AUTOMATION OF CARTOGRAPHY AT THE MEXICAN STUDIES COMMISSION FOR THE NATIONAL TERRITORY

Alberto Torfer Martell
Comision de Estudios del Territorio Nacional

INTRODUCTION

The purpose of this paper is to present the work done in the Studies Commission of the National Territory regarding the implementation of a geographical data base and the automation of cartography. To understand how useful both developments can be to our organization, the scope of our work should be kept in mind.

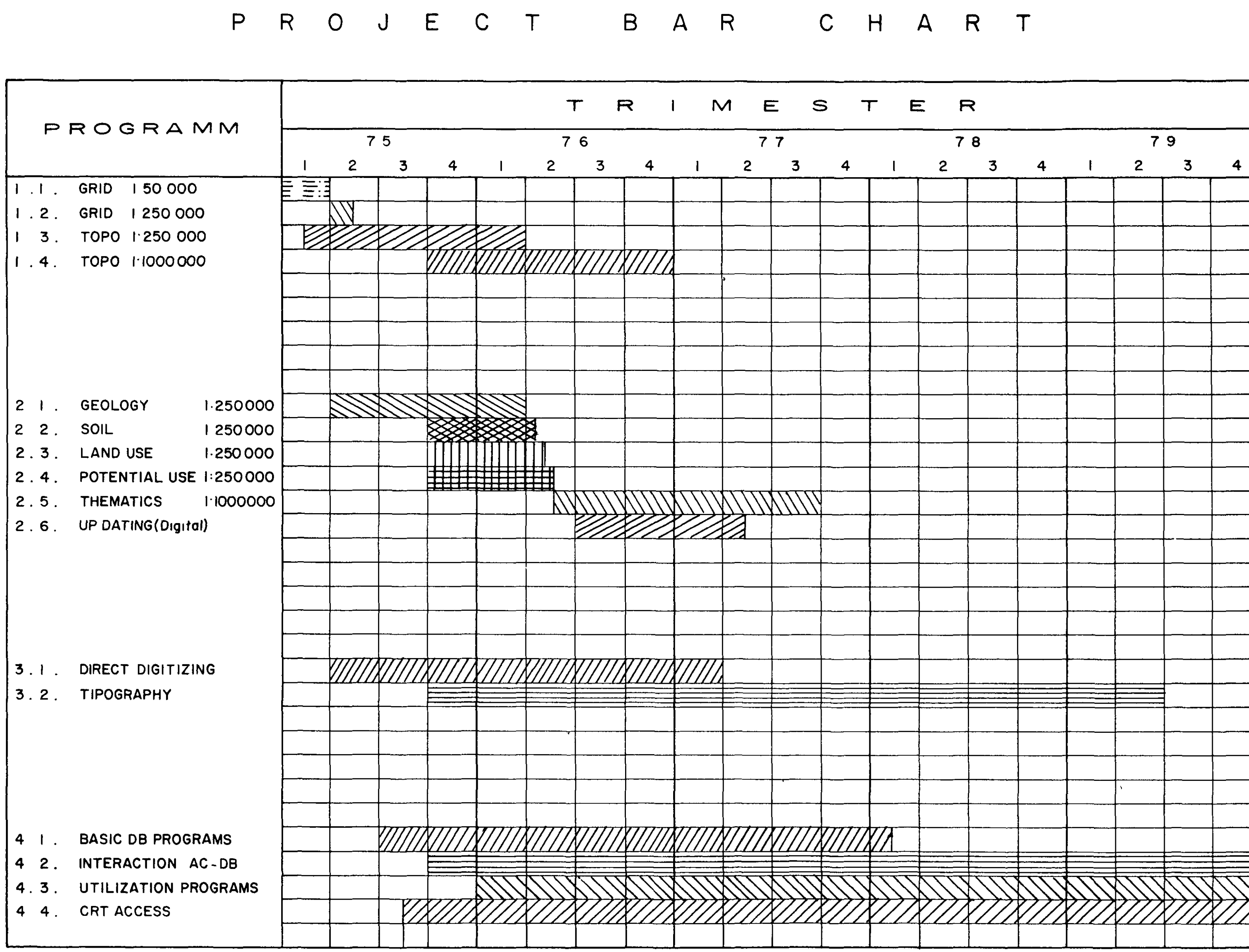
The Commission is in charge of the production of the topographical, geological, land use, soils and potential use maps for the whole Mexican Republic. This work is being done at 1:50 000 scale and to get full coverage we will need 2,354 maps for each series. The work is being done completely at our unit, using the techniques of photogrammetry, photointerpretation and geodesy. Right now, we have printed over 576 topographical maps and over 1,071 thematic maps (See Figure 1).

The topographical map has all the information regarding orography, hydrography, and human works. The geological map has information about rocks, soils, mines and exploration sites. The land use maps show the activity to which the land is being dedicated, along with the classification of types of cultivation, the technology used in development of land, the classification of vegetation, and a very important aspect -- the distribution of population.

The soils maps give information on the physical, chemical, and biological characteristics of soils. The potential use maps show the best way to use the land, what it needs to prevent erosion, what infra-structure should be built to develop the region faster and more fully. It can be stated that the information produced by CETENAL (acronym of Comision de Estudios del Territorio Nacional) represents about 80% of the information needed to make a good decision in planning the development of a nonurban region.

In the few years of the existence of CETENAL, the usefulness of the information produced has been amply demonstrated. What we are trying now is to help users even more by providing alternate ways of presenting information. We estimate that this will be one of the best ways to justify the investment made in the elaboration of our base maps.

Figure 1


PROJECT BAR CHART
PROGRAMM
TRIMESTER
75 76 77 78 79
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
1.1. GRID 1 50 000
1.2. GRID 1 250 000
1 3. TOPO 1:250 000
1.4. TOPO 1:1000000
2 1. GEOLOGY 1:250000
2 2. SOIL 1 250000
2.3. LAND USE 1:250000
2.4. POTENTIAL USE 1:250000
2.5. THEMATICS 1:1000000
2.6. UP DATING (Digital)
3.1. DIRECT DIGITIZING
3.2. TIPOGRAPHY
4 1. BASIC DB PROGRAMS
4 2. INTERACTION AC-DB
4.3. UTILIZATION PROGRAMS
4 4. CRT ACCESS

OBJECTIVE OF THE AUTOMATION OF CARTOGRAPHY

To have a broader view of the problems of a region, you have to generalize the information you are presenting, simplifying by selection, modifying or eliminating the features shown on a base map.

Cartographers do this when they develop a derived map by extraction and generalization of the information presented in a base map. At the same time a change of scale may be used. This process can be computer-assisted by adding digitizing, computer processing and plotting activities.

However, the implementation of these last steps is quite expensive. So, to really absorb the cost there must be enough production once the production line has been established; a significant production time decrease is also needed. Otherwise automation will not be significant or useful. Unfortunately this cannot be accomplished by a simple system, especially with the topographic map.

The digitizing process is a time-consuming and laborious operation in which the best equipment is needed. One should be able to digitize at the same time the photogrammetric compilation is being done to avoid as much as possible the need to retrace any feature. Some steps of the production of the base map itself would also be automated. The use of scanners or line followers may be an alternate way to fulfill the need to speed up the digitization process. This applies mainly to the topographic map. With the resources maps the situation is not so critical because the number of lines separating the different properties is much less than the number of lines for a topo-map.

The cost of the digitization can also be spread among other products. We are trying to make at least two different derivative maps -- at 1:250 000 and 1:1 000 000 scales -- and we are using the information in digital form to build the geographical data base.

Right now, the programs that handle the information of level curves and of hydrography have been finished, as well as the programs to handle the polygons of the resources maps.

Our equipment is an H. Dell Foster RSS 400 II Graphic Quantizer and a H. Dell Foster RSS 700 Plotter. We use a general purpose IBM 370-135 computer for our calculations.

The interrelationship between automatic cartography and the geographical data base will be done by means of several programs. One transforms the polygon data base built at the processing stage for the 1:250 000 scale map to the cell data unit used in our data base. This may be the only sensible way of constructing it, since the manual coding of all the information is quite time-consuming. Another program will form from the digitized contours a more or less crude digital terrain model included in the geographical data base.

OBJECTIVES OF THE DATA BASE

The purpose of the data base can be stated quite easily: To put into computer-compatible form, all the information produced by CENTENAL in order to be able to ask any type of question by selecting, comparing, or merging the information.

To get a flexible system it was decided that the query language should be flexible and it should allow for easily growing types of questions. So, it was decided that the questions should be built with logical operands like 'and', 'or', 'not' and their combinations.

This more or less automatically shifted the decision to a cell system; the Mexican Republic was divided according to the sizes of our maps. That is, a cell of the 1:50 000 map equal to the size of the whole 1:10 000 map, the cell for the 1:250 000 scale is equal to the whole 1:50 000 scale map. To code the properties we have for each cell a basic header that tells us how many superficial properties are coded and the address of all of them and how many lineal properties and the addresses of the lineal property descriptors. The point properties are treated as a special case of the lineal property; all properties are identified by a code.

Also several special functions have been programmed which form the basic building blocks for the questions. These functions are of two types: relational and logical.

The relational functions are:

MAYORQ	-	Greater than
MENORQ	-	Less than
ENTRE	-	Between A1 and A2
DIFERE	-	Different from
IGUALA	-	The same as

The logical functions are interrelated by the logical operands and, or, not (or their combination) and use the relational functions as arguments. They are:

PRO (A1, A2, A3) Property, the arguments are:

- A1. - Which should be the code number of the property evaluated
- A2. - Is a relational function
- A3. - Is the value against which we are comparing

UNADE (A1, A2, A3, A4) - one of A1 and A2 -- are code numbers of properties; between them the system will compare, as marked by the A3 argument, which is a relational function, against the value given in A4.

PROP (A1, Entre, A3, A4) This function serves to find when the property coded in A1 is between the values given in A3 and A4.

EVALUA - Evaluates the properties of a place.

VALOR - Prints the properties of a cell.

CERCA - Orders the system to work also with the neighbors of a cell.

IBUSCA - Used with CERCA to find a property.

With the point and lineal descriptors there is also a special set of functions. They are:

PUEBLO (A1) Find Towns and the related information by coding the number of the town.

HAYVIA (A1, A2) Find the communications linking a town. The type of communication is given in number A1; in A2, the number of the town is coded.

SERPOB (number a, b, c, d, e, f, g) Gives the information of the services already given to a town.

SERPO (A1, A2) Gives the list of proposed services for a town.

These functions are not all the ones that can be programmed. Indeed every question could be stored in a library and could be used in future references. An example of a question is given in Figure 2.

Figure 2

```
                              LECHE                    DATE # 76042

LOGICAL FUNCTICN LECHE%NE
LOGICAL PRC,UNADE,MAYCRG,MENCRG,IGUALQ
EXTERNAL MAYORG,MENORG,IGLAIG
         PRCGRAMA PARA DETERMINAR LAS SIGUIENTES CCNDICIONES PARA
         LA DELIMITACICN DE UNA CUENCA LECHERA.
         1.- PENDIENTES MENCRES DEL 8/1CO.
         2.- TERRENCS NC SALITRCSCS.
         3.- TERRENCS NO RESEALCSCS.
         4.- TERRENCS SIN USC FCRESTAL.
         5.- TERRENOS SITUADCS A MENOS DE 2200 METRCS DE ALTITUD.
         6.- TERRENCS CCN SUELC FIRME%SIN PANTANOSE.
         7.- TERRENCS CCN SUELCS PERMEABLES QUE NC SEAN ROCCSOS.
               QUE NO PRESENTEN GLEYSCL,VERTISOL, SCLCNETZ,
               PLANOSOL,LUVISCL,PODZOLUVISOL,ACRISCL,NITOSOL,
               HISTOSOL C LITCSCL NI COMC SUELO PREDCMINANTE,
               NI COMO SECUNDARIC. TAMPOCO DEBEN TENER RCCAS IGNEAS.
         8.- TERRENOS EN LCS CUALES CUALQUIERA DE ENTRE PRESA,
               BCRDO, DEPCSITC DE AGUA, LAGUNA,LAGO, MAR
               O TERRENC LACUSTRE, NC OCUPEN MAS D53 V0100
               DE LA SUPERFICIE, AL NIVEL QUE SE ESTE BUSCANDO.
 M#90
 N#1CO-M
 LECHE#PRO%58C4,MAYORG,8CE
X     .AND..NCT.UNADE%56C2,56C4,MAYCRG,ME
X     .AND.PRC%57C2,MAYCRG,ME
X     .AND..NCT.UNADE%63C1,64C6,MAYCRQ,ME
X     .AND..NCT.PRC%105,MAYCRG,22C0E
X     .AND..NCT.PRO%603,MAYCRG,CE
X     .AND..NCT.PRC%52C5,MAYCRG,ME
X     .AND..NCT.UNADE%39C2,3924,MAYCRQ,ME
X     .AND..NCT.UNADE%51C3,5113,MAYCRQ,ME
X     .AND..NCT.UNADE%44C2,4414,MAYCRG,ME
X     .AND..NCT.UNADE%42C2,422C,MAYCRG,ME
X     .AND..NCT.UNADE%46C2,461C,MAYCRQ,ME
X     .AND..NCT.UNADE%30C2,3C14,MAYCRQ,ME
X     .AND..NCT.UNADE%40C1,40C6,MAYCRQ,ME
X     .AND..NCT.UNADE%41C1,41C2,MAYCRQ,ME
X     .AND..NCT.UNADE%42C2,422C,MAYCRG,ME
X     .AND.UNADE%23C1,23C2,MAYCRG,NE
X     .AND..NCT.PRO%2303,MAYCRG,50E
X     .AND..NCT.UNADE%4C1,413,MAYCRG,5CE
 RETURN
 END
```

The time required for the manual coding of the information is as follows:

A. -	Land use	114 Man-Hours
B. -	Potential use	64 Man-Hours
C. -	Geology	64 Man-Hours
D. -	Soils	80 Man-Hours

E. - Topography 80 Man-Hours
F. - General information for the sheet 96 Man-Hours

Although there are not enough statistics, it has been estimated that the total man-hours required, when the process has been semiautomated by the use of the digital information from automated cartography will be 10% of the time shown before.

CONCLUSION

The work done so far has convinced us that the use of digital equipment for automated cartography is feasible from a technical point of view. From an economical point of view the feasibility depends in great measure upon ourselves, the users. At CETENAL we are trying hard to integrate a system that will allow us to gain significant economies in the use of digital equipment.

We have by no means all our short term plans in a completely satisfactory way. We have made mistakes in the conception of several programs and are also far from having a modular system. However, with the experience we have to date, we are sure to improve our work.

The complete use of our data base may still be years in the future, since for a data base to be useful it must have complete information.

We are processing the information by state but foresee that development will take us at least six years.

Nevertheless, we are encouraged by the versatility the query language has shown and regard it as a very useful tool for planning and development.