SOFTWARE AND ORGANISATION TO MANAGE DISTRIBUTION NETWORK DATA AND GEOGRAPHICAL INFORMATION

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INTRODUCTION

In this document, we will present two experiences for implementing technical information systems, that of EDENOR in Argentina, which supplies electricity to the northern sector of Buenos Aires, and that of EDF in France. Part of each of these experiences, which supplement each other, will be presented so as to be able to come to general conclusions and recommendations.

THE SOLUTION CHOSEN BY EDENOR FOR ITS TECHNICAL INFORMATION SYSTEM

Objectives

In September 1992, EDENOR decided to organise two major centralised and autonomous technical sectors, independent of the organisation in territorial operational areas, so as to pool and support decision-making for medium voltage networks, by basing them on a solid data management system.

- a single control centre, for centralising the management of quality of supply (unifying modes and reducing times of actions on networks), in which a new telecontrol system has been installed,
- a high and medium voltage planning unit to define and optimise investments (network structure and improvement).

The mapping tools for each case were chosen to meet the specific needs in each application:

- a MV single-line representation system ("BDE-Visual MT") for operation,
- a geographical representation system for MV network planning ("BASIX®/PRAO®").

Data base for planning

BASIX® is an EDF product which consists of a relational data base capable of managing the medium voltage networks of large cities and, through its graphic interface, makes it possible to easily store, update, process and display equipment topology and characteristics, as well as to determine the electrical status of equipment. Using historical data as a basis, it is also able to follow up the development of network components for maintenance, incident management, service interruptions, etc.

In order to facilitate network management, BASIX® allows to customise network equipment models and assign symbols to the most commonly used components (substations, transformers, network sections, switching substations, etc.), enabling the user to enter automatically a large number of repetitive electrical characteristics when inputting the data.

BASIX® is a communication tool that EDF has specially designed to be a data server for the network design and planning software model PRAO®.

BASIX® thus makes it possible to provide the electrical consistency of the data entered and to extract part of the network to be studied with PRAO®, which determines optimum solutions to increase the supply capacity or improve the quality of service, while minimising the investments required. The portion of the network may be selected by HV/MV substations or MV outgoing feeders, with no limitation of the number of nodes in PRAO®.

Finally, BASIX® can be connected to a geographical information system in which the superposition of area map layers and other information provides a network cartographic representation and map generation.

BASIX® and PRAO® are run on PC's environment.

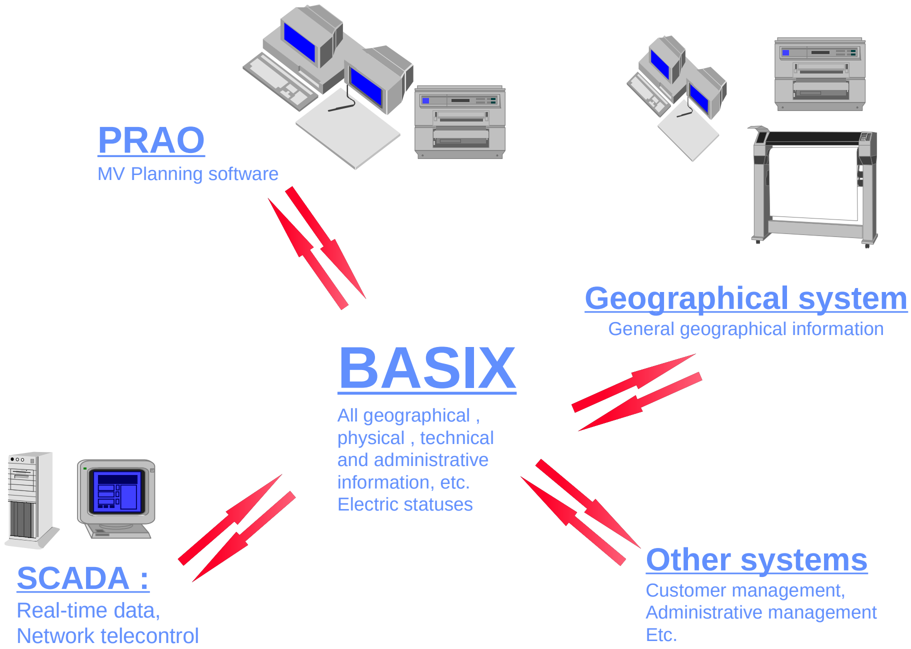

Figure 1: BASIX in a technical information system environment

EDENOR's experience

As concerns planning, the BASIX®-PRAO® system is a tool featuring leading-edge performance for large size grid such as EDENOR's which has 6,700 km of networks (including 45% underground), 57 HV/MV substations, 800 feeders in an open interconnected network and about 11,000 MV/LV transforming substations.

The initial loading of data in BASIX® was divided into two parts:

- the geographical information of MV networks with the coordinates (x, y) of nodes (load, taps, or switchgear) and elbows was input with a digitising table on the basis of information available on hard copy drawings.
- alphanumerical information on the nodes and lines was included integrally by means of Microsoft-Excel tables.

The time required to load about 50% of the whole EDENOR's network, which accounts for approximately 15,000 nodes in BASIX®, came to about 600 man-days, which represents an average data reading and loading time of one day per person and per outgoing feeder.

At the same time, since the operational areas had to manage the link between customers and incidents at the various voltage levels of the supply chain (high, medium and low voltages) to calculate the penalties provided for badly supplied customers by the Concession Contract, they had soon to implement an independent geographical system based on a Computer-Aided Design (CAD) system. This development required much in the way of time and resources (about 2 years and 50 persons) to introduce and check the consistency of the technical and commercial data of more than 2.2 million customers.

The loading of MV network geographical data required a great deal of effort at the outset, especially since part of it was duplicated. To remain valid, these data require constant updating, which demands a great deal of resources due to the large number of works operations in network facilities as a result of the high level of annual investments.

For maintenance and updating, the tendency today is to integrate tools and organisation, while clearly separating the geographical environment from the network design environment, with well-defined responsibilities so as to avoid duplicating activities.

In order to optimise the two data incorporation and updating operations, EDENOR created a small mass data recovery programme (cf. Figure 2: Mass data recovery programme). It provides great flexibility in validating and converting the data required to work with BASIX®-PRAO®, using files from the Graphic Systems.

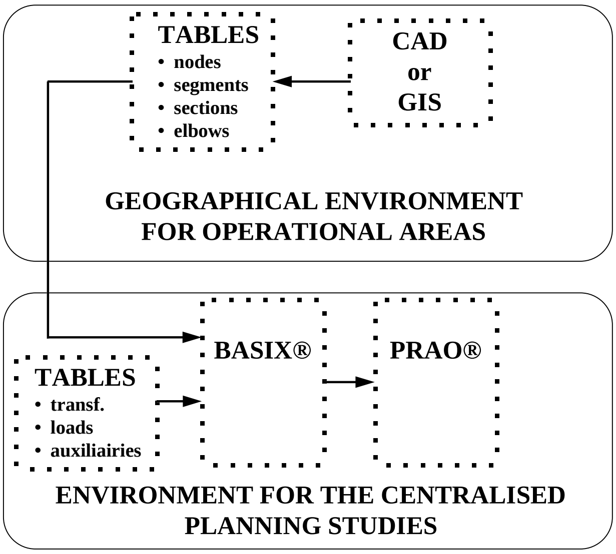

Figure 2: Mass data recovery programme

BASIX® requires the entry of a series of tables containing the data needed for the geographical representation of the network (x, y coordinates of nodes and elbows), the characteristics of power lines and cables, their lengths, the electrical loads of nodes, etc. This information is extracted or generated from existing information systems in the operational areas, which are responsible for at least completing the geographical data in a first stage.

Once this routine for inputting data into BASIX®-PRAO® has been set up, the geographical updating process will focus solely on the existing Graphic System, CAD or in the near future on a corporate standardised GIS. The transfer of data will be possible avoiding the doubling of inputs and ensuring the consistency of medium voltage network data.

THE SOLUTION CHOSEN BY EDF FOR ITS GEOGRAPHICAL INFORMATION SYSTEM

The solution chosen by EDF for its geographical information system is based on the distinction between the technical management of networks, the computerisation of which has been completed for over 10 years now, and the geographical representation, which got under way 10 years ago in CAD. It uses the GEOCOMM© software model. Developed on a Microstation base, this software enables the user to manage multiple information layers and define several types of territory limits (electrical action areas, town limits, etc.). The geographical representations thus set up can be used for topic-related and space-related analyses on PC's running GIS.

The organisation selected by EDF to use this geographical information system consists in centralising the data per operating unit so as to ensure the administration and print out of standard maps, which are placed at the disposal of users (operators, sales staff, etc.) via intranet. Specific studies may be carried out locally with a simple geographical information system, provided with extracts of centralised data.

Today, everybody agrees that geographical information systems for the management of distribution networks are worthwhile. They combine the uniqueness of network description and representation data and the diversity of applications: calculation, maps, inventories, etc.

However, the setting up of these software models and adaptation of organisation cannot disregard the history of the computerisation of technical management.

History of the computerisation of technical management at EDF

At a very early stage, EDF began to computerise the technical management of its distribution networks before micro data processing and graphic software models were developed. The objectives were the calculation of networks and asset management. The descriptive data bases were designed to meet these objectives. Data collection, which required more than a decade, now provides us with operational bases. These bases constitute a major asset for the network design and planning activities.

The emergence of PC's and graphic software meant a new stride forward for network representation with the PC taking over from the drawing board. The graphic representation of networks became standardised with BENTLEY's CAD MicroStation. The draughtsman's task has constantly evolved and each works manager can update the network map, as a result of the sharing of area map layer and network layer data and simplified ergonomics, based on graphic libraries of standardised network components. However, the rate of transfer from hard copy maps to digital drawings is slow. Graphic collection costs more than alphanumerical collection. In addition, it is dependent on the collection of area map layers in digital form.

The link between network descriptive data and their mapping representation amounts to recording the geographical coordinates of substations and sections in the network descriptive base and storing the identifier of each substation and network section in the drawing file.

Developing geographical information without redoing technical management

The purpose of the GIS is to combine studies, asset management and mapping in the same software model. But to bring this about, the network descriptive data bases and drawing files which represent them must be migrated to the GIS. This task comes up against several problems:

- The conceptual model of data for network calculations and asset management is not intended for a geographical representation of substations and network sections.

- The network representation graphic model itself depends on the scale of mapping representation: contents and positioning of network descriptive texts according to the scale.

- The GIS software packages to be found on the market are often based on proprietary languages making it compulsory to synchronise the migration of all computing, management and mapping applications. This creates a “big bang” that is ill-timed for some, expensive for others and hard to control for everyone.

- GIS software packages to be found on the market do not yet cover all management (handling of network objects) and geographical (handling of graphic objects) applications.

EDF has therefore chosen to apply GIS technologies to network graphic representation (MicroStation files), made consistent with technical management descriptive bases (cf. **Figure 3**).

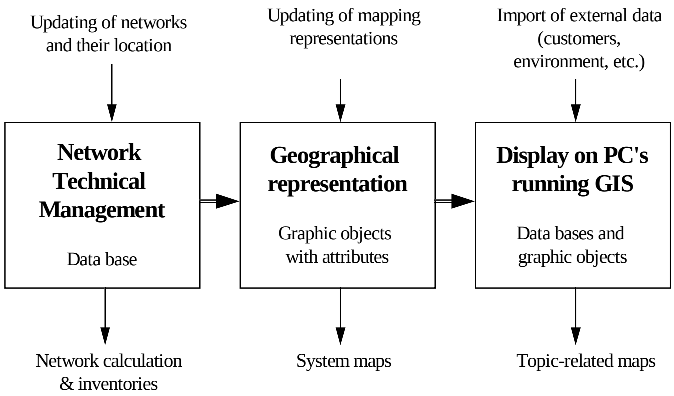

Figure 3: User features and tool architecture

This scheme makes it possible to:

- Get the technical management software and network geographical management software to evolve separately.

- Conserve the graphic data and the plotting of system maps without the need to have technical management migrate to a GIS.

- Load the GIS according to the requirements in the field of topic-related mapping and geographical analysis. All maps, particularly large-scale ones, are not loaded in GIS's.

Geographical information tools: GEOCOMM®

This architecture means having to opt for a GIS software model that is compatible with the CAD MicroStation software. The GEOCOMM© software developed in partnership by Géotech and EDF GDF SERVICES applies GIS concepts to MicroStation files: geographical indexing of files and navigation, definition of topics as a set of layers, divided up into several files, if necessary.

Making use of the CAD features, the software allows one to superpose the following in the same geographical reference area:

- area map layers with differents formats (road maps, cadastral survey, aerial photographs),
- graphic objects representing the substations and sections of a network, technical management extracts,
- symbols representing customers,
- CAD-generated drawings.

© GEOCOMM is developed by Géotech and EDF GDF SERVICES

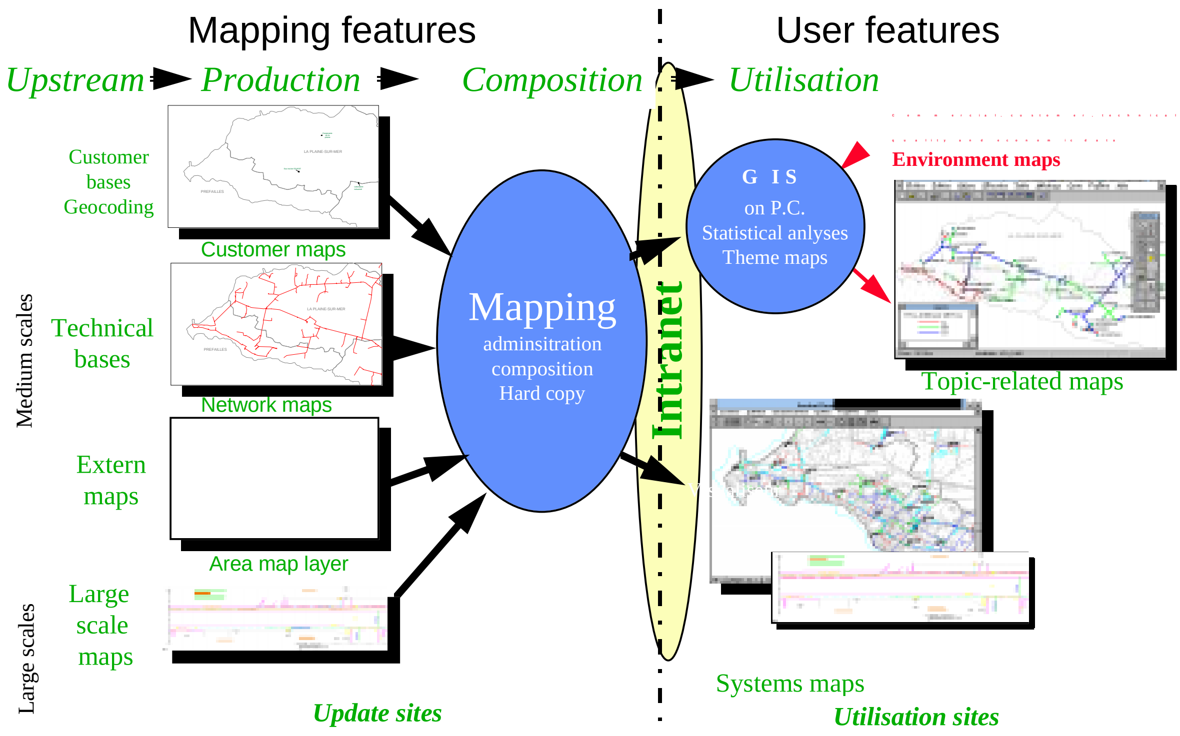

Figure 4: Organisation of computerised mapping features

GEOCOMM® is the basic software of the mapping system. It serves to administer all of the geographical representations, as well as to compose and plot the maps required by the various users in the company. These maps are placed in a documentary base accessible via Intranet. The software is also used to prepare the geographical data for display on PC's running GIS in a format that can be used by these tools.

The organisation takes into account activities and tools implemented in mapping

The mapping user expects a map that can be used directly whether it comes in hard copy form or is a digital or virtual document (when he has access to a continuous 3D representation).

This map is in some way a finished product resulting from a composition. The creation of maps is as much a science as an art. It implements scientific and technical knowledge for the location and qualification of objects and artistic qualities for their graphic representation and their legibility. It makes use of a great amount of graphic data. Its tools necessitate in-depth training. Their implementation requires specialists and map makers who create the maps in a centralised way.

The crossover of topics on maps have become routine for assistance in decision-making and the corresponding office-oriented tools are constantly developing. The creation of topic-related maps, from design to production, is above all the result of the work of various specialists of mapped topics, while making use of mapping processes to a lesser extent. The composition tools of topic mapping must therefore be made available to both map makers and the experts of mapping disciplines. Map makers sort the geographical data and make them available to the experts of all disciplines, in a form that can be directly used in GIS's (cf. Figure 4)

The publication of mapping data is carried out by Intranet. These technologies are well adapted to the consultation of a documentary base (maps as documents) and to the transfer of files (geographical data for GIS).

CONCLUSION AND RECOMMENDATIONS

To successfully conduct a technical information system project, several aspects must be considered with care:

- *the definition of the scope of the system, with regard to which the choice of the data to be computerised is essential;*
- *consistency with the organisation of the company, which must evolve and be prepared for the system project;*

- *and the changeover from the past to the new operation with the computerised system, implying the preparation of teams and the training of users.*

The choice of data to be computerised

Everyone knows that data collection is a costly, long and perishable process. Only computerised data which serve in the relationship with the customer, institutions and suppliers are reliable. However, it remains true that the description and representation of distribution networks requires much detail while being seldom updated.

It is therefore very important to properly define the geographical management needs of distribution networks and to use data that has already been collected as a basis.

GIS's are applied when the user needs the following at the same time as the description and geographical representation of networks:

- Creation of system maps intended for the operator, works and institutions.
- Network studies and planning.
- Analysis of factors solely linked by their geographical location.

The data loaded in a GIS are extracted from the company's information system (management of technical aspects, customers and mapping in the case of EDF). However, all the data of the information system and, in particular, all the maps do not need to be loaded in a GIS. This selection and the determination of the information localiser are an essential aspect of design.

The functional components of the information system can be shown on a requirement scale in GIS (cf. Figure 5).

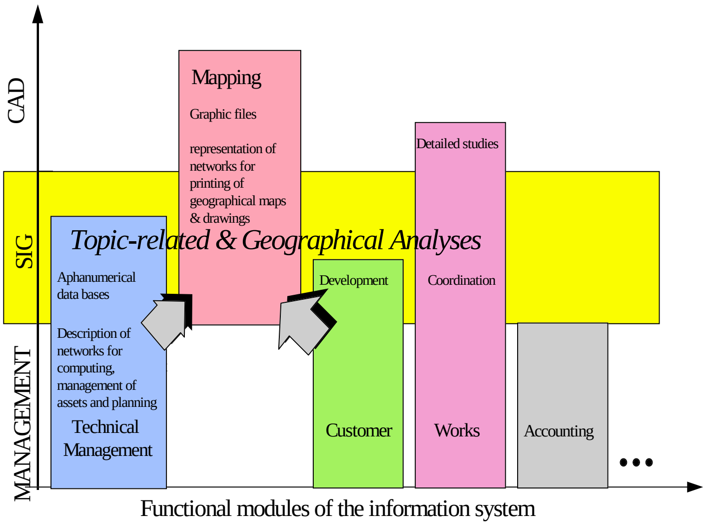

Figure 5: Crossover of the features and needs of an information system

Impact on organisation

The experience developed over these past few years by EDENOR to design a data management and geographical information system shows the importance of the consistency between corporate organisation and data administration. The high cost of the initial input must be optimised and uniqueness in the continuous updating of information provided, while clearly assigning the responsibilities of the central level and decentralised levels.

For EDF, the setting up of technical management has changed network design activities by providing them with powerful network and load knowledge tools.

The setting up of computerised mapping has changed the draughtmans's task and updating processes. However, the user still only sees hard copies of maps and the computerisation of mapping has contributed little to the activity of the drawing office.

GIS tools will considerably change the practice of mapping and design activities. GIS tools enable the map maker to customise maps for the intended users, their updating carried out by automatic processing of the thus parameterised maps. GIS decision-aid tools run on PC's renew the means of analysing networks and development potential.

The preparation of teams and training of users

It therefore appears pertinent to:

- keep mapping under the responsibility of the design structures.
- train map makers and design personnel in the use of GIS tools run on PC's.
- enable the other users, who consult the maps, to comment on them and send their comments to those in charge of studies and mapping.

Indeed, the setting up of GIS's is a factor of quality and consistency of network, customer and map descriptive data. So long as this quality is not obtained, one cannot expect an operator or sales person to directly consult his networks, customers or prospects on the GIS. This will be another quality step forward.