

**Title: Analog Mapping Computer Files.**

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**Abstract.** Analog map files have never been used before as the support structure on Geographical Information Systems. In this paper, the generation, use and integration, of Analog Mapping Computer Files with other type of data is discussed. How these files are developed, what advantages and benefits can be enjoyed and differences with other systems are also described.

**1. Gis Data Base requirements.** The combination of computer techniques with mapping files, together with adequate software tools, has created a powerful industry encompassing the different products required, both hardware and software, known as Geographical Information System. Many different packages are available, marketed by well known companies, which offer the user the potential of handling large amounts of spatial data in a very logical, intelligent, efficient manner.

As a GIS is a managing tool, it requires the data files to be in formats which can easily be handled by the software, so that rapid classifications, development of decision taking information, measurements, and other actions triggered by a certain set of conditions can be obtained. Also the data files have to have the proper built-in intelligence so that logical, intelligent results can be achieved. In a highway inventory, for example, an intelligent result will be the length of a winding road from point A to B, which is information associated to a line entity; in opposition, a non-intelligent result would be the straight line between these two points. For the purpose of obtaining intelligent decisions, there is only a possible solution which is the use of digital data in vector files.

One of the requirements of these systems is the ability to be easily interpreted by the operator. To help him in this objective, the system provides not only the vector layout supporting the data of interest but also the mapping imagery of the same geographical area, at the proper scale. An example: for purposes of civil protection, it may be required to be able to view the railroad infrastructure with the maximum amount of details, track and station locations, signs, tunnels, switches, etc.; however it may also be convenient to have the possibility of viewing simultaneously the geographical area surrounding these entities, so that in case of an emergency, the operator has at hand the proper information to decide the best way to evacuate wounded personnel, the closest roads for ambulances and firemen, and in case of an accident in the open country, even the altimetry which could be of tremendous help in finding the best ways for the assisting parties to arrive at the accident scene. This example, which is almost typical in any GIS application, describes the need to associate vector spatial data (of the subject) with general geographical imagery of the same area.

This requirement has been filled by using raster files. Through the use of a scanner, a raster file of the maps covering the areas of interest can be generated. These raster files can be scaled and geometrically corrected so that exact registration with the vector files can be achieved. In this way, the user can make use of the vector files to obtain, modify, update, or in any other way use the critical digital information related to the subject. At the same time, he has the general geographical area visible, when the raster file of the same zone is called to the screen.

**2. Raster files.** Up to the present time, this has been the only way to handle this proposition. The operators use potent software tools to manipulate the digital files, and at the same time they have powerful hardware peripherals which enable them to generate and to later view simultaneously the vectorial information superimposed on the raster background file.

Raster files, used as background of the necessary vector files, have great advantages; the proper hardware is available to generate rapidly high resolution files; these files can be stored on CD-ROM's which, in turn, can be read in economical and handy CD-ROM readers. The software to handle this type of data is available and the requirement to register these data with the vector files has long been met. The fact that the data are stored on this convenient vehicle facilitates the dissemination of information, which in turn enlarge the potential market.

On the other hand, raster files have tremendous disadvantages, the most important being the huge size of the files. This demands large amounts of memory, as well as very fast computers; normally, raster files require the use of workstations in order to obtain acceptable operating speed. Also, as a consequence of the huge amount of data, compressing and decompressing techniques have to be used to reduce the memory required. The use of CDROM's makes it impossible to navigate seamlessly from once scene to an adjacent one.

**3. Analog files.** The arrival of multimedia techniques at the marketplace, has brought along a series of new tools which provide new solutions to the problem outlined.

We are giving the name "analog files" to the series of video images created by using a high resolution video data recording setup which are later stored on an optical video disk. The file is created by processing the reference maps in a video image capture system that divides the maps into sections, or tiles, which all together make up the geographical support imagery. When the video images are being recorded to the optical disk, an index is created which permits almost immediate access to any particular scene. Not only this, the video image capture system, taking into consideration the datum and projection of the cartography being used georeferences every picture element of the analog file. This characteristic is utilized by the software to provide the operator with the exact geographical coordinates of the point that the

cursor is resting on. The images can be extracted from the optical disk by using a video player controlled by the computer. As the images are displayed one by one, the video player must be operated in still image mode.

These analog map files can be obtained of any type of cartography, the only requirement is to have the proper documents which have to be videoscanned, either on paper or film, to generate the proper video imagery. Therefore the system can be used with any type of documentation, maps, charts or plans with graphical information of the territory. The georeferencing process is the key to the system and therefore is specially appropriate for data linked to the territory.

Naturally, these video images, recorded to the optical disk, provide the user with all the benefits attached to the multimedia world; they have an almost instantaneous access, the operator can travel from one scene to the next in a seamless manner, and it can be used as the support for any other type of information, either purely digital, vector, raster or video format, even sound or text can be associated to any specific point. And these points of interest can be identified by the operator by using icons, which can be easily created and precisely placed on any scene.

**4. Comparison.** If a comparison is made of the operational capabilities between these two types of files, there is no question that the analog video files are far superior to the raster files. Suffice it to review the characteristics already mentioned: immediate access, easy, economical and fast generation of the analog georeferenced file, and the limited computing requirement, a standard off-the-shelf 486 PC is all that is necessary. On the other hand, the price of the elements required by both systems may vary widely, and the CD-ROM, with its reduced economy and ease of use is a very attractive solution.

**5. The analog file as the structure element in a GIS.** After considering the differences established in the preceding paragraphs, let us see now how these analog files can be used, not only as a background reference layer, but also as a structural support network to which the data, subject of the GIS, can be attached. The analog map files, combined with the proper software tools, have turned out to be extremely versatile products, lending themselves easily to being the supporting structure of a GIS.

A GIS, a Geographical Information System, by definition, is designed to manage data with a geographical signature. It is for this reason, that the georeferenced analog map file is specially adequate for this purpose. As every picture element in the video imagery is georeferenced, it is possible to identify each specific geographical point and attach to it whatever attributes or qualifications may be necessary.

This approach is exactly the opposite to the classical GIS approach. Normally a software suite is written to handle the subject data, and after the data are collected they are associated with the specific location geographical coordinates. And, as a final convenience, a background raster file is added incorporating to the data base the geographical imagery extracted from the available maps. In our approach, the opposite method is followed; first the structural geographical analog file is created of the area of interest; this file can be visualized as a Christmas tree when it is initially purchased, it is empty and its only mission is to serve as the support for the lights, the presents and the ornaments.

In our case, in the same fashion that we hung ornaments, presents and lights on the Christmas tree, we can attach to the analog file, in the exact geographical location, the icons symbolizing the subject data of interest. And these icons lead to the proper data.

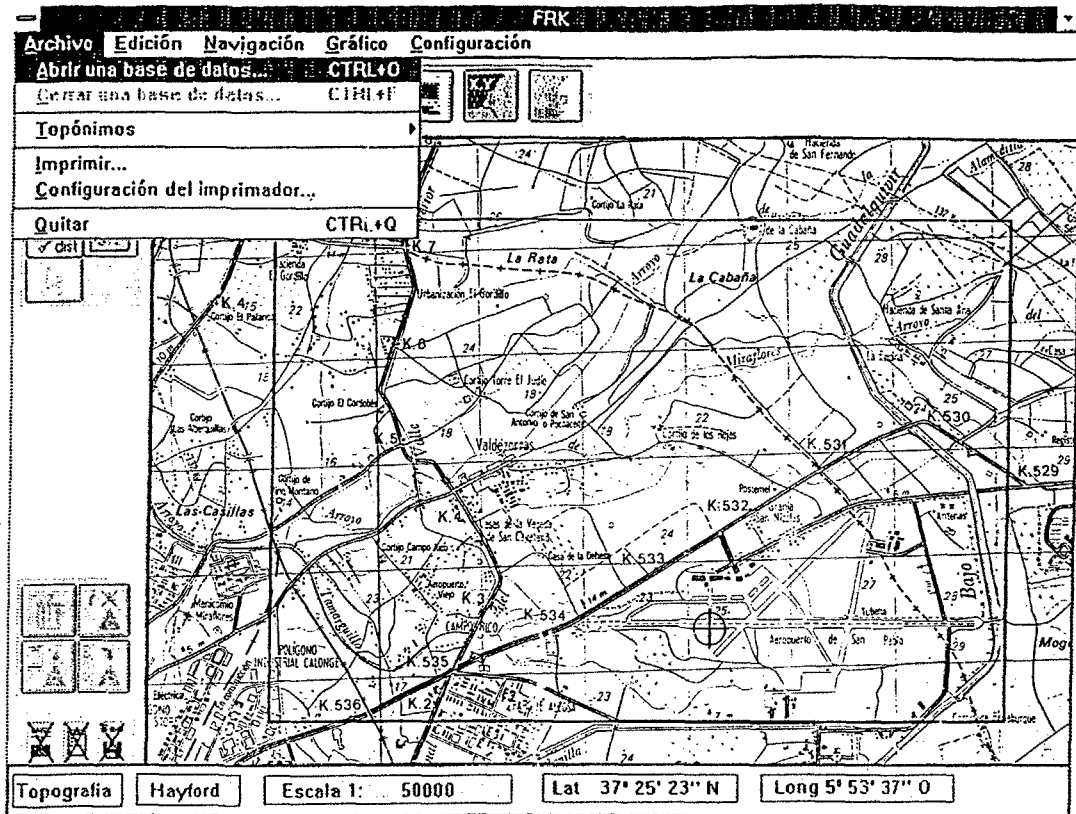
This is the one, single feature that makes the analog map files different from anything used so far, and at the same time, makes them so useful and practical. By becoming the support structure of any type of attribute, either point, line or area, any type of record, either strictly digital, vector or raster files, video imagery, text, sound, etc., the analog map file is an ideal tool for the asset manager. The operator can easily and rapidly access any geographical point if the coordinates are known. In certain applications (like BACARES (Base Cartografica de España)) a toponym list is included which allows immediate access to a specific geographical point if the name of the location is entered through the key board. Once that area on the screen, it shows the symbols or icons which gives way to whatever other data are attached to the base analog map file on the specific locations where the icons are placed.

At this point, it should be stressed that the analog map files has NOTHING TO DO AT ALL with the potential or ability of the algorithms included in the data handling software. The software itself inputs, manipulates, process, modifies, merges, deletes, updates, or outputs the data of interest, it may have a larger on smaller potential, it may be more or less efficient but this consideration is beyond the interest of this paper. The subject data are stored, attached, mounted on the analog map file as described previously, how the data are processed is another question.

**6. Conclusion.** We have seen that the analog map files obtained and organized as we have described in the preceding paragraphs, constitute a computer tool never used before as the support for a geographical data base; it is a versatile tool, as maps at any scale, of any geographical area, can be transformed into analog files. They are also a tremendous source of graphical information as it holds all the information contained on the maps, nothing is missing (as a matter of fact, it is like a photograph of the maps); and at the same time allows the user to access any other type of data which, being of interest, have been attached to the georeferenced analog data base. We have seen that by using this approach we can enjoy all the benefits related to multimedia, different

effects, instantaneous access, seamless navigation, and easy and convenient update methods.

As with any other type of technological advancement, there will be some time until the users appreciate the advantages explained above and the benefits that can be extracted, but there is little doubt that the georeferenced analog map files described here will become, in the near future, the preferred support for managing any type of data associated to the territory.



A typical scene showing an analog map file as extracted from the optical disk. The cursor is placed on the airport runway. The coordinates of the cursor position are shown at the bottom windows. Scale 1:50,000.