ and in An Index of U. S. Voluntary Engineering Standards (NBS Special Publication 329 and its supplement)⁴. They show the format of a KWIC (keyword in content) index of the titles. In this system each important word in the title is displayed in the center of the page so as to be readily listed in alphabetic order. The words on either side are retained within the limits of the width of the page to display the context in which the indexed word appears.

Programs are available for preparing KWIC indexes from a file of titles. But even this minimal effort would be a diversion from more important work at this stage when INEN is gaining experience with new computer techniques. In the other areas enumerated above and discussed below, computerization should yield faster dividends.

3.2.2. Preparation of the Normas Tecnicas Ecuatorianas. In this section we suggest a number of modifications to the existing system at INEN for producing the INEN standards so as to reduce the "bottlenecks" in the present system. A major drawback to the present system is that the single station MT/ST does not allow for the numerous and heavy revisions and editing entailed in bringing a standard from the first draft to the final approved document.

Director Estrada recognizes this problem and has ordered a typewriter that records on magnetic cards (MC/ST). That machine will make it much easier to handle draft revisions. It does not, however, interface with the MT/SC Composer which produces the camera-ready pages of the published standard.

In view of the fact that INEN now owns two single station MT/ST's as well as a composer (MT/SC) and has had considerable experience with these machines, it seems wise to build on that experience in upgrading the facility.

Thus if INEN were to acquire a dual-station MT/ST to supplement the single station machines, the text revisions could be handled more expeditiously via the present system. In addition, these machines can provide input to a more modern phototypesetter discussed below. Were it not for the fact that INEN anticipates an increased workload in this area, we would have suggested that one of the single-station MT/ST's be traded in for a dual-station machine. Another alternative is to trade both machines in for dual-station versions, thereby making them both self-sufficient editing devices. The price of these machines has been reduced recently in

the U.S. It is therefore worthwhile to open discussions with Mr. Alfonso Falcony concerning a trade-in arrangement.

Another drawback to the present system is the requirement to change type balls during the "typesetting" process. This problem can be avoided by the purchase of one of a number of modern phototypesetters ranging in cost from \$15,000 to \$25,000. The addition of a modern photocomposer in the \$25,000 class would not only speed up the production of INEN standards, but would provide sufficient reserve capacity to undertake a major publication program for technical tracts related to the INEN mission.

One of the new phototypesetters can be obtained with a device to read MT/ST tapes. The selection of such a system would allow for a more or less painless conversion in which the existing equipment and experience can be carried over easily to the more modern technology. In addition, as long as INEN retains the MT/SC composer, there will be a good backup system. At a later stage, when the new system is well established, the older system could be passed on to another governmental organization whose workload is more commensurate with the capabilities of that equipment.

It is important to note that the newer phototypesetters can be fed not only from MT/ST cartridges but from a variety of paper and magnetic tape produced on a computer. While this feature is of no immediate advantage to INEN at its present state of computer sophistication, it will be useful later. Nevertheless, the mode of production of INEN standards recommended above will make it possible to accumulate a computer file of text and related information concerning the INEN standards.

In a recent visit to Washington, Director Estrada had an opportunity to observe, first hand, the operation of a system described above in a competitive commercial environment. As he is now in possession of the pertinent technical specifications, there is little need for us to do much more on this problem.

3.2.3. Current INEN Standards on Computer Tape. In the previous section we suggested that a more modern phototypesetter can operate from MT/ST cartridges. Here we suggest that the very same cartridge (containing the complete and final text of a standard) can be converted to computer readable magnetic tape via a commercial device costing in the neighborhood of \$7000. If such a converter were available at INEN, it would be a fairly painless process to accumulate a computerized data base of published INEN standards to facilitate:

- a. subsequent revisions of individual standards
- b. preparation of subject indexes
- c. generation of cross references lists.

Since the preparation of indexes and cross reference lists would be needed long before the newer standards will be subjected to revisions, considerations should be given to automate these indexes and cross-reference lists in an independent operation. That operation can be carried out either via a keypunch or via the remote computer terminal. Which method is chosen initially should be governed by the experience the INEN staff develops and by the priorities assigned to various tasks requiring the use of the particular terminals. It is fortunate that a practical

system can be developed using either machine. Further suggestions on this topic must wait until access to the computer by INEN has become a reality and we know more about the software systems that are available for the machine. In the next section (Section 4) we outline the steps being taken at NBS to assess the capabilities of the computer to be installed at the Escuela Politecnica Nacional, with specific reference to the needs of INEN.

3.2.4. Magnetic Card vs Magnetic Tape Typewriters. The previous discussion was predicated on the assumption that for the short term it would be wise to rely upon existing equipment and practices in upgrading the typesetting facility. Mention has already been made that INEN will shortly acquire an MC/ST which uses magnetic cards instead of magnetic tapes. NBS makes extensive use of such mag card machines as they are more convenient to manipulate than the earlier MT/ST's. Furthermore there is a communicating version of the mag card machine which can be used as a computer terminal as well as a stand-alone off-line editing device. Further still, the on-line text editing system (ATS) used extensively at NBS accepts input from the communicating mag card machine as well as a variety of other terminals. It is therefore to the point to inquire how the machine to be installed at the Escuela Politecnica Nacional can be made to accept input from MC/ST's as well as from the 2740 terminals. It is questions of this sort as well as many others which must be raised and answered before a long range firm plan of action can be recommended. Some of the steps NBS has taken to acquaint itself with the capabilities and potentialities of the Escuela's computer configurations are discussed below.

4.0 System Analysis and Evaluation

As indicated in section 2, INEN can have access to two computers (IBM 370/125) - one at the Mobilizations Office in the Army and the other at the Polytechnic Institute. The latter can be accessed via a remote terminal over telephone lines, and we understand that INEN has made arrangements to acquire a terminal and the requisite telephone interface. Since the computer is new to the Polytechnic as well as to INEN, (and even to IBM Ecuador), INEN must rely upon NBS or a similarly experienced institution for advice. Furthermore such advice is needed as soon as possible so to mesh with the plans of the Polytechnic and with the current expansion program undertaken by INEN. The advice cannot be given without a careful detailed functional analysis of the exact computer configuration in question and the software which the hardware can utilize.

In view of the situation described above, NBS has obtained a complete set of manuals for the 370/125 and has established contact with local organizations utilizing this machine. We have also arranged for the services of Dr. Blanton C. Duncan, a former NBS staff member and a leading exponent of text processing in a standards environment, to carry out a detailed system analysis as outlined below.

4.1 System Evaluation Tasks

Prepare a functional analysis of the operational capabilities and of the potential application areas of the IBM 370/125 computer configuration as installed at the Escuela Politecnica Nacional, Quito, Ecuador with special reference to:

- a. Remote batch job entry and teleprocessing
- b. Interactive processing via Time Sharing Option (TSO)
- c. Feasibility of supporting the Administrative Terminal System (ATS) and/or the Advanced Text Management System (ATMS).
- d. Assemblers and compilers (BASIC, FORTRAN, COBOL, PL/1, etc.) delivered with the computer or that can be leased for operation on the computer configuration in question.
- e. Capabilities for extended print capability including printing scientific text taking into account the range of capabilities of compatible printers available for installation in the system.
- f. Range of input/output media needed to be considered in data capture and data interchange.
- g. Formal and de-facto standards relevant to current and projected system applications with specific reference to standards developed for computers and information processing by the International Organization for Standardization (ISO).

5. Numerical and Statistical Analysis Programs

Reliable and efficient computer programs for mathematical and statistical data analysis are essential tools for carrying forward scientific and technical as well as administrative projects in any modern scientific organization. In a standards organization special attention must be paid to the reliability and accuracy of the computed results. The above sentence would seem uncalled for, were it not for the unhappy fact that many existing computer programs for statistical analysis have failed to measure up to the accuracy they report, when subjected to rigorous tests. This state of affairs has been documented in two separate studies by James W. Longley in the Journal of the American Statistical Association⁵ and by Roy H. Wampler in the NBS Journal of Research⁶. In large measure, the programs that fail to measure up to good standards of accuracy make use of techniques that are quite adequate for hand computation on a desk calculator but suffer seriously from round-off errors on a digital computer. The problem is further aggravated by the fact that even modern school texts on statistical techniques still feature calculation methods better suited to desk calculators than computers.

A more general but less critical survey of statistical packages was published by W. R. Schucany and Paul D. Minton in 1972 in Computing Reviews⁷. Another view of problems associated with handling data (especially large census data files) is contained in a paper published in 1970 by Rudolph C. Mendelsohn in The American Statistician⁸.

5.1 OMNITAB II

It is no accident that the OMNITAB^{9,10} system for numerical and statistical analysis developed at NBS receives prominent mention in each of the above cited works. Although statistics was only a small part of the original OMNITAB implementation, we were careful to employ methods most appropriate for computer operations. The result is one of the more accurate systems in existence. Another important advantage of OMNITAB is that its use requires no programming experience, as the instructions to the computer are given by simple commands consisting largely of declarative English sentences. This feature of the system allows it to accept commands in other languages just as readily.

The system has been rewritten completely in standard ANSI FORTRAN by the staff of the NBS Statistical Engineering Laboratory and is available under the name OMNITAB II¹¹. That version has been made jultilingual and will accept commands in either English, Spanish, Italian, French, Swedish, German, etc. It would therefore be natural for us to recommend that system, except for the fact that it is too large for the computers presently available in Quito.

We understand that plans call for increasing the core size of both machines as their use increases. When this is achieved the OMNITAB II system will probably fit. Until that time, good use can be made of two of its modules. These are the PLOT and STATIS modules. The former will allow for the generation and maintenance of control charts, while the latter will provide a comprehensive statistical analysis of the type described by Dr. H. H. Ku in NBS Technical Note 756¹².

The plot routines are available as a separate FORTRAN package. They are described in an informal programming document (PAC 11) prepared by the NBS Statistical Engineering Laboratory¹³. The STATIS program is available as a separate BASIC program. Copies of these programs will be forwarded as required later.

5.2 Minitab

Minitab is a smaller statistical analysis system patterned after OMNITAB. It was written at the Pennsylvania State University. Although it does not have any facility for finite difference operations or many higher mathematical functions, it is richer in statistical methods. Furthermore it is more likely to fit on the Quito computers as they are presently configured.

The Minitab system is specialized for students and statistical researchers and is therefore quite suited for the Escuela Politecnica Nacional as well as for INEN. A brief description of the Minitab system was published by T. A. Ryan and Brian L. Joiner in 1973 in The American Statistician¹⁴.

After two years experience in using Minitab in the instruction program at the Pennsylvania State University, the system was rewritten and a second larger version is now available as Minitab II. The preliminary manual for the first version has been revised extensively and is now available from the University book store. The latter is especially well written and may well be a candidate for translation into Spanish if the Minitab II system can be made to run on one of the computers in Quito. Copies of the users manuals for Minitab¹⁵ and Minitab II¹⁶ will be sent along later.

The authors of Minitab - Professor Thomas A. Ryan of Penn State and Professor Brian L. Joiner (now at the University of Wisconsin) have graciously made their systems (both Minitab and Minitab II) available to NBS for transmittal to INEN. Their system tape is now at hand. It will be studied here briefly to ascertain which problems, if any, could arise in getting it running on the computers in Quito.

6. Programs for Text and Data Manipulation

Any utilization of computers for accumulating bibliographics, text material, indexes, etc., requires programs for editing, searching, sorting, and other manipulative chores. The Data Systems Design Group in the NBS Office of Standard Reference Data has built, up over the years, a package of general purpose programs to assist in such operations. Some of these programs have run successfully with little or no modification on a number of computers of different manufacture, and others can be made to do so with only moderate effort.

These programs have been described in the following NBS Technical Notes: 444, 470, 500, 700 and 820. These publications are already available at INEN. Additional copies will be sent to the Polytechnic. In addition we will endeavor to run these programs on a 370/125 locally. When they have run successfully here, we will send them to the INEN to pass on to the Polytechnic and/or the Army computer facility.

7. Equipment Considerations

7.1 Keypunch

Even though INEN will have access to the computer at the Polytechnic from a remote terminal (2740), it is not realistic to rely solely upon that device. For some time to come, the facilities available via the 2740 terminal will be limited in comparison with those available via conventional punched card input in the batch mode. It is important to recognize that programs for batch mode operations will be required, and that a keypunch machine will be essential for the efficient utilizations of these programs.

7.2 Communicating Magnetic Card Selectric Terminal (MC/ST)

From a preliminary appraisal of the features of the 370/125 and from a discussion with the original designer of IBM's Administrative Terminal System (ATS), we are reasonably confident that ATS will run on the machine at the Polytechnic. Should this be the case, it will be necessary to use either a 2741 Terminal or a communicating MC/ST. The former is less expensive, but the latter allows for typing and editing off-line as well as on-line. Both of these terminals are being used effectively at NBS, where the ATS system has been in use for the last seven years with excellent results. Unlike other software packages, ATS can be obtained from IBM without cost as it is a type 2 program and is considered to be in the public domain.

8. Epilogue

In the foregoing, we have touched upon most, but not all, of the areas of current INEN concern in adopting modern computer techniques in furtherance of its mission. It is recognized that the precise pace and direction in which computerization will progress depends upon sundry variables - staffing levels, funding, delay in delivery of equipment, institutional cooperation, administrative priorities, etc. It is quite possible that rapid advances in one area would argue for modifying plans in another.

We have been careful, in our recommendations, in three ways. First, we have suggested techniques that take advantage of existing experience and talent at INEN. Secondly, we have recommended terminal equipment and computer software with which NBS has itself had considerable experience. Finally we have recommended and will supply software packages of utility to the Polytechnic as well as to INEN.

After the computer is installed at the Polytechnic and it has had its "shakedown cruise" it would be appropriate to consider one or two workshops for INEN staff and for the technical staff of the industrial organizations that make up the INEN constituency. Such a workshop might well be planned as a prototype for a series of workshops and seminars under the sponsorship of the Andean Development Organization or other regional organizations.

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