DEVELOPMENT OF AN INTEGRATED MAP PLOTTING SYSTEM FOR HYDROCARBON EXPLORATION

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ABSTRACT

There has been a rapid growth of computer usage and associated database concepts and technology in the hydrocarbon exploration industry. This has led to a state where a majority of data used in the exploration process has been entered and stored in a multitude of databases. There is a need for much of this data to be plotted in combination by personnel from different disciplines. In the past each database was accessed separately, the files of retrieved data collected together and, after the addition of a framework, plotted. This was inefficient and caused many problems and failures due to data and parameter incompatibility. The paper traces the development in BP Exploration of a system which combines all the retrievals into a single driver, ensures the compatibility of the data and plots it with a range of symbology and high degree of cartographic presentation.

INTRODUCTION

Computer assisted mapping has been used in BP Exploration for the past 15 years. Initially there was little input from the cartographic group and the rather crude system that evolved reflected more the state of the art of computer mapping rather than its inherent limitations (Monmonier 1982). The system was largely ignored by the cartographers within the company until five years ago, when not only its potential, but also the potential for disaster if it was further ignored, was realised.

For most of its existence the system has been used for geophysical shotpoint mapping, but with the ever increasing computer usage throughout the company the whole range of earth science specialists and the cartographers themselves have realised its practicality. This has given further importance to the need for the system to be based on sound cartographic and geodetic principles.

This paper traces the development over these five years and concentrates on the present developments and those planned up to early 1987.

BACKGROUND OF THE PRESENT SYSTEM

The system was initially developed for BP's Geophysical Division in the late 1960's and early 1970's. It was run on the corporate UNIVAC mainframe computer, written in FORTRAN IV and used standard eighty character card input. The map framework generation program required cards containing spheroid and projection parameters and the framework and map sheet parameters. The projection computations were basically a digital form of the standard projection tables and only Transverse Mercator and Lambert projections were catered for. During the 1970's further projections such as Mercator and Oblique Stereographic were added, some enhancements were made to the framework generator, and the system fulfilled its basic role of shotpoint mapping.

The late 1970's saw a steady increase in computer usage and members of the Survey and Cartography Division began to make use of the system. However their input to the development side was limited to a few cosmetic enhancements. As late as 1979 the system was still based on card input and batch processing and combined with a very slow plotting system was tedious to use. At this time the seismic processing group perceived a definite requirement for non-batch processing and interactive screen input. This was developed and used for a short time on the UNIVAC but was moved to a DEC VAX machine in early 1980.

At this time BP Exploration set up its own independent Computer Division. An early decision was made to standardise on Digital Equipment Corporation (DEC) VAX equipment. DEC's minicomputer range and its world wide support offered the necessary environment for the then present needs and future development of Exploration computing.

Soon after this move Survey and Cartography Division realising the need for the computer-assisted mapping system to be based on sound principles, set a brief for one of their surveyors to look into all the coordinate handling applications within the computer environment and provide support for the development of these systems.

FIRST PHASE OF DEVELOPMENT

The main objectives of the initial phase of development was to provide firm foundations for coordinate data handling on which future developments could be based. Within these foundations would be:

* A wide range of geodetic processing and transformation routines.

* A storage system for datum and projection parameter data.

* Easy access to the above data and routines.

* An enhanced map production system and user interface.

* A storage system for topographic data.

Geodetic Processing Routines

The requirement to be able to efficiently transform coordinate data between different datums and projections was of prime importance. BP Exploration activities are world wide and cover a wide variety of datums and projections (it should be noted that the word datum is used to cover both a specified geodetic datum and/or a specified spheroid). It is a requirement within certain obvious limits that all of this data should be compatible but that the general user, although being aware of the incompatibilities, should not have to be aware of the processes involved in making the data compatible.

A general conversion interface with a large number of underlying conversion routines was needed that could be easily called by application software. The routines should cover forward and reverse geographical to geocentric conversions and all the forward and reverse geographical to grid conversions that were required for BP operations. Computer processing power had risen to such an extent, and was forecast to continue this rise, that the use of double precision and precise spheroidal algorithms to a large number of orders could be implemented without causing undue overheads in processing time. The interface should be capable of receiving input, deciding on the conversion route to be taken, calling the necessary transformation routines and returning the result. Figure 1 illustrates the interface design and operation and also the Earth Constants Data storage covered in the next section.

Earth Constants Data

It was considered that the attribute information necessary for any coordinate handling operation was complicated and outside the comprehension of the general user. In the past both small and gross errors had been caused because it was necessary for the user to input this data. What was required was a storage system for all the datum, spheroid and projection parameters and for the user to be able to access this data through one or two 'keys'. This would mean that for any coordinate handling operation all that would be required from the user would be the input data and 'keys' and the output 'keys'. From this developed what was termed the Earth Constants Database and the 'keys' consisted of a geodetic datum mnemonic and a projection mnemonic (a vertical datum mnemonic was optional). This means that as long as a graticule coordinate has a datum mnemonic attached and a grid coordinate has a datum and a projection mnemonic attached then the coordinate can be handled by any of the conversion routines.

Access to Coordinate Handling Routines

For the successful implementation of the above system the actual access must be as easy as possible. This was provided by the provision of a FORTRAN callable routine that could be called by

any application requiring coordinate handling. The coordinate, the coordinate type and the mnemonics for input and the coordinate type and mnemonics for output were all that was required for the output coordinate to be returned. All processing and data retrieval was handled within the transformation system (Figure 1).

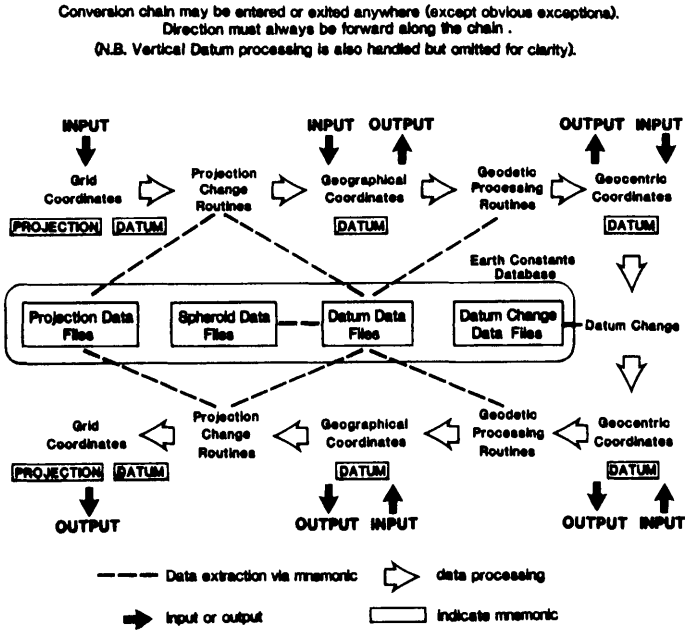

Figure 1 COORDINATE TRANSFORMATION PROCESS

Map Production

Although some use of the system within the Survey and Cartography Division is for straight coordinate manipulation with other than graphical output the major use made of it within Exploration is for map handling. This covers both digitising and plotting and although basic programs were available many enhancements were necessary.

The benefits offered by the coordinate handling system developed were great enough to easily persuade the involved disciplines to make use of them. It was probably an indication of the success of the design of the system that it was so easily accepted and integrated into the existing mapping system and other applications.

The existing routines that generated the map frame were extended to cater for the full range of projections covered by the new

conversion routines. Few cosmetic enhancements were made as the actual 'look' of the map was considered at this stage to be acceptable for working purposes.

A new user interface was a high priority and a series of data input screens from which the program input cards were prepared was written. This consisted of a program to define what was termed the 'area of interest' and a second program that defined the map design. The area of interest program allowed the input of the top right and bottom left coordinates in either grid or graticule terms, the Earth Constants mnemonics and the scale. The map design program defined such items as the overlaying grid and graticule, the annotation, titles and label box information, and other such user defined features as a scale bar and a north arrow. The program had a series of hierarchical screens with an expanding amount of map design control being given the further the user progressed down the hierarchy.

Cartographic Database

Another high priority was the design of a cartographic database. This would hold topographic data that could easily be included as basemap data on application mapping. The system was developed in house so that full use could be made of the existing software, but it must also be noted that no suitable proprietary system that could be adapted for BP use was available at this time. The design and operation of this database is not covered here but described elsewhere (JONES,HARRIS,LOTT 1982).

SECOND PHASE OF DEVELOPMENT

Progress of Phase One

The Earth Constants Database, the conversion software and the plotting software and interface were in operation world wide during 1983. The new Geophysical Database was reliant on the system and other databases and newly planned databases also made use of it. The Cartographic Database development had experienced some teething problems but was in operation in head office in a prototype version by late 1984.

System Evaluation

At this stage the actual plotting system and the appearance of the produced maps had changed little. The basic foundations planned in phase one had been laid and would be built on in phase two.

The system faults identified in late 1984 and which were to be rectified in phase two were as follow:

* The constituent parts that made up the plotting system were unlinked.

* Due to this there was still no overall control throughout the process covering the parameters defined in the area of interest and mis-matching caused by data incompatibility still occurred.

* Different disciplines were using different sub-sets of the programs, causing unconformity and thus confusion among the users.

In essence these were the first steps toward an integrated map plotting system. The idea was to link the constituent parts by providing a high level user interface that carried control from one program to another and supplied certain defining parameter data to the individual parts. The development would also test the feasibility of accessing data from different databases from the one interface. If successful the system would provide the whole of Exploration with a single mapping system.

Early on it was decided that the system would in fact form a prototype for the third phase of development. This was due to the unknown user response to such a system and it was felt that this would provide invaluable assistance in the development of a fully integrated map production system. This meant that the development work only occurred on the interface linking the existing programs. Little or no work was carried out on the individual programs although for some users some of the constituent parts would be new.

The concept used for the system was based on hand map-drafting principles. The area of coverage and the projection to be used are first defined. The map framework and the map sheet layout are then designed. After this followed the data inclusion phase including topographic data and any application data that was required, with any coordinate conversion that was necessary handled by the system. Finally the output plot type is defined and the job run. The actual processing and data extraction was only to be made available in batch mode.

The system would ultimately be used in 10 to 15 overseas Exploration offices covering a wide spectrum of plotting devices. This required that the system had an installation process which catered for these differences. During the installation certain site configuration details were requested by the program which then wrote the parts of the interface which were site specific.

The system development went very smoothly and it was released to all Exploration sites that had suitable facilities at the end of 1985. The system was generally favourably received and a great deal of constructive user response was generated. The system installation proved exceptionally successful with only one site experiencing any difficulties during installation.

THIRD PHASE OF DEVELOPMENT

Phase Two Evaluation

Much of the user response generated following the release of phase two was predictable, although certain aspects of the criticism were surprising. For example one of the predictable criticisms was that the structure of the framework generation program interface was complicated and it was necessary to run through the program even if all the default values were to be taken. What was surprising from a cartographers viewpoint was the amount of the criticism and the overwhelming user view that only very rarely did they require any change to the default values. Another surprising response was that the different screen management systems used in the different parts of the system, which we considered a major fault, was considered as a very low priority problem.

The release of phase two had given the development team the knowledge that they were following the correct lines of approach in the development of a map production system. Phase three would provide the enhancements that would turn the system into the integrated map making process required within BP Exploration.

Phase Three Concepts and Development

The user response and various studies that were carried out during the release of phase two led to the definition of phase three as follows:

* The framework generation program, although not to be re-written, would be considerably enhanced.

* The user interface to the framework generation program would be completely re-written to provide a more streamlined operation and user friendliness.

* Much better on-line help facilities would be made available.

* The constituent parts of the system would, as much as possible, look alike and data input would be standardised.

* A greater range of symbology for both point and line data would be made available and automatic key generation would be provided.

* An interactive graphics display of the map would be provided for suitable hardware, although no graphics editing capabilities would be included.

* A standard interface to outside databases and sub-systems would be designed to enable other users to link into the mapping system with relative ease.

An expansion of these concepts, and their implementation which is presently taking place is as follows.

The complete user interface including the cartographic database retrieval would be re-written. One screen management system would be used and it would follow an agreed standard. It is hoped that although different screen management systems may be used within the sub-systems the modern flexibility of these systems will allow them to look as one to the user.

A far greater flexibility will be allowed as to how the user progresses through the interface. At the highest level the user can define the area of interest and can then opt for a completely automatic generation of a basemap. This will include topographic data and be known as a standard BP Exploration basemap. Each overseas site will be allowed to alter the standard format during installation so that it meets local requirements. This move is of great importance as when hand drafting techniques are employed then the cartographer designs the map for the specialist. A computer-assisted system should also follow this principle. This will allow the specialist more time to concentrate on the inclusion of his own specific data rather than having to waste time worrying about the map design. On the other hand the system should also allow a cartographer a quick pathway to the lower levels of the system and provide a high degree of flexibility in the map design. User response from cartographers in many locations has identified areas where greater interaction is needed. These include label box design, location map generation and symbology.

However these last options will generally be generated automatically. The location map will cover an area around the map limits, will highlight the actual map sheet area and will include very small scale topographic data. The key will be generated from a standard symbol table and will include all symbols that are used on the map sheet. Each sub-system will pass this information back to the main interface including user defined symbols. In the existing system the title and label information have been input during the framework generation stage. User response has identified this as a major fault requesting that this input should be after entry to all the sub-systems. In fact much of this information will be passed back from the sub-systems themselves.

The sub-system interface will be defined in precise terms. This will enable future sub-systems to interface with ease. The mapping system passes information such as the area of interest and map registration parameters to the sub-system. The user then works within the sub-system defining the specific data that is required on the map. On completion the sub-system passes back such information as to the map overlays that have or will be generated, the symbols that are to be used and title and label details. Any number of sub-systems can be entered any number of times and the ability to include previously generated data will be given.

Help facilities which were very poor in the existing system would be much improved. Virtually all the help that was available was provided as information on the input screens. This made the screens over-crowded and as only new users generally needed this

information it was unnecessary for the majority of users. Two levels of help will be provided. There will be a help option on the menu which will give a general overview of each input screen and a help key on the keypad which will give field specific help depending on where the cursor is situated.

Phase three will therefore provide a fully integrated computer-assisted map production system. The world wide release should take place during the first quarter of 1987 and the available sub-systems will be the geophysical and geological databases. This will mean that the majority of explorers within the company will be relying on the system for their mapping requirements. This has given the development an importance that is well identified and it is felt that the planned system will fully meet these requirements.

Future Developments

Future developments of the system perceived at present will include enhancements to the appearance of the output, the ability of the user to carry out some interactive editing of the map and the ability to include raster data. The use of colour will greatly improve the appearance of the map and will in fact be possible within phase three. However the colour electrostatic technology is such that it is not seen that this will be available to the general user for some time to come. Colour infill for electrostatic plotting is at present too process intensive to be available to the general user and for automatic colour infill generation some alteration to database structures will be necessary. However these facilities are presently available through the Survey and Cartography Division.

The ability for the user to be able to edit the data that he has included on the map sheet is also seen as a future requirement. Editing of data outside the users discipline, except for deletion, will not be allowed. This development is very hardware dependent but with the move towards provision of locally linked graphics workstations throughout the working environment this is seen as a near-future development. Again this facility is presently available within the Survey and Cartography Division.

The inclusion of raster data is seen as a 'slightly further in the future' development. This is mainly due to the problems of processing time and output media. Processing power will steadily increase thus overcoming the first problem and it is hoped that colour electrostatic plotting will develop so that output using this process will be viable. It is envisaged that an earlier development will be the the ability to display raster data as a map overlay on a graphics workstation.

Conclusion

Computer-assisted mapping has slowly evolved within BP Exploration rather than experiencing the sudden explosive development that has accompanied many computer application

developments. In retrospect this has been highly beneficial and a very sound map production system has evolved. The speed of the evolution has been slow but it must be remembered that it is taking place in a full working environment. It is imperative that any system, such as a mapping system, that is relied upon as heavily in everyday company operations is developed in this manner. The integrated map production system that has evolved is a robust and practical system that is based on sound theoretical principles and that has been enhanced through user input. This has meant that the user can at present, and will in the future, have confidence in the map making process and can place trust in the mapping of his specialist data.

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