PART II - THE VILA NOSSA SENHORA APARECIDA MARGINAL AREA CASE-STUDY

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1 INTRODUCTION

In 1989, the International Service Voluntary Association (AVSI), together with the Pontifical Catholic University of Minas Gerais and the University of Bologna, sponsored a course of Specialization in Town and Country Planning for an inter-disciplinary group of Brazilian experts. This course lasted nine months and was integrated by a one-month stage in Italy.

The collaboration work among Universities continued in 1991, when three Brazilian scholars participated in a three-month stage in Italy, deepening the issues related to geographical information systems, town planning and housing plans. During that occasion, the Managing Board of the Architecture and Town Planning Institute of the Bologna University showed its intention to develop a joint research work with the PUC-MG Architecture and Town Planning Department.

After discussing the common interest subjects, it was then decided to deepen the study of computer technology applied to town and regional planning, and in particular to marginal urban areas. At present, the use of computer science in data collection and processing is an indispensable tool for planning and development activities in urban areas. In addition to that, the choice of computer science was considered to be essential for the cultural enrichment of the PUC-MG Architecture and Town Planning Course teachers and for the training of students, namely the future experts who shall have to fully meet the new labour market needs.

The choice of urban marginal areas led to the AVSI involvement in the research, because the pilot area chosen was a favela and the methodology developed could be further applied in other derelict areas. AVSI is an Italian cooperation organization, which has carried out very important works in Brazil since 1984, showing a special interest in the social, economic and cultural recovery of marginal areas

and their communities, through favelas' urbanization and legalization programmes, the building of town facilities (children's services, health centres, community centres, etc.), and the creation of job opportunities starting from vocational training and apprenticeship.
The research objective was to develop a methodological study for cartographic and alphanumerical data collection and processing and for the setting up of an urban diagnostic system of a favela in the Belo Horizonte Metropolitan Region.
The following phases have been developed in the research work carried out in the pilot area of Vila Nossa Senhora Aparecida, in Venda Nova:
- collection of already existing data in Public Authorities and of further data in the field;
- cartographic and alphanumerical data processing and computerization;
- map production with partial diagnoses of the area and its general profile.
This procedure has allowed to know the situation of the area and its quantitative analyses as well as some simulation attempts of the possible consequences deriving from the actions which would be undertaken.
The research was carried out from August 1 to October 30, 1992, by a work group made up of a researcher from the Architecture and Town Planning Institute of the Bologna University, 21 students and a professor of the Architecture and Town Planning Course of PUC-MG and one URBEL technician on behalf of AVSI. The Belo Horizonte AVSI technical representatives also participated in this research initiative.
Computer science applications were developed in the CAD 126 Computerized Cartography Laboratory at the AVSI headquarters in Belo Horizonte, where the PUC practical courses were held. Furthermore, courses on the application software were held in the PUC-MG Electrical Engineering Laboratory.

2 FORWARD

A geographical information system applied to data management related to urban areas has been used in the present work.
The town, which is regarded as a physical space, includes a social stratification with all its related implications. Favelas are set up as an attempt by low-income population segments to take possession of an urban space, as a solution to their housing problems. Given the rapid creation and growth of favelas, as well as their specific features, their

great internal dynamics and their massive presence in the urban landscape of major Brazilian towns, it has become today impossible to keep ignoring this reality. The use of modern data storage and management technologies thus becomes urgent in order to centralize information and to set up a data base oriented towards the necessary actions for the integration of these areas in the urban fabric.

When considering the importance of the creation of an information system, one should not forget the low reliability of data acquired by the competent bodies, due to difficulties related to data updating, collection, management and processing.

The choice of a favela area as a case-study is extremely significant from a social, educational and technical point of view:

-at a "social" level, the previous considerations should be borne in mind as well as the effective, objective and economically accessible use of an advanced technology at the service of a low-income population;

-at an "educational" level, a special consideration should be given to the participation of an interdisciplinary work team, coming from different institutions and experiences. At the same time, the participation of the PUC-MG Architecture and Town Planning Course students corresponds to the University's objective to guide students to a reality-oriented training, in which the human aspect is also taken into consideration, and to allow them to develop a critical approach towards social problems on the basis of practical experience. Furthermore, the application of information technologies allows a more effective training of future professionals, thus meeting the new labour market needs;

-at a "technical" level, attention is focused not only on further training and experience exchange, but also on the analysis of results, a solution-oriented approach, and, finally, on planning. This is made possible by computerization, which makes the whole process faster and easier.

Favelas must not be regarded as "islands" within the city. It is important to respect their specificity and to analyse their interrelations with the surrounding urban structure. Town planning actions must, therefore, derive from an overall study, always considering the integrated dynamic process, in which causes and effects are often interrelated.

Computerization allows to link alphanumerical and cartographic data bases and to manage, process and store them in a consistent way. These features and functions allow the production of thematic and synthesis maps and, finally, of the diagnosis map, which partially or fully outline the study area profile.

The scope of the present research is the production of a diagnosis of an urban area, which is designed to facilitate the interpretation of the

present reality and of its needs, potentials and trends and, also, to help experts develop specifically targeted urban actions.

3 THE CHOICE OF THE STUDY AREA

In the present research, the choice of the pilot area is based on the following considerations:
-the limited three-month period devoted to the work development, which included a whole series of activities with varying degrees of difficulty. It was, therefore, necessary to start working on an area about which data were already available, thus reducing the time required by their collection in the field;
-serious financial limitations, which have prevented the full completion of the topographical survey and of the specific census data collection, thus not fully meeting the project objectives.
Hence, the favela of Vila Nossa Senhora Aparecida, in Venda Nova, was chosen, for which the topographical survey and a social and economic data base on its inhabitants were already available. In fact, other developments had already been undertaken in this area, through an agreement between AVSI and URBEL, with a view to promoting its land legalization. During the research development, the legalization and urbanization processes were being concluded (road paving, containment wall building, etc.).
The Vila Nossa Senhora Aparecida is made up of 128 parcels and 143 dwellings, and it stretches over a total surface of 27,481.35 m2, out of which 2,688.95 are occupied by the street network, 14,826.89 by parcels, 3.344.27 m2 by non-buildable areas and 6,621.24 by individed areas.
Recent urbanization and legalization actions in the area have contributed to make the community more aware and ready to collaborate in the research, both by popularizing its objectives and by supplying the data, which were to be collected in the field.
The use of the existing updated data (cadastral parcels, road system, block boundaries, parcels of land, boundaries of non-buildable and undivided areas) has facilitated the research work. Nevertheless, somelimitations in the accomplishment of the research must be pointed out. They were due to the fact that the topographical survey had been performed with the main purpose of legalizing only the (PBH) Belo Horizonte Municipal Prefecture area (128 parcels). No topographical survey could be carried out and no census data could be collected in the rest of the Vila, which was made up of private properties. That is why these areas have been classified as non-buildable areas, thus characterized only by boundaries, their actual occupation or subdivision into parcels not being taken into

account. No altimetry survey of the area was made.
The lack of a parcel plan of the whole Vila (PBH area plus private areas) and the partial definition of the real situation of non-buildable areas (lack of data on the road system and its parcelling) allow only an incomplete overview, not fully representing the Vila as a whole.
It is important to consider that the unsurveyed Vila area coincides with the most socially and physically derelict area, and it also creates the greatest access difficulties to the surrounding urban area, given the land steep slope.
Hence, all development actions in the Vila should be the result of an overall project, based on the study of the whole area, in order to assure a more balanced development from a social and town planning point of view.
At an educational level, the target area has sufficiently met the study requirements of the alphanumerical and cartographic data computerization problem. It will be possible to use the applied method also in other urban areas, provided that the necessary adjustments are made to suit the specific needs of different situations.
It must, nevertheless, be stressed that the lack of a global view of the Vila area makes it impossible to carry out the area's overall planning and integrated design.

4 WORK FACILITIES, AVAILABLE RESOURCES AND ADOPTED RESOURCES

The subject suggested for the research work has been developed in a CAD laboratory, equipped with graphic hardware and software and data base management packages.

4.1 The software used

The software used were Microstation - Intergraph, dBase III, Dig-Road and Cartocad - TDV.

4.1.1 Microstation-Intergraph

The software used for the implementation of the information system is the Microstation-Intergraph, version 4.0. The choice has been determined by practical reasons and also by considerations on the package qualities, especially as some of the following characteristics are concerned:
1.the experience developed in the Architecture and Town Planning Institute of the Bologna University over the past few years, through

research works carried out with other Italian bodies in the field of geographical information systems, in the Intergraph "environment";
2.the limited financial funds allotted to the research, both because the hardware platform which has been used (PC DOS 386/387) is one of the most economical ones in the sector and also because Intergraph grants the University the use licence to the purpose of research under extremely favourable conditions;
3.the experience acquired over the past few years by AVSI in CAD (Computer Aided Design) applications and, in particular, in the use of AUTOcad software. It has therefore been decided to continue the AVSI work, choosing a software like Microstation, which is specifically suited for CAD.
To this regard, it should be stressed that this version of Microstation-Intergraph, which has been specifically developed with CAD specifications - even though the version 4.0 already has some spatial analysis capacities of geographically referenced data attributes - cannot be defined as a complete GIS package.
Yet,it should also be pointed out that, in particular, Microstation 32 implemented on Workstation Intergraph and its new version for PC DOS 486 are equipped with additional modules (even though partially) which allow to manage data by means of a raster-type model and a vectorial model (which is specific of CAD) and to manage the topological attributes, which are necessary to carry out these spatial analyses.
Even if the software used for research is rather well-known by experts in the field, it seems important to highlight a few characteristics, which have proved to be particularly useful in the research work.
First of all, the Microstation graphic data vectorial model has allowed us to obtain two main advantages:
-easily transfer the data which had already been acquired by AVSI and URBEL in vectorial form, through the land-based automatic topographical survey, together with other ones deriving from the digitization of topographical maps produced through a 1979 aerial photogrammetry (PRODABEL) (at the time no raster format data were available);
-obtain a substantial storage saving. As is well known, graphic objects (i.e. lines or polygons) in vectorial format, representing the land components (i.e., parcels or buildings), are stored according to geometrical characteristics (i.e., the two extremes in the case of a segment), unlike the raster model, which stores the element point by point.
Another important feature is that each element is characterized not only by the above-mentioned geometrical properties and by those useful for its representation (thickness, colour, line style), but also by

a further attribute (the level or layer), which allows to organize graphic elements according to information layers with similar characteristics. In other words, the map could be imagined to be the result of the overlay of several transparencies, on which homogeneous data are displayed. For example, at a certain level the roads of the study area are drawn, at another one the parcels' administrative boundaries are drawn, etc.
Two additional capabilities, particularly useful to the research purposes, namely REFERENCE FILE and ATTRIBUTE LINKAGE, will be described later in further detail.
Finally, these programmes are user-friendly, thanks to an effective interactive management of the user's interface menu.

4.1.2 Dbase III

Microstation runs an interface towards two of the best-known relational DBMS (Data Base Management Systems), namely ORACLE and Dbase III.
The software used in the research as data base management system is DbaseIII, an ASHTON TATE INC. programme particularly effective in the applications on PC platform. This package is rather well-known in applications available on the market, which are specifically designed for data base management, and supplies users with its own programming language to customize applications.

4.1.3 Dig-Road and Cartocad-TDV

The topographical software used is the DIG-ROAD system by TDV - "Technische Datenverarbeitung" - Austria. This system allows the input of data surveyed in the field on paper or through electronic collectors, through the traverse calculation with the distribution of linear and angular error and the calculation of topographical points, which have been surveyed by means of electronic theodolyte. The surveyed and calculated points can be displayed on the screen, or printed on paper by means of plotter or printer. This system also allows the calculation of the digital terrain model (DTM) and of contours.
Cadastral maps have been produced by means of the CartoCad programme by TDV - "Technische Datenverarbeitung" - Austria. CartoCad is a type of CAD which processes the points surveyed in the field, calculated and drawn by means of the DIG system. This software has been specifically developed for the design of the urban cadastre. It is equipped with the necessary resources designed for this kind of activity, such as the automatic calculation of boundaries'

dimensions and of parcels' surfaces. Furthermore, it performs typically CAD functions, such as the drawing of lines, patterns, symbols, basic graphic elements, etc.

4.2 Type of hardware used

During the topographical survey stage, two Total Stations by Geotronics - model 142 and 134 - have been used, with the following specifications:

Model 142:
- 2.5 Km range with a prism;
- linear precision 3mm + 5ppm;
- angular precision 1";
- electronic data collector.

Model 134:
- 1 Km. range with a prism;
- linear precision 5mm + 5ppm;
- angular precision 1 and 3";
- electronic data collector.

The calculation and cartography system is made up of a CAD (Computer Aided Design) station, equipped with:
- I.B.M. compatible 386 DX, 33 Mhz, 4 Mb RAM computer;
- mathematical coprocessor;
- 80 Mb hard disk;
- monochromatic monitor;
- 19" (1280x960) high resolution monitor;
- 60 Mb backup streaming tape;
- graphic printer;
- AO size digitizer.

Once they have been checked on the high resolution screen, cadastral maps are drawn by means an Oc Graphics (Benson) AO size 8-pen 1645R model plotter, with continuous roller paper feed and a drawing speed of 60 cm per second.

4.3 Work facilities

The research work has been developed in the CAD 126 ComputerizedCartography Laboratory, at the AVSI seat in Belo Horizonte.

5 WORK STAGES AND METHODOLOGY

The adopted methodology is based on the organization of already existing information in the area, on new data collection and on the performance of profile analyses of the Vila, in the form of thematic maps.
The Microstation software by Intergraph has been used for cartographic data management and the DBIII has been used for alphanumerical data management.
Data have been collected in relation to the urban area around Vila and to the road system, parcels, buildings and dwellings of the area under study. Not all the data related to the whole Vila area have been collected, but just the ones in the area belonging to the Prefecture, which is going to be legalized.

The following work stages can be identified:

1.Search and collection of available data and material:

-social and economic data base;
-basic cartography with the area's cadastral planimetric survey;
-mapping of the area surrounding the Vila.

2.Data collection in the field and data base organization;

3.Basic cartography transfer from Autocad software to Microstation. Data organization and completion with the drawing of the surrounding urban area;

4.Linkage of cartographic and alphanumerical data;

5.Thematic map production by means of graphic editing and/or data processing. Production of basic maps, synthesis maps and the final diagnosis map;

6.Assessment of results.

6 RESEARCH DEVELOPMENT

The research work has gone through the following stages: existing data organization, the new data base collection and structuring, attribute linkage of cartographic and alphanumerical data and thematic map creation.

6.1 Data organization

The existing data were organized: drawing file and alphanumerical data. The drawing file of Vila Nossa Senhora Aparecida was completed with the design of the bordering urban area.

6.1.1 Description of the existing drawing file and its transfer to the microstation software format

The starting cartographic base is a plan of the Vila Nossa Senhora Aparecida - Venda Nova cadastral parcels, carried out by the AVSI-URBEL Convention, with the aim of legalizing the area. This map derives from the automatized topographical survey carried out in the field by means of the Total Station (electronic theodolyte and automatic data collector), which was concluded with the final map digitization, by means of a digitizer and the Cartocad software, by the Austrian TFV. This survey technique has allowed the transformation of graphic elements, which make up the land elements, into a vectorial format, according to UTM coordinates, with a high precision level.
The area topographical map is thus transferred from Cartocad _ which processes the output data of the electronic collector _ to the AutoCad software, through an exchange format. AutoCad has been useful for the necessary editing stage, which has been carried out to insert corrections and to add technical details, according to the specifications set forth by the plan approval regulations.
The topographical map includes the road system and the related toponymy, blocks, parcels with area and linear sizes, the definition of undivided and non-buildable areas, the traverse marking the SE-4 boundary and its cardinal points, the boundaries of the area belonging to PBH, the already existing PC code (i.e. the Plan Code - numbering of the municipal cadastre), applied to the adjacent urban area, and the future PC, which will be approved for the new plan. It also includes tables with the measurement list of parcels' surfaces, which are to be approved, the cadastral cartography sheet layout, the description of the competent local authorities' legal profile, toponymy tables, the blocks and quarters cadastral codes and, finally, the legend and list of data subjected to the competent authorities' approval.
This drawing file has been generated by means of a layer (information level) structure, basic element blocks, pattern, colours, etc., according to the previously defined blocks. In order to transfer this drawing file from AutoCad to Microstation, it has been necessary to reset it according to new objectives. The elements' structure has been rearranged in the following way:
-redefinition of new layers with distinct elements at each level;

-exploded view of blocks (compound elements) showing their basic elements;
-exploded view of pattern showing its line-type basic elements;
-erasure of unnecessary elements for the successive processing and change of parcels' boundary lines so that their apexes coincided in order to form closed areas.

These editing operations have been carried out by means of Autocad and successively by Microstation. Changes can be made by means of editing controls, which interact on individual elements, or on groups, whose alterations remain the same for all the group elements. Both procedures have been used to educational purposes.
In order to import data from AutoCad to Microstation, whose internal vectorial format (DGN) is different from the former (DGW), it is necessary to use a Drawing Exchange Format (DXF), which is common to almost all software using vectorial graphic data bases. The DXF format exchange file is a text type ASCII code file, made up of four sections. The first one contains some general parameters, such as the work units, the drawing origin position and other minor details. The drawing features and their definitions (coordinates, display features, element levels, etc.) are stored in other sections. The Microstation software is equipped with a routine, which interprets the DXF format and recodifies the drawing in its (DGN) internal format.
As far as data import is concerned, it should be pointed out that the AutoCad and Microstation compatibility is not satisfactory in relation to the Autocad blocks, which are interpreted by Microstation as CELL type elements (corresponding to blocks at a conceptual level). After the import operation, problems arise in the CELL LIBRARY management (i.e. special files containing elements grouped as CELLS, which can be used in all the drawing files). For this reason, it has been decided to work on Autocad blocks exploded views and to import basic elements into Microstation.
The drawing file tranfer has, thus, entailed the rearrangement of graphic data according to new objectives to be achieved. For instance, in the cadastral drawing production, parcels are identified by the lines representing boundaries. Yet, the attribute linkage between the parcels' cartographic data and the related alphanumerical data can be carried out more easily if the parcel is represented as a shape-type element, namely as a single closed element (polygon). The shape generation representing parcels, starting from the initial line elements, can be carried out on all the elements by means of a routine applied to the Microstation drawing file.
The following considerations must be taken into account when transferring the drawing file from Autocad to Microstation:

1.The Vila original map was expressed in UTM coordinates. Nevertheless, Microstation has its own coordinate system, so that a new drawing file origin has to be defined in order to frame it in another coordinates system (in this case, in UTM). On the basis of a couple of UTM coordinates of a point represented in the drawing file, Microstation makes it possible to change the drawing plane origin, so that the value of one of its coordinates couple coincides with the known value of the topographical survey and thus of the others;
2.A 90-degree rotation has been necessary to let the geographical North coincide with the upper side of the drawing plane, because a rotation in the opposite direction had been carried out in AutoCad in order to frame the map for the AO format output;
3.The elements' size and the distance between the drawing points have been changed, multiplying or dividing them by a scale factor, so that they correspond to the real ones, namely to the 1:1 scale, in the drawing file;
4.Proper work units have been defined related to the precision and size of the area to be represented. Considering that it was a topographical drawing file, the mm resolution choice was regarded as acceptable. As a consequence, the drawing plane surface, which can be represented, is a 4000 Km-sided quadrangle, which is more than sufficient for an urban area.
5.Finally, it has been decided to work with two distinct files, one with the Vila cartographic data and the other with the bordering urban area, in order to work in a more flexible and appropriate way. Microstation allows to open just one active file for each work session; therefore, editing operations or file overall parameter changes can be performed only in this file. Nevertheless, up to 255 different reference drawing files can be linked to the active file, so that a few operations, such as data display and analyses, are made possible. This potentiality allows the user to work with more files at the same time, and to link them according to requirements, thus making the work process more flexible and effective.

6.1.2 Digitalization of the area adjacent to the pilot one

The data of the urban area around Vila have been acquired from a 1979 aerial photogrammetry by PRODABEL. Some elements representing the road system, hydrography, buildings and contours have been obtained from a 1:2000-scale heliographic copy of the aerial photogrammetry by means of a digitizer. This process has entailed afew problems, namely:
1.A non-updated map obtained on the basis of the 1979 aerial photogrammetry. Direct observations have shown that the road system

of the area around Vila did not correspond to the present situation in many points. It has therefore been necessary to compare and integrate these data with another source of data (Urban Soil Use and Occupation Act of Belo Horizonte, 1985) and with surveys in the field. Furthermore, the integration of data digitized from an aerial photogrammetry heliocopy, less precise than the basic map data surveyed in the field by means of precision instruments, has thus introduced a further distorsion, giving rise to a few mistakes in the connection between the road system data drawn from the two different sources;

2.As for the drawing of the Vila buildings, the map obtained from the outdated 1979 flight data source has been judged unreliable, given the area's dynamic changes. Indeed, a reconnaissance in the field has shown a completely different real situation. A new photocopy of the 1989 aerial photogrammetry has been obtained by PRODABEL (the body in charge of data processing of the Belo Horizonte Municipality). Yet, it has not been possible to digitize this map due to its high distorsion. These same already digitized data would have been available - thus certainly being more reliable - but, due to the high market cost, it has been decided to survey the Vila buildings by means of sketches directly in the field, which were successively digitized. This goes to the detriment of the precision level, which is not essential, though, for the production of thematic maps;

3.The contour digitization has been obtained on the basis of the 1979 map provided by PRODABEL. Given the steep slope of the area and the map scale (1:2000), it has only been possible to carry out a 5-m survey of the contours. Even in this case, the most ideal solution would have been to use already digitized data on the basis of the 1989 aerial photogrammetry.

It is important to point out that working with heliographic copies or photocopies, some limitations have to be taken into account, such as distorsions on the edges and the natural dilation of paper. In addition to that, the error ensuing from the digitization process also has to be taken into account. It must be borne in mind that the Vila mapping has been obtained by means of high precision field instruments, whereas the adjacent urban area has been digitized from a heliographic copy of an aerial photograph. Therefore, the obtained result must be carefully assessed,judging whether errors introduced can be tolerated in view of the objectives to be achieved.

6.1.3 Existing social and economic data

Some already existing social and economic data related to the Vila

Nossa Senhora Aparecida, available at the URBEL Occupants' Official Cadastre, have been used. These data have been recently acquired by the AVSI/URBEL Convention, with the objective of legalizing the area. The Occupants' Official Cadastre is made up of a questionnaire used in the legalization process, with the objective of knowing the reality of each parcel (use, occupation form, occupants' number, etc.).
These data are part of a data base, whose key element is the code of the parcel, block and Vila. It then becomes possible to define the final situation of the assignment process of the title-deed to property for each specific case. The questionnaire is structured according to parcels and contains the following data:
-interviewees' identity;
-data related to the type of parcel use;
-occupation system of the parcel and of each individual building within it;
-evaluation of other real estate ownership by the components of the same family (if this is the case, the type, location and occupation position are specified);
-social and economic data related to each occupant;
-observations;
-final judgement on the assignment of the title-deed to property.
It must be pointed out that these data were organized by parcel and not by dwelling, because the final objective was the assignment of the parcel's title-deed to property. This was the reason why it has been possible to use just a limited subset of these data. The research aim was the analysis of data related to buildings, dwellings, parcels and streets. Furthermore, information had to be adjusted to the organization by building and dwelling.

6.2 Data base collection and organization

Concerning the assessment of data available on Vila N. Sra. Aparecida, it became clear that further data regarding the area's physical aspects, urban infrastructures and services of streets, parcels, buildings and dwellings had to be collected in order to develop the area's diagnosis. Furthermore, it was necessary to characterize the adjacent area's soil occupation, urban infrastructures and services. Therefore, a questionnaire was initially drawn up to survey the necessary data.
This questionnaire concerned street segments, identifying retail and wholesale points of sale, services supply, public services, industries, the water network, the sewage and rain water drainage system andthe electrical network; further data were collected on the kind of road paving and the prevailing building typology.
The Vila street-based data survey provided information on the

presence of public health services (street cleaning and frequency, waste collection and method), water network, sewage and rain water drainage system, presence of walkways and pavement type, location of rain water drainage pits and access sewage shafts, electric power distribution and public telephone services.

The parcel-based data survey provided information on typology (horizontal one-family house typology, vertical one-family house typology, vertical multi-family house typology, commercial typology, service supply, public services, mixed services, free parcel), the respect of a certain distance between buildings (front, back, left side, right side and between buildings of the same parcel) and information on infrastructure (electric power, water network and sewage system). In the questionnaire used for the survey of these data in the field, the sketches of the buildings present in the parcels were drawn. The disposition of masses, the number of planes and the distance between buildings related to the parcels' distance were calculated. All this may be useful to check the quality of data acquired from different sources, such as aerial photogrammetry and orthophotomaps. Furthermore, these additional pieces of information, which were not surveyed in the previous AVSI work, were necessary for the attribute linkage of alphanumerical and graphic data and for the successive thematic maps processing related to data on buildings and dwellings.

In addition to the above-mentioned sketches on buildings' perimeter, further data were collected on the distance between buildings, the buildings' conservation state, risk state, type of fencing, type of finishing and building date.

As for dwellings, data were acquired regarding the number of rooms, the description of construction materials of walls, roof, floor and window and door- frames, the type of sanitary appliances, the number of rooms with and without openings, with ventilation and without openings, and without ventilation. These new data were added to the already available ones related to social and economic features (number of people per dwelling, age range, education degree, employment situation and family income, calculated on the basis of the minimum wage number).

Data have been organized in four different files related to streets, parcels, buildings and dwellings, whereas those related to the urban area adjacent to the Vila were not stored in a digital form, because it has not been thoroughly studied yet how to calculate the Vila's influence area. It was then decided to tackle this problem in a successive stage. Files were organized and managed in DBMS DBIII, which was also used to produce output masks for the presentation of information deriving from the data base queries.

6.3 Attribute linkage of cartographic and alphanumerical data

Once the cartographic data have been organized with the elements of the area under study in different drawing levels and once the alphanumerical data base has been created, it is then possible to perform the attribute linkage of cartographic and alphanumerical data. This attribute linkage is a process which increases the "intelligence" of graphic elements, allowing to connect data files to drawing files, so that their features can be described. This connection allows to draw qualitative and quantitative information of each data element and of a data record.

The graphic data base structure in a Microstation environment, version 4.0, shows the CAD features, namely an unindexed non-sequential file. In this structure, only information related to the geometrical features of the elements and attributes of their representation (i.e., of a point element, x, y, z coordinates, level, thickness) is stored. Therefore, a data base external to the package must be used, in order to link non-geometrical attributes to these elements. Microstation is designed to be interfaced with some relational DBMS, such as ORACLE and DBIII. The latter has been used in our research work.

The Microstation files graphic elements, which are stored in DGN format, have some attribute linkage dedicated bytes, with the alphanumerical attributes data base records. In order to perform this linkage, the drawing file must be related to an external file, by means of another data base (Master Control File), where the description of the whole attributes data base structure can be found.

In each data base file, records are univocally identified by a specific numerical mslink field. The graphic element pointer - to which the file corresponding attributes are linked - is physically addressed to this indexed field.

The linkage process between the graphic element and the corresponding record, which has been identified by the mslink field value, can be performed on a single element basis, by means of a Microstation control, or automatically, by means of a UCM (User Command Language) procedure.

In this research, text-type graphic elements (street names, parcels' and buildings' codes), linear graphic elements (lines representing streets and parcel patterns) and area elements (parcel and building polygons) have been linked to records contained in the data base together with the attributes of streets, parcels, buildings and dwellings.

If there are many elements to be linked, the linkage procedure becomes very lengthy and may give rise to many mistakes, if performed on a single element basis. In this case, a UCM language procedure can be used instead. The User Command Language is a

programming language which enables the automatic performance of controls on the (DGN) Microstation graphic file in order to achieve a preset objective. In the case of the Vila Nossa Senhora Aparecida area under study, UCM language procedures have been developed to perform the automatic linkage between alphanumerical and text-type graphic elements of parcels, buildings, dwellings and streets codes and linear-type graphic elements of parcels' patterns.
These routines may be used in other applications of this methodology type in different geographical areas, thus speeding up the performance of the linkage between cartographic and alphanumerical elements.

6.4 Thematic mapping

The thematic mapping was produced by means of graphic editing and through the processing of the data base alphanumerical data.

6.4.1 Thematic mapping by means of graphic editing

As illustrated in paragraph VI.2., the prototype area's and the adjacent area's physical data have been collected by means of a standard questionnaire. These elements, which are present in the land, are characterized by point, linear or area-type graphic elements. The data acquired may be:
-point data: rain water drainage pits, sewage system access shafts, electric power distribution points, dustbins, stairs, points of sale, services supply and public services;
-linear data: water network, electric power network, sewage system;
-area data: road pavement type.

Each element has its own graphic representation and can be repeated with the same features in different points of the drawing file. As is easily understandable, the repeated editing of the same graphic symbol may be a time-consuming operation.
Microstation allows to create a so-called CELL LIBRARY of all the symbols, which may be repeatedly copied in the same or in different drawings. A CELL-type element is made up of a set of basic graphic elements, which are processed by the software as a single element.
All the complex graphic symbols, which have been repeatedly used in the drawing, can therefore be transformed in cell-type elements, thus being processed in a more rapid and effective way.
These elements, which have been created with certain features, may also be used in a point-type or in a pattern-type way. In the case of this research work, cell-type elements have been created to represent point-type data, whereas linear elements have been created as basic

elements.
Finally, CELL-type elements have been used in area-type representations, drawn from cell libraries already available in Microstation and located in the cartographic drawing in a pattern form.

6.4.2 Thematic mapping by means of data base processing

Thematic maps can be produced not only by means of graphic editing, but also through the processing of the data base alphanumerical data. This procedure is based on the answer to two main questions in the cartographic reading:

-what are the features of a certain place?
-where are these features located?

The production of thematic maps by means of this procedure derives from the classification of spatial elements according to their own attributes, which are organized by dBaseIII RDBMS ("Relational Data Base Management System"). Files containing the key field of data records showing certain features are created through dBase standard language queries; the graphic elements linked to these records are successively processed by means of the Microstation's fence filter control. This control allows to change the display features of these graphic elements (i.e. colour), whose attributes in the data base have answered a query.
The thematic map on the Vila population density, for example, has been obtained by means of queries on the dwellings data base, creating files with the records made up of the dwellings code, whose occupiers' number was in classes from 0 to 4, 5 to 8, and 9 onwards, namely the classes of occupiers per dwelling have been identified and then represented on the map. The same procedure has been adopted for other maps, such as the one related to the buildings' construction date, the dwellings' quality standard, income brackets, etc.
In addition to thematic maps related to one single variable classification, other ones with more variables within one same file of the data base can be created. For instance, the parcels' codes corresponding to different conditions in relation to services (electric power, water, sewage) have been identified in the parcels' file, thus obtaining classes, which can be represented in the map. Classes must be identified so as to include all the possible combinations which mayoccur.
Thematic maps may also result from conditions contained in different variables in different files of the data base. For example, the urban

infrastructures' synthesis map has been obtained through the query on variables present in the parcels' file (including conditions on water, electric power and sewage services) in relation to the streets' file variables (with conditions on the type of street cleaning and paving). The management of relationships between different files within the dBase (DBF) format data base is carried out creating proper common key fields in individual files and the corresponding index file. In view of the research objectives, the parcels-streets, buildings-parcels, buildings-streets, dwellings-parcels, dwellings-buildings and dwellings- streets files had to be in relation.
Since a relational DBMS is used, each file must have a "primary key" field (i.e., the mslink in this case for the above-mentioned reasons), whose value univocally identifies a single record, and other "secondary keys", which are necessary to establish relations between the different files. The new "key" fields, which have been created for each file, are the following ones:

FILE	FIELD	DESCRIPTION
STREET	mslink primary key	street code number assigned by Prefecture
PARCEL	mslink primary key	code made up of the Vila code, block code, parcel code
	street code secondary key	equal to the street's mslink
BUILDING	mslink primary key	code made up of the Vila code, block code, parcel and building code
	street code secondary key	equal to the street's mslink
	parcel code secondary key	equal to the parcels' mslink
DWELLING	mslink primary key	code made up of the Vila code, block code, parcel code, building and dwelling code
	street code secondary key	equal to the street's mslink
	parcel code secondary key	equal to the parcels' mslink
	building code secondary key	equal to the buildings' mslink

In order to establish relations according to the pattern illustrated above, as far as the relation between the buildings' file and the

parcels' file is concerned, for instance, it is necessary to create an index file related to the parcel code key field of the buildings file, which is equal to the mslink key field of the parcels file. Concerning the dwelling/building relation, instead, it is necessary to create an index file related to the building code key field of the dwellings file, which is equal to the mslink key field of the buildings file, and so on for the other relations.

Concerning the queries results display resources, area-type thematic maps (whose graphic elements answering queries are polygons) can be produced by means of patterns (having different features as for style, line thickness and scale) or by means of the closed element's area fill option (a polygon, whose area is filled with a colour). The pattern solution allows to simplify the analysis of overlaid maps. To create thematic maps, a proper pattern of (area) graphic elements representing the various land items (buildings, parcels, etc.) has to be made, in order to distinguish them at the output, when the pattern feature (colour, line thickness, etc.) is changed on the basis of the query performed.

As for the area fill option, it makes the analysis of different overlaid thematic maps more difficult and it can be used only on screen, but not on paper, since the normal pen plotter cannot be used in this case. Yet, on the other hand, the area fill option allows to display elements in a clearer way and during the processing stage it requires much less RAM memory as against the pattern mode. Given the large number of elements to be processed, also in the case of the area fill and pattern options,the UCM language written procedures were applied.

6.5 Processed maps

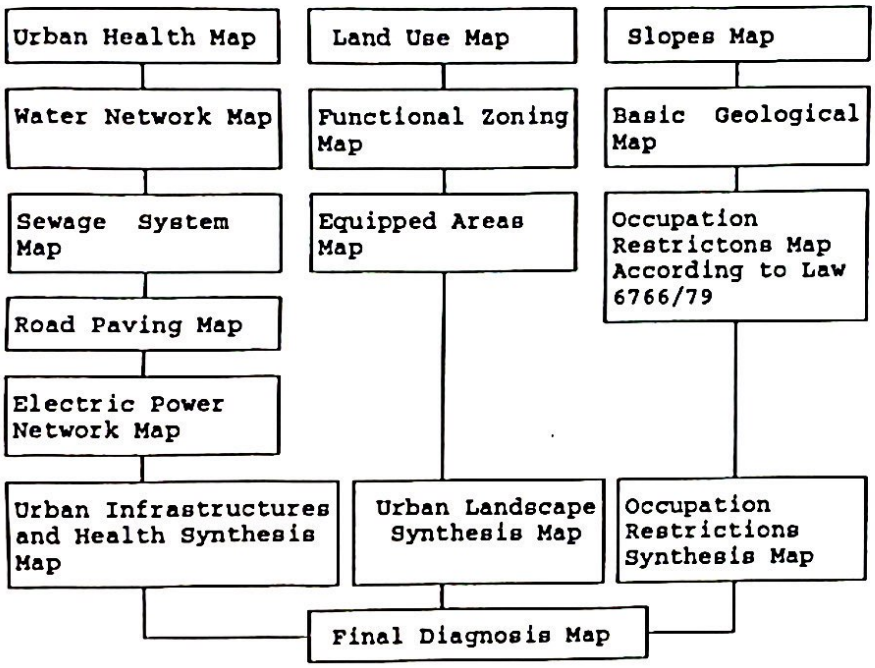
The adopted methodology for map production is based on thematic mapping, which allows a partial and detailed view of the features of each set of elements and also allows the partial syntheses with the study of correlations between variables and a final diagnosis with the area profile.

The cartographic representation is a data analysis and synthesis method. Thematic mapping is an important tool for the description of issues concerning the town, because it can represent elements which are mutually related and which can be individually identified, thus providing a proper description of the urban space dynamics.

The initial maps described in detail the features of the road network (paving type, waste collection, street cleaning, water, sewage and electric network), of cadastral parcels (connection to water, sewage and electric network), of buildings and dwellings (land use and functional zoning) and of the Vila area (slopes, basic geological

situation, equipped areas and occupation restrictions according to Law 6766/79).
These data are summed up in the Urban Infrastructures and Health Synthesis Map, Urban Landscape Synthesis Map and Occupation Restrictions Synthesis Map. Synthesis maps have finally been synthesized in the Final Diagnosis Map, whose objective is to provide the overall view of the area profile.

Process pattern:



6.5.1 Map production

a) Urban Infrastructures and Health Synthesis Map

The Urban Infrastructures and Health Synthesis Map is the result of the Maps on the Pavement Type, Water Network, Sewage System, Electric Power and Refuse Disposal. The Pavement Type and Electric Energy Maps have been synthesized in the Urban Infrastructures Map, whereas the Water Network, Sewage System and Refuse Disposal have been synthesized in the Urban Health Map. The definitions of Health and Infrastructures have been classified according to good/medium/low standards, keeping in mind the fact that this terminology had to be adjusted to a favela reality. An area can be classified as low from the health point of view and medium for its infrastructures, and so on.
The good/medium/low standards have been quantified as follows:

Urban Infrastructures:

-Paving
 earth.....0
 asphalt.....1
 cement,stone blocks,oth.....2
(bearing in mind features like: absorption/ heat reflection, rain water drainage, land containment, etc.)

-Electric Power
 present.....1
 not present.....0
Max. obtainable score = 3

Urban Infrastructures:

good_____3
medium_____2
low_____0 or 1
scores

Health

-Water Network
 present.....1
 not present.....0
-Sewage System
 present.....1
 not present.....0
-Waste collection
 not performed.....0
 individual.....2
 dust bins.....1
-Street-cleaning (frequency)
 not performed.....0
 3 or more times a week..3
 1-2 times a week...1 or 2
Max. obtainable score = 7

Urban Health:

good_____from 5 to 7
medium_____from 3 to 4
low_____from 0 to 2
scores

Linking the classifications, which have been separately adopted for infrastructures and health, the street-based Urban Infrastructures and Health Map is obtained, according to good, medium-to-good, medium, low-to-medium and low standards, as shown below:

		HEALTH		
INFRASTRUCTURES		Gh	Mh	Lh
	Gi	GiGh	GiMh	GiLh
	Mi	MiGh	MiMh	MiLh
	Li	LiGh	LiMh	LiLh

Good = Gi+Gh
Medium-to-good = Mi+Gh or Gi+Mh
Medium = Mi+Mh or Gi+Lh or Li+Gh
Low-to-medium = Mi+Lh or Li+Mh
Low = Li+Lh

b) Urban Landscape Synthesis Map

The Urban Landscape Synthesis Map results from the sum of the Equipped Areas, Functional Zoning and Land Use Maps.
The Equipped Areas Map, which has been produced by a direct survey in the field, identifies areas used for or to be potentially used for recreation and leisure services.
The point-type Land Use Map identifies the points of sales, services supply and public services in the Vila.
The Functional Zoning Map is designed to identify the quality standards of the Vila buildings, classifying them into residential areas

with medium, medium-to-low and low standards. It is important to point out that this classification takes the Vila reality into consideration, and these classes could not be applied to a non-marginal urban area. The Functional Zoning Map development is based on the same linkage procedure already described for the Urban Infrastructures and Health Map, that is, partial classifications are carried out, from which the final one is drawn.

In this map, dwellings have been evaluated according to the comfort quality level and conservation state. As for the former feature, it has been noticed that the number of people per habitable room (rooms used permanently, except for those used as kitchen and bathroom and considered "wet" rooms) and the building's bioclimatic situation (considering the presence or not of the distance between buildings, of windows or the rooms' ventilation possibility and the roofing material). The conservation state and risk state (presence, type) have been assessed. A classification study has been carried out for comfort quality features and the conservation state. Both have then been scored according to good/medium/low standards.

The Functional Zoning Map development has integrated information on the comfort quality and the conservation state according to the previously described pattern, developed according to the following classes:

CONSERVATION	QUALITY		
	Gq	Mq	Lq
Gc	GcGq	GcMq	GcLq
Mc	McGq	McMq	McLq
Lc	LcGq	LcMq	LcLq

Good	Gq+Gc
Medium-to-good	Mc+Gq or Gc+Mq
Medium	Mc+Mq or Lc+Gq or Gc+Lq
Low-Medium	Mc+Lq or Lc+Mq
Low	Lc+Lq

The Equipped Areas, Functional Zoning and Land Use Maps have been synthesized in the Urban Landscape Synthesis Map, in which the following elements have been included:

-points of sale and service supply
-public services points
-operating and potential equipped areas
-low-level residential areas
-medium and medium-low level residential areas.

c) Land Occupation Restrictions Synthesis Map

The Land Occupation Restrictions Synthesis Map results from the sum of the Slope, Basic Geological and Land Occupation Restrictions Map according to the Federal Law 6766/79.
The Slope Map identifies 0 - 10%, 11 - 20%, 21 - 30%, 31 - 47% and 47% onwards slope ranges. According to the Federal Law 6766/79, the area with a slope above 30% is regarded as a non-buildable area. Yet, in Belo Horizonte, land occupancy is allowed up to 47% slopes.
The Basic Geological Map identifies the area's undifferentiated basic complex, which is made up of different structures of biotite-gneiss, granite and migmatite (according to the IGA Geological Map of Belo Horizonte, 1:500,000 scale, 1978). In addition to that, the area has been identified as unstable or with a potential slip risk, as indicated in the Geological Risk Preliminary Map of the Town Development Plan of 1989 (Planning Secretariat - PBH).
Areas with a slope above 30% and the strip along a watercourse (in the present case, an already partially canalized stream) are represented in the Land Occupation Restrictions Map, according to the 6766/79 Federal Law.
The following elements are, therefore, represented in the Land Occupation Restrictions Synthesis Map:
-land occupation restrictions with a slope above 47% (municipal law) and 30% (federal law);
-land occupation restrictions located along the (canalized) permanent stream bed;
-potential risk areas due to the specific geological situation;
-risk areas which are located on slopes from 20 to 30%.

d) Final Diagnosis Map

The Final Diagnosis Map is the result of the sum of the Urban Infrastructures and Health Synthesis Map, Urban Landscape Synthesis Map and Land Occupation Restrictions Synthesis Map.
This map, whose main objective is to outline the area's general profile, results from the representation of the following elements:
-occupation restrictions;
-low and medium-low standard buildings;
-(used or potentially usable) equipped area;
-a poorly served area, in terms of shops, services, urban infrastructures and health;
-a poorly served area, in terms of shops and services supply;
-a poorly served area, in terms of urban infrastructures and health.
In order to plan any development action in a marginal area, it is important to define the most critical areas, as well as their needs and the already existing positive trends, which should then be promoted.

It is possible to identify the area's main trends and needs from the Final Diagnosis Map. On the basis of these data, a bill concerning the Vila land use and occupation should then be defined. Furthermore, starting from the information contained in the maps, town-planning studies and projects could be developed. If the main features and constraints of most existing buildings are observed, a code of the Vila's necessary works can be defined.

6.5.2 Assessment of maps results

The analysis of each individual theme map, of the synthesis maps and of the final diagnosis map enables to draw some conclusions concerning the Vila's partial and general profile. On the basis of the results obtained, it is then possible to make some considerations on the Vila's problems, identify some of the existing potentials and develop projects for the area.

a) Urban Infrastructures and Health Synthesis Map

As a whole, the parcels' infrastructures and health services conditions are satisfactory, namely: the water, electric power and the sewage system services are present and in a good conservation state in relation to a marginal area. In almost no case can a shortage of services be recorded, whereas a medium standard can be observed in a small area of the Vila, near Emilia Carneiro Alley, whose access is also difficult due to a steep slope.
Therefore, as a whole, the Vila can be considered rather uniform. Yet, it must be remembered that the sector under study is limited to the area in the remit of the Belo Horizonte Prefecture (PBH). This is an already urbanized area, equipped with paving, water, electric power and sewage systems, and it is pending legalization. In the case of medium or low-quality services, a negative influence has been exerted by the buildings' precarious conservation state, the land slip risk and the presence of illegal water, electric power and sewage services, if not even their complete lack.
As far as streets are concerned, the features related to the type of paving, presence of water, electric power and sewage networks and public health services (street cleaning and refuse disposal) have been taken into consideration. The lowest-quality street is the one close to the (already canalized) stream crossing the whole Vila area. In this case, the situation is precarious due to the lack of minimum distance between buildings near the watercourse. Camila Souza Machado Street (old Main Street) is in a medium situation, and the other streets which converge into it, such as Izabel Vieira Street (the opposite entrance to

the Vila), can be considered to be in a medium-good or good situation.

b) Urban Landscape Synthesis Map

The Vila road system is characterized by a main branch, Camila Souza Machado Street, and two other access streets, Passarela da Vila Street and Izabel Vieira Street, blind alleys on which a few other blind alleys converge.
From a brief overview of the Land Use Map, it can be seen that the points of trade and services are concentrated in Camila Souza Machado Street (main Vila street), in the Vila parcels which look over the streets of the surrounding quarter, and in Izabel Vieira Street (in a point where it widens into a sort of small square where a few activities are concentrated).
Areas used (or potentially usable) for leisure and recreation activities are represented in the Equipped Areas Map. The former are located along the old Main Street and at the crossing with Izabel Vieira Street, whereas the potentially usable recreation areas are located in a small square around the Vila and at a crossing of Passarela da Vila Street (at a widening in the final part). The points observed ar at the street crossings and in the Vila main street, namely places which are characterized by a greater concentration and passage of people.
The Functional Zoning Map, concerning the buildings' standard assessement, shows the Vila as a rather heterogeneous area. Yet, it is possible to observe a concentration of medium/good-quality dwellings in the parcels at the outskirts of the area under study, which look over the bordering streets. Camila Souza Machado Street is characterizedby a medium level. A concentration of medium-low quality can be observed in the final part of Emilia Carneiro Alley, a sector whith medium-quality parcels (therefore worse than the rest of the Vila).
The Urban Landscape Synthesis map shows that the area next to Izabel Vieira Street is in better conditions for the quality of its buildings and the concentration of activities, which raise the value in use. It can be observed that sales points coincide with equipped areas (crossings and main streets) and with higher-standard residential areas.

c) Land Occupation Restrictions Synthesis Map

The features emerging from the Basic Geological Map show that the whole Vila is located in an unstable area, with a potential slip risk. As for the region's lithological composition, granite-gneiss is the main component, thus not giving rise to major concerns. The risk derives from the contemporary presence of other unfavourable conditions,

such as hydrogeological unbalance due to atmospheric conditions and land surface unbalance due to erosion.
The Slopes Map shows a wholé series of problems related to the area under study, because most of the Vila area is located in the strip above a 30% slope, most of which even exceeds 47%. The Vila land has a concave shape surrounded by a strip above a 47% slope. The lowest zone is crossed by an already canalized stream, which is located in the less steep area.
The Land Occupation Restrictions Map, according to the 6766/79 Federal Law, shows the non-buildable areas with a slope above 30% and those along the permanent stream strip. The map distinguishes areas between 30 and 47% slope from those above 47%, because, even though there is a federal law which defines areas with a slope above 30% as non-buildable, the municipal law raises this limit to 47%. As already mentioned, a very large portion of the Vila land is within the so-called non-buildable area. The less steep zones are near the crossings, which are important areas for the concentration of activities. Therefore, the Land Occupation Restrictions Synthesis Map, once again, points out that most of the Vila land is not buildable or that some areas can be occupied only with the proper precautions, since they are located on lands with a slope between 20 and 30%. A further source of concern derives from the fact that the whole area is situated in a position of potential slip risk.

d) Final Diagnosis Map

This map shows already developed partial analyses in more detail and provides an overall view of the area under study. Spots with more homogeneous features can be seen over the Vila land. One of them is the region next to Emilia Carneiro Alley, where medium-quality buildings prevail, in terms of urban infrastructures and health, and a construction medium-low quality can be recorded, most of the area being within a belt with a slope above 47%.
As already mentioned, the belt whose gradient exceeds 47% stretches for a very wide area of the Vila. Together with the belt between 30 and 47% gradient, it is the area with the lowest quality and highest risk dwellings.
A certain trend has been observed towards the promotion of activities, involving the whole Vila community, in Izabel Vieira Street. The same applies for Camila Souza Machado Street, which is the Vila main street, even though it does not have the same potentials as Izabel Vieira Street, from the space configuration viewpoint.
Passarela da Vila Street is situated at the favela's lowest level, where the already canalized stream flows. It is in a rather precarious

situation, because it is not adequately covered by commercial services, urban infrastructures, health and public utilities. In addition to that, buildings are within the stream strip, even though the problem has now been alleviated thanks to the canalization work. Yet, a certain flood risk exists, given the fact that this area is located in a concavity surrounded by a steep sloping belt. This situation requires a very effective maintenance of the watercourse canalization. Nevertheless, it has been observed that a potential development of the activities for the Vila community could take place in this area.

6.5.3 Study of development action examples in the area

Some simulation attempts of quantitative studies design and development action have been made aimed at studying some of the adopted software capacities. Nevertheless, more thorough studies shall have to be still carried out.
For example, taking into account the need to open new roads or modify the already existing road layout and establish proper traffic directions, some areas have been identified which are not properly served by the road network. Therefore, it is possible to calculate the required paving surface and to design stairways, depending on the gradient. Furthermore, the software enables to calculate the road width, to identify the narrowest roads, pointing out the narrow necks which should be eliminated in case the road occupies an important role in the circulation system hierarchy.

7 CONCLUSIONS

The research work carried out so far is extremely interesting for the parties concerned. The PUC-MG team has carried out this study according to their educational tasks. Both students and professors have dwelt upon the town-planning aspects of a marginal area and the specific software applications for alphanumerical and graphic data processing. The Bologna University team has deepened the urban use issue of marginal areas in a developing country. For the Belo Horizonte AVSI group, this methodological study has been an opportunity to face problems related to the favelas' urbanization and legalization process with new resources, which could be partially or fully applied in the continuation of their research activity.
In the specific case of Vila Nossa Senhora Aparecida, it has been observed that most of it is located in an area of slope above the acceptable threshold and slip potential risk. As for the buildings' conservation conditions, they are not completely unsatisfactory, compared to other favelas in Belo Horizonte. The streets and parcels

of the area under study are already equipped with urban infrastructures and public health services, showing specific shortages as for street-cleaning and refuse collection services. It was not possible to draw up an overall profile of the whole Vila, because the research has been carried out only in the area where the initial cadastral planimetric survey existed, namely the area included in the legalization project and already subjected to some reclamation actions. The whole Vila land survey would be very interesting in order to thoroughly study the changes which have taken place in the area after the town-planning developments and the occupiers' awareness of the importance of their own land acquisition.

The methodology developed in this work can be applied to the diagnosis of other urban areas, provided that the specific adjustments are made to each individual case. If this procedure were applied to the case of a non-marginal urban area, the classification and quality levels used in the thematic maps should be reviewed.

The development of the thematic carthography concepts, through the adoption of computerized mapping resources and the linkage of cartographic and alphanumerical data, allows the representation of the Vila's general and partial profiles. The urban dynamics can be represented by means of the search for correlations between variables and of the whole complex systemic view.

From the analyses carried out in the prototype area, it has been possible to identify its main problems, the places requiring greater attention, as well as its potentials. Once the area's diagnosis has been outlined, it is then possible to develop action proposals, town development plans and works for the Vila.

Furthermore, it is important to recall that even though data have been collected on urban areas next to the Vila, they have not been analysed, because the influence exchange area first had to be more clearly defined. It would be extremely important to study this problem carefully in view of remedial actions to be taken in the favela. Recent study trends in the urban complex systemic view point out the need to deepen these interrelations in order to carry out the area's integrated planning.

Knowing one's own land features is the initial step towards the awareness of the reality in which the community lives. The representation of urban diagnosis maps for the community, through thematic mapping visual communication resources, can undoubtedly favour the users' involvement and the sharing of responsibilities and decisions concerning urban-planning actions, starting from co-operative planning.

8 RESEARCH DEVELOPMENT PROSPECTS

As already mentioned, this research work cannot be regarded as exhaustive, as far as both methodological and technical aspects are concerned. In fact, in addition to a very limited time available for the development, other shortages must be pointed out, such as the lack of more suitable information and technical equipment.

First of all, there was the lack of some important data sources, such as an up-to-date aerial photogrammetrical survey and the sampling points elevations required to produce the digital terrain model. These data have been taken into account at a methodological level, by simulating their presence by means of data digitization from cartographic support. It would be extremely important to work on an up-to-date aerial photogrammetrical survey especially in a context like that of marginal areas, where land changes are determined by a rapid and intense urban dynamics.

From a technical point of view, the prospects of increasing GIS potentials applied to town-planning reclamation actions in marginal areas undoubtedly are more far-sighted and provide an easier solution. Higher quality products, compared to the ones used in this research work, are now available on the software and hardware market at accessible prices. As far as the hardware is concerned, the performances of a 80486 microprocessor PC, in terms of instructions performance speed and of PC accessible costs, are much higher than the PCs which have been used. Even the RAM and mass storage capacity of the PCs, which have so far been used, could be substantially increased, enabling users to work with more powerfulattribute and cartographic files, thus being able to cover much more extended areas than the one which has been studied.

It should also be pointed out that the GIS implementation on a more powerful hardware than PCs, such as Workstation, is a feasible opportunity, given the fact that Workstation prices are now not much higher than the PC ones. As far as GIS sytems are concerned, hardware and software manufacturers usually tend to supply a complete and integrated product on dedicated workstations, rather than on a PC. The advantage provided by a workstation, compared to a PC, does not lie so much in higher speed and storage performances - which are just slightly higher than in a PC - but rather in the possibility to run a software product using its capacities at best, not just in terms of its application development, but also because it is installed so as to fully use the hardware capacities.

Greater capacities and the development of deeper analyses could derive from the use of other software packages both by other manufacturers and by Intergraph itself, namely the Microstation

manufacturer. Both the new version for PC 486 and that for Workstation Intergraph (UNIX operating system) include additional modules on the Microstation shell, offering further GIS-oriented modules.

Amongst them, a package designed for DTM (digital terrain modelling) and for slope and aspect calculation and representation is of fundamental importance in marginal areas, where the knowledge of the soil morphology and geology is useful to identify possible risk zones, with the possibility to manage specific reclamation actions, if the land conditions allow it.

Other capacities include raster format data management as vectorial format data background, and raster/vector conversion programmes. These capabilities are very useful for the (raster and vectorial) spatial data base updating of the information system on the basis of data deriving from remote sensing, and for the simulation of scenarios deriving from remedial action planning on the urban fabric.

Finally, the spatial analysis use possibility should be pointed out. As already mentioned in other chapters, this type of analysis would allow to perform queries on spatial objects themselves through their topological proximity, contiguity, inclusion and intersection relations, and to derive new information from the overlay of point, line and area themes already contained in the data base (i.e., identification of non-buildable areas, obtained by the overlay of geological risk areas with the slopes map).

9 REFERENCES

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