

# Designing multimedia GIS for territorial planning: the ParcBIT case

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## **Abstract**

This paper examines the design and implementation of ParcBIT, a multimedia GIS CD-ROM presenting the information required for the development of a Master Plan for a Technological

Park in the island of Majorca (Spain). The CD-ROM is the information resource of an international competition for Master Plan proposals in which world leading architects took part.

Environmentally conscious planning is one of the possible fields of application of multimedia GIS and in this paper the methodological approach for the generation of the content and structure of such a multimedia georeferenced database is described and discussed. The interface and navigation issues are approached from the point of view of making accessible multimedia GIS for non-expert users. Finally, the current situation of the development tools, which makes difficult the integration of GIS and multimedia, and feed-back from the users of the application are evaluated.

## **Keywords**

Multimedia, GIS, Territorial Planning, Balearic Islands

## **Introduction**

The introduction of (computer-based) Geographical Information Systems (GIS) has been described in the Chorley Report as 'the biggest step forward in geographic information handling since the invention of the map' (Department of Environment UK, 1987). A consequence of the widespread use of GIS has been to base upon these systems the development of multidisciplinary applications such as urban and regional planning, which is currently object of much research in Southern Europe (see as examples Henriques *et al.* 1992, Fonseca *et al.* 1994a and 1994b).

Multimedia has been defined as the communication of information in a variety of formats - text, graphics, still images, synthetic animations, video, audio - (Bill, 1994). Multimedia here is synonymous of multiple formats, but some authors promote the use of the terminology *integrated media*, stressing the integration of different media in a computer system allowed by current digital technology. More recently multimedia is qualified by *interactive*, as digital information is more directly accessible and interactive multimedia has been coined as a new medium of communication where the user plays an increasingly important role, instead of being

a more or less passive observer. The term *hypermedia* is also used in order to denote the hypertext-like structure of the multiple media.

Raper's recent survey paper (Raper, in press) advocates for the introduction of multimedia in the manipulation and analysis of spatial data in GIS, describing the main technological challenges for multimedia, the current situation of hardware and software development tools and reviewing examples of integration of multimedia and GIS which show the power of integrating multiple information formats. Another step forward in the role of the user and the presentation of the information will probably be offered by the generalisation of Virtual Reality (Jacobson 1991, Neves *et al.* 1994, Dias *et al.* 1994, Câmara *et al.* 1994, are examples in the context of GIS), while the development of fast speed telecommunications networks, both public and private, is a promising area for further uses of GIS (see for example Smeaton *et al.* 1994 about the development of multimedia courses over computer networks).

An already classical example of pioneer work integrating multiple formats of data and GIS is the Domesday project (Openshaw and Mounsey, 1987), while GISTutor (Raper and Green, 1992) is the important development of a hypermedia system for interactive, self-paced education. The project Riverfront 2000 (Kindleberger, 1989) pioneered the use of hypermedia systems for planning - used to assess the development of St Louis area of Mississippi River -, where the written description of each potential development site is linked to maps, aerial photographs and video; overlays for simulation and user annotation are possible within the system.

An important specialisation of GIS and multimedia with applications in planning are Collaborative Planning Systems, an example being provided by the implementation described by Shiffer (in press), which allows participants in a city planning meeting to benefit from, and add to, a geographically-oriented multimedia information base; Shiffer presents specific multimedia tools which are developed to enlarge human - computer interaction and give improved support for city planning.

The CD-ROM ParcBIT (1994), described in this paper, is a tool for urban and regional planning combining georeferenced information and interactive multimedia with some new characteristics. It was prepared for the international design competition for the Master Plan of the ParcBIT (*Parc Balear d'Innovació Tecnològica*, Balearics Technological Innovation Park based in Majorca) and aims to deliver information which the architects / planners might require for the preparation of proposals for this competition. Its content and structure is based on the premise that the Park development will mean a wide impact on the whole island of Majorca. The territorial planning should be environmentally conscious and take into consideration complex social issues.

The information in the CD-ROM is structured from the most general level, Balearic Islands, to the most specific, ParcBIT, through the intermediate steps of the island of Majorca and the city of Palma where the Park is to be located. The information extracted from the GIS database is the key one at each scale of access, mainly through textually annotated maps and georeferenced socioeconomic data. There are also a large number of photographs, a fairly substantial length of aerial video sequences and a variety of information in other formats. In this paper the methodological model of environmental impact assessment which lies behind the generation of a substantial GIS database on the Balearics in the recent years and behind the CD-ROM content and organisation of the information provided for the architects is discussed. The CD-ROM Flight of Fancy (1993), previously developed by UIB, is briefly referenced in this context.

The variety of this information and the fact that architects / planners are not GIS specialists led us to integrate all this information into a full interactive multimedia application. To access this application a quite simple to use novel Video User Interface was developed for this specific purpose. The interface is a central tool for the access or navigation of information in the different formats - navigation is the word used in multimedia literature for the interactive access or browsing of the information - . Video plays a very important role occupying usually the right half part of the screen and keeping up a sort of peer-to-peer dialogue with the more traditional way of conveying georeferenced information, the informed maps. This fresh approach somehow disregarding traditional GIS interfaces has proved quite beneficial in integrating quite a lot of information which is necessary to offer GIS results to non-GIS professionals. The interface developed for ParcBIT is analysed in detail later, explaining the thinking which has guided the main choices in the design. These choices are critical for understanding the integration of new formats of information with traditional GIS data and the way the user can navigate through them in a rich and significant way.

The development problems of ParcBIT raised quite a few new questions about how to integrate much more fully the different types of digital information into GIS in a territorial application and are object of detailed discussion in the third part of the paper. Several issues concerning the usability of GIS through multimedia interfaces and the solutions adopted are also included.

The discussion of the innovative aspects of ParcBIT should not hide the fact that it is not just a research prototype but a product intended as an information resource and in the final part of the paper some users' feedback is taken as starting point for a final discussion of the contributions of ParcBIT to the actual use of GIS through multimedia in territorial planning. Some limitations of the project are underlined and future lines of research indicated.

## **GIS methodology and information content structure**

Territorial planning and environmental impact assessment are two fields of applications of GIS technology, where GIS are used in two main ways: to provide a territorial inventory of

territorial resources by extracting information from a database and as an analytical tool which allows to extract complex geographical features by means of spatial analysis techniques. A multimedia GIS application which is useful for planners has to provide at least a presentation of the basic information (thematic cartography and statistics), description of the procedures with which this information has been treated, cartographic models used and presentation of the processed results.

The cartographic information which is the key information in ParcBIT is essentially descriptive, and comes mainly from the database created at the GIS lab at Universitat de les Illes Balears (LSIGT-UIB) in the past few years. This database has been created in parallel with carrying out quite a few environmental impact assessments. This experience has led to the development of a methodology where the territorial variables are elucidated and procedures have been put in place for obtaining a cartographic integration where potential conflicts and environmental impacts are apparent. The results of these assessments have been presented in the way described in the previous paragraph, both on paper and on the multimedia CD-ROM prototype Flight of Fancy (1993). In this CD-ROM three different examples of environmental impact assessment (localisation of a new energy plant on the island of Majorca, analysis of touristic potential of the different areas of Majorca and analysis of the new urban plan of one of Majorcan municipalities) are fully developed within an integrated multimedia GIS presentation.

The descriptive cartography in ParcBIT is organised around two key factors: scale and topic. From the experience described earlier, the thematic cartography is much more than maps of basic variables; plenty of derived maps are generated which are directly useful for the planning; as examples, one can mention maps of distances to natural areas of special interest, or maps of distances to the road network, .... A narrow approach has been avoided as much as possible by providing a wide range of information in ParcBIT as shows its content summarised in Table 1, but GIS has been used extensively to provide the derived maps that are required in the models of environmental impact assessment that UIB has used in the past.

The index of the information as reflected in Table 1, reveals the extensive breadth of the information, presented through an interplay of the scales Balearic Islands, Majorca, Palma and ParcBIT and the main thematic cartography headings which are Physical Geography, Geodemography and Territorial Framework. But general information, economy, culture, history, administrative structure, architecture, landscape is also provided by means of text, graphics, pictures and video as significant elements for planning use. Going into more detail at each level explains the choices of information in this approach.

	<b>MAJORCA</b>	<b>PALMA</b>	<b>PARCBIT/UIB</b>
<b>Physical geography</b>	Orography, Climatology (mean annual temperature, climate typology), Hydrogeography, Geology, Biogeography, Intrusion, Bathymetry, Danger of storms, Natural spaces legislation, Distance to Natural Areas of Special Interest, Distance to the coast	Orography, Climatology (mean annual temperature, climate typology), Hydrogeography, Geology, Vegetation, Natural spaces legislation, Distance to Natural Areas of Special Interest, Distance to the coast	Orography, Climatology (mean annual temperature, mean precipitation), Hydrogeography, Geology, Vegetation, Natural spaces legislation, Distance to Natural Areas of Special Interest, Distance to the coast
<b>Geodemography</b>	Population growth, Demographic distribution, Demographic density, Demographic rates, Population / Economy	Development and present structure of the population, Natural growth and migratory growth, Structures by age, Structures by origin, Population and employment, Educational attainment, Geodemography by districts	Structures by age, Structures by age and sex, Structures by origin
<b>Territorial Framework</b>	Land use, Centres of consumption, Road network, Tourism, Marinas, Distance to urban centres, Distance to the road network, Distance to the electrical grid, Distance to commercial ports, Distance to the airport, Distance to marinas, Distance to golf courses	Land use, Tourist offer, Industry Areas, Distance to Industry Areas, Road and rail network, Distance to the road network, Urban public transport, Distance to commercial ports, Distance to the airport, Marinas, Distance to marinas, Golf courses, Distance to golf courses, Electrical grid, Distance to the electrical grid, Water distribution, Sewage system, Urban Planning, Facilities by district	Land use, Distance to Industry Areas, Road and rail network, Distance to the road network, Urban public transport, Distance to commercial ports, Distance to the airport, Distance to marinas, Distance to golf courses, Electrical grid, Distance to the electrical grid, Urban Planning
<b>Specific Headings</b>	<b>General Geographical information</b>	<b>The City</b> Significant civic and religious buildings, Gardens, squares and boulevards, Outstanding civic buildings, City walls, fortifications and historical remains, Churches, Airport, Port	<b>ParcBIT Position</b> <b>UIB</b> Geographical position, History, Legislation, Infrastructure, Human resources, Financial resources, Academic resources, External relations
<b>Background information on the Balearic Islands</b>			
<b>Geographical information</b> , Geophysical characteristics, Population, Economy, territory and society, Similar regions, <b>History</b> , <b>Administrative structure</b> , The Autonomous Government, Municipalities, Foreign consulates, <b>Competitive strategy</b> , <b>Culture</b> , Museums, Newspapers			

*Table 1: A tabular representation of the clickable index of ParcBIT. The hierarchy goes from Balearic Islands through Majorca and Palma to ParcBIT/UIB.*

The Balearic Islands module has been introduced as a general background: Physical Geography, Population, Economy, Territory and similarities with other European regions are the main GIS-related headings; addition information about history, culture, regional government, etc. are included as part of this background information. Video (shot from a

helicopter) illustrates the Mediterranean scenery of the Islands and its significant landscapes. The heading 'Competitive Strategy of the Balearic Government' is of special significance to the Master Plan competition and is described by means of digital video, graphics, and tables. It tells the users about the perceived needs of diversification of what is now the main economic resource of the islands, tourism. The technological park ParcBIT is part of this diversification strategy for preserving the islands as a wonderful landscape and nice weather resort close to most of Europe, along with attempts to attract a new range of professional people to the islands who use telecommunications networks to develop their work - teleworking -.

The next level of information is the island of Majorca. Its material is much more precise, nearly all of the cartographic type. The scale is 1:50,000 and the raster maps use units 500 x 500 m. Geodemography, with demographic distribution, demographic density at local levels, demographic rates of growth and migration, and Territorial Framework, with land use, centres of consumption, road network, distance to urban centres, to commercial ports, to the airport, etc. are headings developed in a lot of detail along with a special emphasis in climatology for obvious planning reasons. The helicopter-shot video presents short sequences of various distinctive and relevant landscapes, both urban and rural.

The next level in the scale is the city of Palma: here the textual information considers its high level of urban quality; while significant information for planning in form of the global aspect of the city, churches, monuments, ... is presented by means of video and pictures. In Geodemography, information on the 80 districts, recent evolution both registered and actual, level of instruction and the population by activity sectors are the most significant variables. The Territorial Framework is described paying special attention to the airport and port (for its importance relative to the strategy described earlier), land use, tourist opportunities, industrial areas, road and rail network, several networks of services, urban public transport and facilities by district. These subjects along with climatology are key aspects which are presented treated at the scale 1:25,000 and the raster unit is 100 x 100 m. The urban planning directives are included with special reference to the district where the ParcBIT is to be located.

The final level of information covers the location of the ParcBIT and of the University, which is in the same area and in itself relevant for the perspective of a technological park development. At this scale climatology and Geodemography are presented at a much more detailed level with pyramids of population and in Territorial Framework very detailed material on the services available for the administrative districts of the zone is provided. While again the scale is 1:25,000 and the raster unit is 100 x 100 m, all ParcBIT maps have a coverage of topographic information (level curves and other references) and are based on enlarged maps of Palma. The information on the University is probably too comprehensive but it was interesting for the University developers of the CD-ROM; a significant part is the Special Plan of the Campus which is accompanied by maps belonging to the 1985 General Urban Plan of Palma.

As a separate resource outside the multimedia GIS application, relevant digital pictures of the area are provided in the CD-ROM. They are the land use and the geology of Palma at 1:50,000; the road network and the topographical map of Palma at 1:25,000; the Special Plan of UIB Campus with its position, location and network of galleries (sewage, ...) at 1:5,000 and all of them come in standard PICT format. A 3D Digital Terrain Model data of the ParcBIT area with services network coverages in .dxf (AutoCAD) format is also provided. These were thought as being the main elements which planners might be interested in importing to their computers in order to implement their own ideas on them.

Bibliographic references are also provided in the CD-ROM under the headings: Balears, Majorca; Palma; New Information and Telecommunications Technologies, Teleworking; Ecologically Conscious Urban Planning; Sustained Development.

## **Interface and interactivity design**

The complexity of GIS in terms of the structure of the geographical information, database management, spatial analysis algorithms, etc. makes them difficult for non-expert users, but at the same time GIS have an enormous potential even for daily life applications. A current alternative for designing multimedia GIS specific non-professional applications is the development of friendly customised interfaces using interactive multimedia technology, while a full integration of multimedia capabilities in GIS is attained in the future.

In order to develop a multimedia customised interface, it is pertinent to recall that all design should begin with an understanding of the intended users (Shneiderman 1992). The fact that the intended users are architects / planners led to approach the design from a fresh point of view quite unrelated to current GIS interfaces, which deal mostly with the more geographical issues described in the previous paragraph. As an example, scale in the ParcBIT goes from Balearic Islands to ParcBIT, through the steps of Majorca and Palma. The reason to use these four levels which somehow limit the full range of spatial analysis which GIS allows is because these are the most relevant scales and it is far easier for the architects / planners to interact with the information, while a more formal GIS approach would probably hinder the use of the information. The numerical scale seems both less intuitive and less relevant than the direct local / island / regional and the latter allows for a more significant grouping of the information; then a specific and different numerical scale is used at these levels as described in the previous section.

This novel Video User Interface for users who are not GIS professionals places video information, which is specifically relevant, on the right part of the screen, while cartographic type information usually occupies the left side. As a useful tool for navigation, the upper part of the screen tells the user where he / she is with respect to the index, while the bottom of the screen is kept for interactive buttons which allow the user to browse through the information. This basic scheme, which leaves almost half of the screen empty, has proved quite easy for

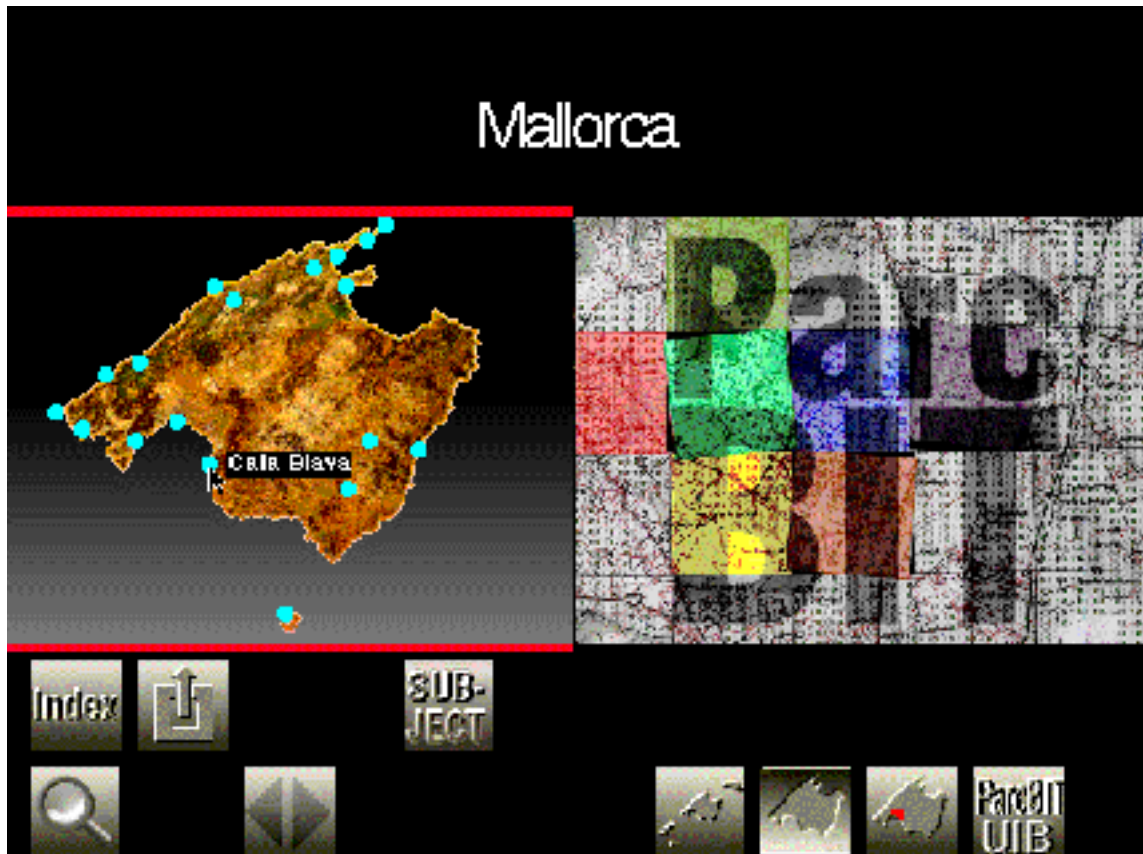
non-expert navigation and examination of complex information and is facilitated by the addition of a 'magnifying glass' button. The screen therefore never appears cluttered, while interesting details, additional information, full screen video... can be displayed by clicking on the 'magnifying glass' button or other relevant buttons.

In practice the application developed is consistent with Waters (1994) who says that 'the concept of publishing for geographic information is more than the conversion of conventional maps to digital media, more than the connection of non-graphic attribute databases to map features and more than the provision of 'hot-buttons' on maps for the 'popping up' of script or image information. It is the complete process of taking the raw information through to a usable product in the computer or network and enabling the user to access it in a user friendly fashion'. How this is approached is shown here through different examples of the interface/navigation design .



*Figure 1: A video sequence corresponding to a hot button from Majorca*

In the interface a sort of dialogue between cartography data and video/still image data is established. A typical screen where video appears looks like Figure 1. In the screen dump corresponding to Figure 1 one sees how the hypermap concept is implemented by allowing the connection of maps to video: the button 'Cala Blava' turns into red when either video from this area appears or when the user selects it and gets the video running. The red bars appear indicating which part of the dialogue video/cartography is currently active while the inactive one changes colour (compare Figures 1 and 2).



*Figure 2: General main screen of the Video User Interface*

Figure 2 shows the general main screen of the video user interface. As it appears in it, the navigation through the CD-ROM is facilitated by direct access (from all the screens) to the comprehensive hierarchical index (schematised in Table 1) from the 'Index' button. The index appearing by clicking the buttons is itself clickable text allowing the user to go directly to the item of interest. Immediate access to the different scales is allowed by the four buttons on the bottom right. One can also browse by subject or through the subjects themselves along a sequence (buttons allowing forwards and backwards movement). The two other buttons appearing here are for exiting the application and for magnifying items such as maps and video to full screen size. It is important to note that most of the buttons are context-sensitive, meaning, for instance, that if the user changes scale (from Majorca to Palma, say) he / she remains in the same subject of exploration (for example in Geodemography) and this context-sensitive principle holds throughout the application.

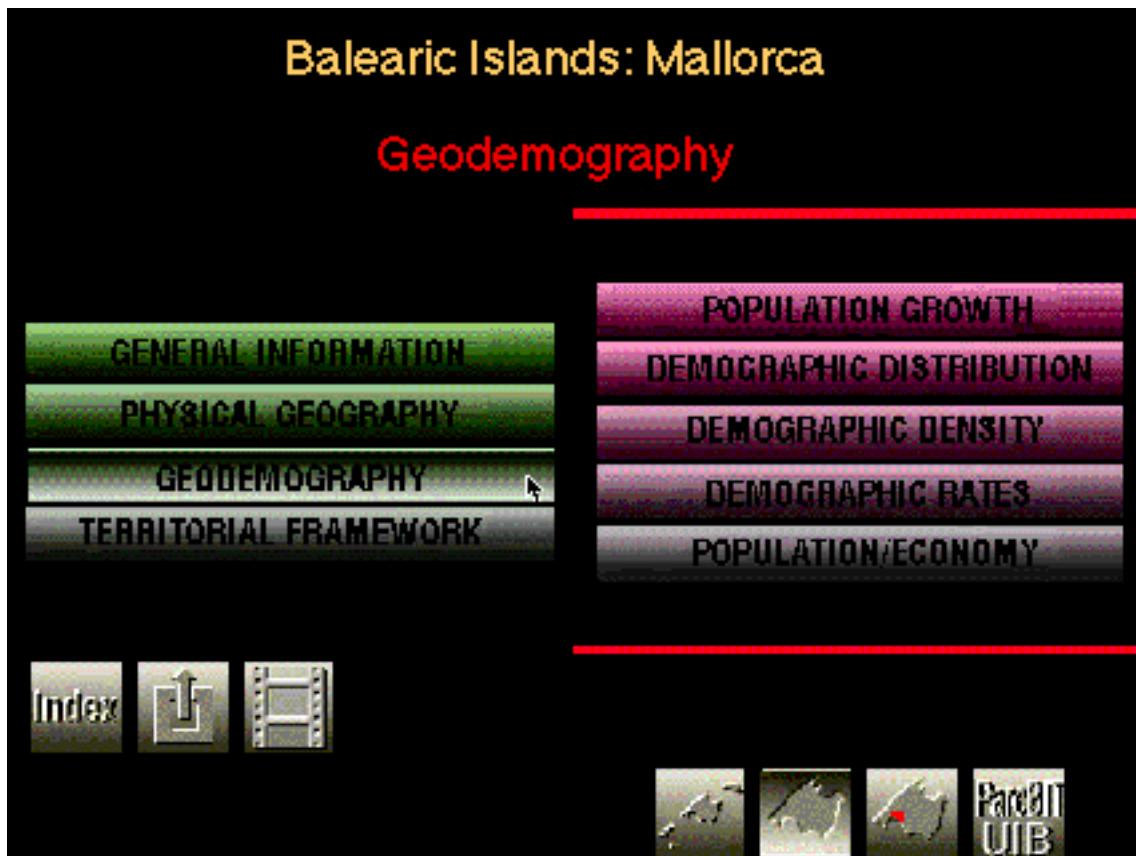


Figure 3: The typical appearance of the tree-structured menu on a screen

The thematic navigation also implements standard recommendations for casual users (Shneiderman 1992) by using menus in a tree-structured way. A typical menu screen is shown in Figure 3. A quite uncluttered organisation of the screen has been chosen and it appears quite attractive from the visual point of view, but it is also important from the navigation point of view. It allows for basic navigation buttons to be always present at the bottom. At the top of the screen another extremely important navigation help is displayed, namely the place in the structured menu where the user is currently located. This avoids the requirement for the user to memorise commands / location and his / her cognitive overflow.

Typical screens showing more explicit cartography appear in Figures 4 and 5. Note that link map to legend is automatic. Usually there is information associated to the map and the link is activated by means of the 'Info' button. The design of the buttons also follows standard recommendations to limit the number of icons and giving them a consistent appearance while using popular symbols (Shneidermann 1992) or text labelling when no popular symbols appear to exist (Vertelney *et al.* 1990). In many cases geographical representation or geographical metaphors are used because of their power in this context; in particular they are used in the buttons for the selection of the scale.

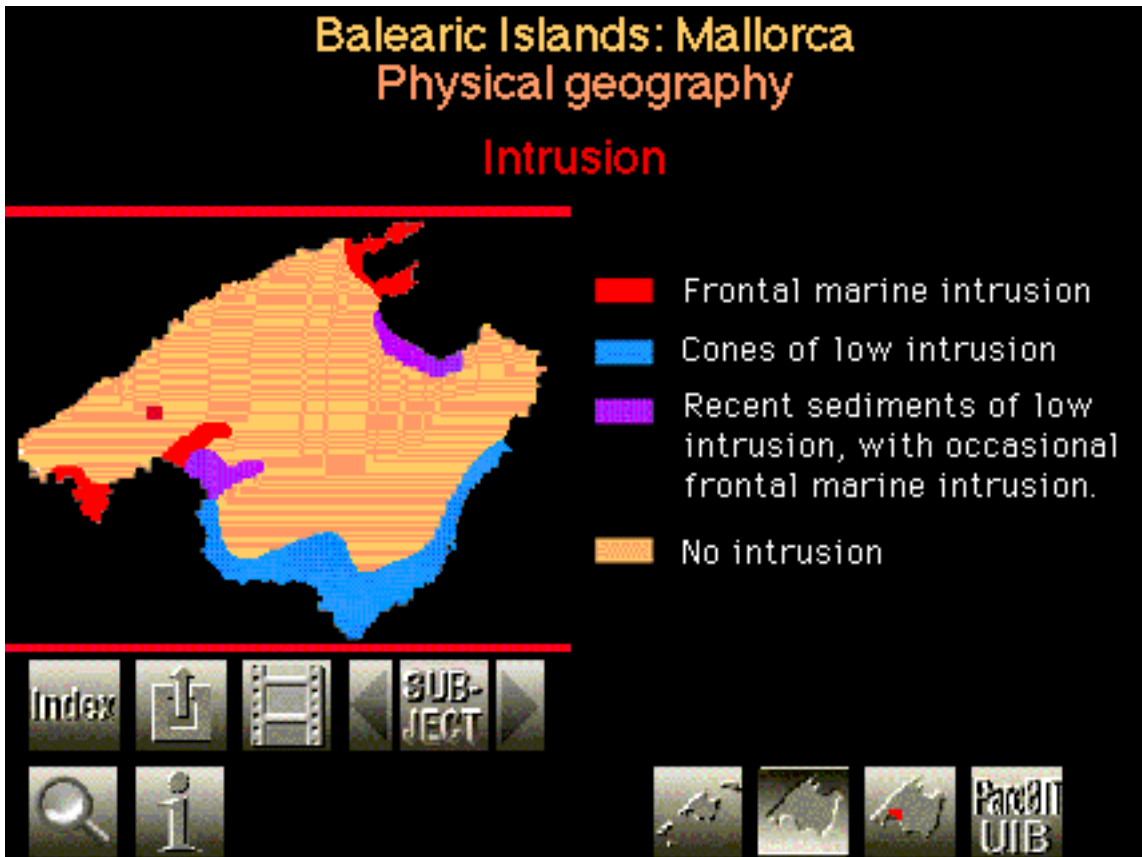


Figure 4: An intrusion map of Majorca with its corresponding legend

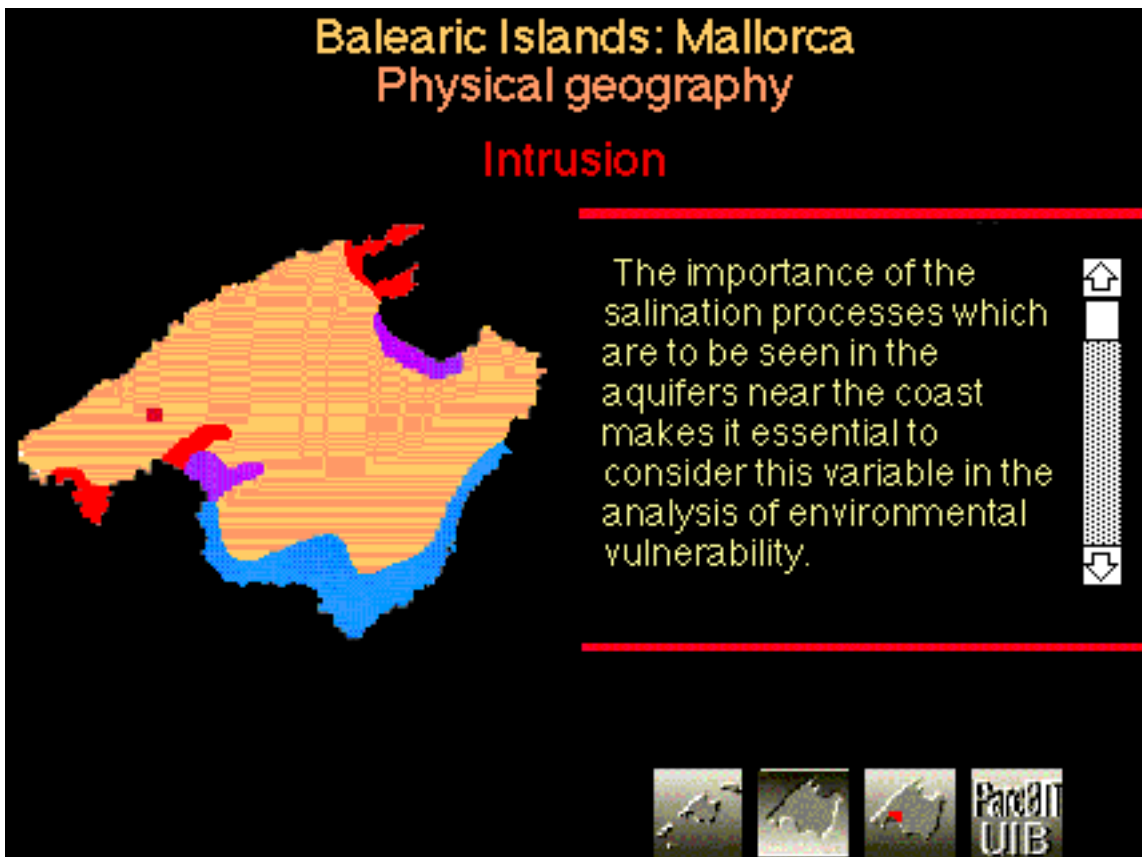


Figure 5: The previous intrusion map from Majorca with the associated textual information

## **Integrating multimedia and GIS into the application**

Interactive multimedia is not an option currently offered by standard commercial GIS packages such as Arc/Info, but promised for later developments after the end of the development stage of this project. Using a flexible combination of a multimedia authoring tool and a GIS package seems a convenient solution for developing a fully fledged multimedia GIS. It has been used for developing user-friendly customised interfaces for users without any knowledge of the geographic information system command language (Linsey and Raper, 1993), and a sole authoring tool such as Hypercard might suffice for Computer Aided Learning purposes (Green and Raper, 1992).

For the ParcBIT project, the initial idea was to play basically with two elements, a multimedia authoring tool and a GIS visualisation one. With the powerful MacroMedia Director the authoring of a very appealing interactive interface would be developed. External commands can be added to Director, and through this interface the commands of ArcView 2 (associated to Arc/Info) would allow the accessing of the geographical database and the viewing of the results of GIS processing. This solution was impossible to implement for ParcBIT due to time constraints for dealing with some technical and copyright problems. The information coming from the database had to be extensively converted for integration into Director and the database was not thus directly and easily accessible except in the way pre-designed in the application. Of course, this is not an optimum solution but seemed to be the only possible one for developing the main concept, namely that a rich multimedia information structure was required for the targeted users.

In order to achieve the integration of multimedia and GIS in ParcBIT, a multidisciplinary team was created with cooperation between Geography, Computer Science, Biology and Architecture, with two main subgroups, one related to the Department of Earth Sciences and the other one to Mathematics and Computer Science. The GIS team was mainly responsible for the content design, including also selection of variables, procedures, and assembling the thematic factors; GIS production, from the existent database and collecting some additional data; defining the tree-structure of the application by identifying basic relationships among elements; and georeferentiation of different types of data. The interactive multimedia team was responsible for refining the content design structure and interaction; designing and implementing the interface; processing of the information - both GIS and other formats -; additional programming and integration; CD production (as it was a limited edition, the required copies were actually printed at the development laboratories).

The development was mainly based on high-end networked PCs and Macintoshes. The difficulties of current integration of multimedia and GIS that we discussed earlier are illustrated by the wide range of tools which were used for ParcBIT: the main software tools were, on one hand PC Arc/Info, MapII, ArcView 1 and Atlas\*Pro and, on the other hand MacroMedia

Director, Photoshop, SoundTools, Premiere, QuickTime. WORMs (the copies of the CD-ROM) were written using Meridian Data System based on a Philips CD-Recording drive. The ParcBIT CD-ROM uses a runtime application for Director, Projector, and has two versions, for Macintosh and for Windows. It works under relatively minimal configurations: Macintosh (LCIII or better) under system 6.0.7 or later versions or PC (386 or better) under Windows 3.1; 640x480 monitor with 256 colours which is the VGA colour standard; 8 Mb RAM (less for Windows); CD-ROM player at minimum speed of 300 Kb/s; QuickTime 1.5 for Macintosh or QuickTime 1.1 for Windows; SoundBlaster compatible card for Windows configuration.

Perhaps some statistics about the CD-ROM implementation give some idea of the amount of work involved in passing from research prototype to a usable product: it contains 223 maps (in reduced and large formats), 28 graphics and 91 pictures adding to 565 compressed images which occupy 53.8 Mb; 41 Director movies occupying 20.4 Mb; 55 QuickTime movies with a total duration of 38' 44" and occupying 439.4 Mb; the total number of buttons (excluding the clickable index) is 181, made of 8 general, 4 territorial, 132 thematic and 37 hot-buttons on maps.

Existing powerful commercial GIS software packages are currently far from fulfilling the wishes expressed by Waters (1994) and quoted in the previous section; full multimedia GIS involves currently dealing with quite a complex development. Even so, the basic data structure of current GIS is preserved and multimedia information just means new information resources which are added in applications such as ParcBIT. This enlarging of GIS with other information formats should be only the first step in integrating multimedia and GIS. Further developments should be concerned with implementing a much more integrated data structure and automating and presenting the models for analysis in the environmental impact assessment context as well as allowing simulation possibilities. This is not present in ParcBIT (1994), in itself essentially descriptive in its aims, but is present in Flight of Fancy (1993) in the form of a maquette / prototype.

## **Discussion and conclusions**

The CD-ROM ParcBIT was commissioned by the Economy Department of the Balearic Government as the information resource for the international design competition for the Master Plan of ParcBIT. In this competition well-known architects such as Norman Foster; Skidmore, Owings and Merrill; Hiroshi Hara; de Prada Poole; Ove Arup; Richard Rogers; Torres y Martínez Lapeña; Michel Mosseian; Koetter Kim took part. The projects were evaluated in May 1994 by different expert panels. Both the architects and the experts received copies of the CD-ROM in the format (Macintosh or Windows) of their choice. The CD-ROM results from research previously undertaken but goes beyond the research prototype showing some concepts and tested in a laboratory context. It is a finished product which went to end-users.

From this point of view, a first point of discussion should be about the usability of ParcBIT by these users. A fairly detailed questionnaire on the CD-ROM with the headings: the use; the interface; the type of information; the contents and general questions was sent both to the participants and the expert panelists; for most of the questions, four levels of the linguistic variables were given as a choice. The questionnaire was answered by around 40% of the recipients with similar proportions of competitors and panelists. Only one of the experts knew of and referenced the St Louis video-disk (Kindleberger, 1989) and thus, from the results of the questionnaire, the CD-ROM ParcBIT seems to be the first in the world related to territorial planning in an open competition. The overall rating of the different items was between average and good.

The first important reference from the users' feedback is that the CD-ROM was actually used and showed to other people outside of the team, 5 on average, which seems quite high. It probably reflects the potential of multimedia as a means to increase the diffusion of GIS-based tools or products to a wider audience if they leave the laboratory prototype and go open to the public in the form of more finished products. One significant remark that was received from one of the competitor teams was that it was the first time they saw multimedia being used not as a consumer tool, mainly related to games, but as a professional tool.

There was a high degree of requests for more information to be included in the CD-ROM, although the information provided was quite wide and deep as indicated in the corresponding section. This result is somehow paradoxical, as the information made available, both in the more traditional GIS-based format and in non traditional formats, was much larger than what is usually made available for a planning competition. It seems to indicate a very positive aspect of delivering the information in this multimedia GIS way which appears attractive and easy to use and thus the user requests for a lot more of what is offered (which already was more than usual): the information in the GIS format and other formats seems to be perceived as important additions.

How to implement the access to these information requests is quite challenging. Providing a lot more of georeferenced information requires clearly the automation of access directly to the database in such a way that potential information existing in it can be recovered easily, while keeping the user-friendliness by presenting it in the appropriate way. This was the initial aim of the project but, as described earlier, the existing tools did not allow this plan to be fulfilled within the time and budget constraints but it seems a clear requirement for any further development. At the same time, enriching GIS with multimedia seems to call for strengthening the structure of these novel formats in GIS, at least matching the items of the database, although probably the structuring of these new aspects will ask for an enrichment of the data structure of current GIS and is part of current research perspectives.

The interface was highly rated for its ease of use and its visual aspect was especially praised but it was perceived as needing refinement. These results seem to indicate that it was appealing to the user, which is a key aspect for an end-user product where no help is in principle available. But they also seem to indicate that it still lacks flexibility failing to convey adequately the needs of information; it is likely that more possibilities for compare and overlay information should be included and a compromise between a single-window appearance and a complex structured multi-windowed should be reached. Some tools allowing for some of these types of enlarged computer-human interaction in the context of a collaborative planning system were described by Shiffer (1994) and suggest further lines of exploration and development of more useful interfaces.

Improving the simulation capabilities at hand for the user is also very important for non-GIS use of environmental impact assessments, as this gives decision makers a better perception of the choices. It too gives a much improved user interface in the interactivity aspect and allows to enrich with multimedia usability the spatial analysis tools which are yet to be incorporated in our design. Another aspect which again needs further reflection and improvement is combining the clarity and accessibility of the information with an increase in the flexibility for analysis at different levels.

Integrating multimedia and GIS is a relatively new area with few precedents and less in using this integrated approach in a territorial planning application context. ParcBIT has been an application leaving the research prototype into an end-user product. Through the visually appealing and easy to use interface, experiencing it has been positively perceived by the users. But it has revealed the limitations in making available information and making it more usable. The challenge is now to exploit the full potential of this new approach. The main factor limiting the development of usable products seems to be the lack of power for integrating multimedia and GIS of the current software tools which should be object of research and development along the lines of the previous discussions. New tools should also consider the incorporation of even more recent perspectives such as wide access to high-speed digital networks and virtual reality.

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