Title: A Hypertext on Architectural Object GIS. The St. Marcus' Basilica in Venice. Educational applications.

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"Abstract"

The Course of "Architectural survey" in the Faculty of Architecture in the Politecnico of Milan, organized in two semestral modules (250 students each one - third year inscription) gave the opportunity to test and develop actual didactic chance for high number of students. The opportunities offered by Multimedia information to the teaching experience can now be differentiated. They could become in a not far future the core of low cost information transfer in the age of globalization. In the paper are summarized different experiences in technology transfer and it's explanined an application of interactive representation of information in HTML (HyperTextMarkupLanguage) on Architectural Object. The research has to be developed in the field of mapping GIS in Internet, to allow data banks to be located remote and to be spatially georeferentiated, due to teach complex levels of related and structured data (GIS) by Internet and due to make more people able to get geographic data and to extract data by quering GIS from Internet or Intranet.

I. Teaching experiences: PC assisted lessons

Thanks to the technology of the lecture-hall of the Course of "Architectural survey", provided with VideoBeam (but it could be used a DataShow too), it has been organized by the Authors themself a cycle of lessons assisted by PC from the chair. All the Softwares time by time needed for each lesson had been installed on portable PC (486/16Mb RAM). The lessons were organized in different thematic area, i.e. :
the methodology to build the geometry of architectural objects (from the project and survey of topographic network, to the data processing, to the integration with the direct survey of details...);
the use of *CAD* to support those steps, to import x,y,z coordinates with '.scr' files, to draw the horizontal and altimetric sections,...;
the data management with electronics pages using *Excel and Access*;
the digital processing of images (rectification and ortophotoprojection) *using Archis and Orthomap* (Siscam), *Real-2D* (Nikon).

Particularly here is explained one example of theoric lesson with the related Exercise made by the students, about the "Rectification of digital images". First they learn from the PC on the chair the methodology to process the image: the omographic projection has been teached using *Software Excel* due to calculate the eight parameters of the transformation ("a_1", " b_1", " c_1", " a_2", " b_2", " c_2", "u", "w"), using both 4 and 6 topografic points. The students saw directly by the VideoBeam how to prepare the electronic page and to wright the matrices to obtain the 8 parameters with the two solutions: - $\mathbf{A^{-1}L}$ in the first case and - $\mathbf{(A^t A)^{-1}A^t L}$ in the second case.
Second time it has been showed them the *Software Archis* for the rectification of the digital images with some examples and cases applied on architectural objects to support the restoration project (facades in the Historical Centres, floors...).

Exercises made by the students. For the Exercise each student was provided of the absolute coordinates (obtained by topographical survey) of 4 and 6 points on the face and of a B/N photo (made by Rollei 6006) of the same facade. The resoults and the steps of their work is summarized in ***Fig.1***: they built the matrices in the electronic page with Excel, and using the parameters, once calculated, they reconstructed the shape and geometry of the facade on CAD. The students realized the exercises using the structures of the Graphic Center of the CIA (Informatic Center of the Athenaeum) of the Politecnico.

$$X_i = \frac{a_1 x_i + b_1 y_i + c_1}{u x_i + v y_i + 1}$$

$$Y_i = \frac{a_2 x_i + b_2 y_i + c_2}{u x_i + v y_i + 1}$$

X_i, Y_i = coordinate terreno P-iesimo

x_i, y_i = coordinate lastra P -iesimo

a_1, b_1, c_1, a_2, b_2, c_2, u, v = 8 parametri incogniti

$$u x_i X_i + v y_i X_i + X_i = a_1 x_i + b_1 y_i + c_1 \quad \} P1$$

$$u x_i Y_i + v y_i Y_i + Y_i = a_2 x_i + b_2 y_i + c_2$$

con quattro punti di coordinate lastra (x,y) e terreno (X,Y) note si scrivono 8 equazioni:

$Ax + L = 0$

$x = -A^{-1}L$

x = vettore incognite

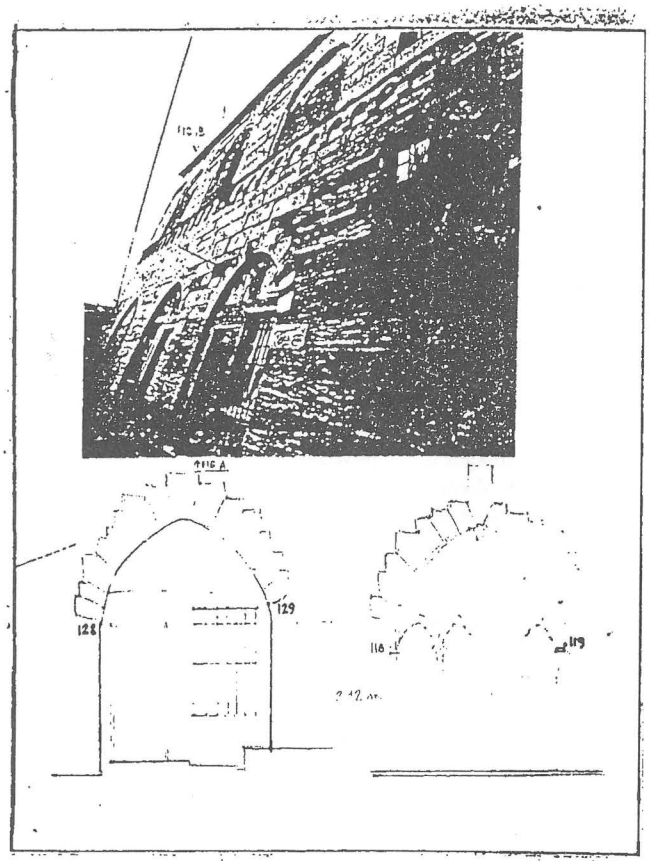
A = matrice dei coefficienti

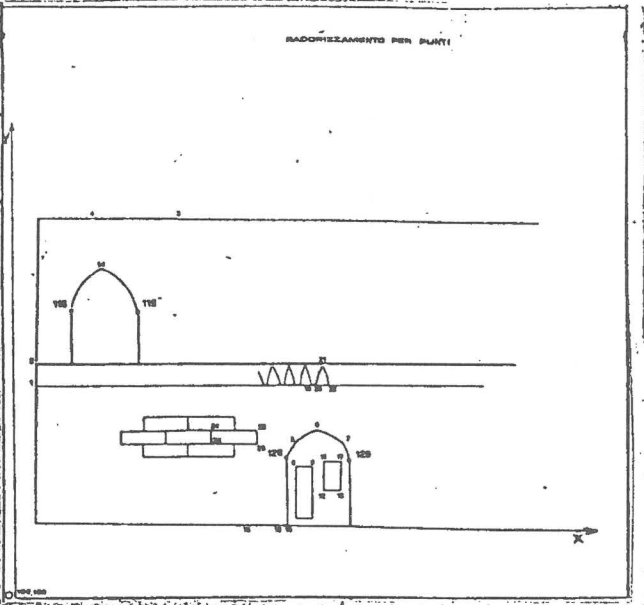
L = vettore dei termini noti

incognite = 8 parametri = a_1, a_2, b_1, b_2, c_1, c_2, u, v

coefficienti = coefficienti delle incognite delle 8 equazioni P1, P2, P3, P4

termini noti = coordinate terreno (X,Y) note -minimo 4 punti noti: 8 equazioni:





$$x = \begin{vmatrix} a_1 \\ a_2 \\ b_1 \\ b_2 \\ c_1 \\ c_2 \\ u \\ v \end{vmatrix} \quad L = \begin{vmatrix} -X_1 \\ -Y_1 \\ -X_2 \\ -Y_2 \\ -X_3 \\ -Y_3 \\ -X_4 \\ -Y_4 \end{vmatrix} \quad A = \begin{vmatrix} x_1 & 0 & y_1 & 0 & 1 & 0 & -x_1X_1 & -y_1X_1 \\ 0 & x_1 & 0 & y_1 & 0 & 1 & -x_1Y_1 & -y_1Y_1 \\ x_2 & 0 & y_2 & 0 & 1 & 0 & -x_2X_2 & -y_2X_2 \\ 0 & x_2 & 0 & y_2 & 0 & 1 & -x_2Y_2 & -y_2Y_2 \\ x_3 & 0 & y_3 & 0 & 1 & 0 & -x_3X_3 & -y_3X_3 \\ 0 & x_3 & 0 & y_3 & 0 & 1 & -x_3Y_3 & -y_3Y_3 \\ x_4 & 0 & y_4 & 0 & 1 & 0 & -x_4X_4 & -y_4X_4 \\ 0 & x_4 & 0 & y_4 & 0 & 1 & -x_4Y_4 & -y_4Y_4 \end{vmatrix}$$

RADDRIZZAMENTO DI UN FOTOGRAMMA

	coordinate lastra (in cm.)		p.to	x	y		coordinate terreno (in metri)			p.to	X	Y
			118	4	11					118	102,2486	111,461
			119	4,925	11,775					119	104,627	111,4459
			128	5,35	6,325					128	110,8214	105,3834
			129	6,4	6,6					129	113,3502	105,3463
	102,249			0,04	0	0,11	0	1	0	-4,08994	-11,2473	
	111,461			0	0,04	0	0,11	0	1	-4,45844	-12,2607	
	104,627			0,04925	0	0,11775	0	1	0	-5,18271	-12,3433	
L=	111,446	A=		0	0,04925	0	0,11775	0	1	-5,48871	-13,1228	
	110,821			0,0535	0	0,06325	0	1	0	-5,92694	-7,00945	
	105,383			0	0,0535	0	0,06325	0	1	-5,63831	-6,6655	
	113,35			0,064	0	0,066	0	1	0	-9,52142	-7,48111	
	105,346			0	0,064	0	0,066	0	1	-8,84939	-6,95288	
				903,4083	5471,035	-791,21	-4781,61	-434,804	-2444,74	322,4055	1755,315	
				777,9625	4869,697	-879,947	-4257,7	-347,642	-2206,94	249,6082	1594,941	
				278,8217	-505,05	-226,34	441,4068	-145,796	225,6817	92,31632	-162,039	
		A inv =		420,7123	-85,0214	-367,697	92,52814	-187,993	17,23243	134,9804	-24,7392	
				0,773205	-5,40603	-1,69683	4,726552	3,64363	2,416583	-1,67041	-1,7351	
				-4,75344	-12,333	4,15445	9,71435	2,12408	8,478013	-1,52538	-5,85934	
				7,462478	46,43629	-8,52211	-40,5847	-3,33461	-20,7501	2,384245	14,68852	
				3,211334	-2,84001	-2,80866	2,490002	-1,43499	1,273084	1,030317	-0,91407	

Fig.1
Example of the exercise on the "Omographic transformation" made by the students with Sofware Excel and CAD

II. A proposal to translate on CD the complete Course of "Architectural survey"

The theoric lessons, the demonstrations, the exapmples of different architectural surveyes made by the DIIAR (Department Of Ingegneria Idraulica Ambientale e rilevamento - section Rilevamento) and the exercises are written with standard Software and formats: *Page Maker and Microsoft Word* for the text, *Excel and Access* for tables, delimited text, files of coordinates and matrices. Input and Output Digital Images are showed with JPG and TIF formats (to allow them visible by *Photoshop, PhotoStyler...*), and the drawing step of the architectural survey are memorized in DXF and DWG formats.
Those attrbutes allows to think to make available first time the contents of the Course on CD. And second time, where it would be obtained a partial *interactive Course,* perhaps to make the *Exercises "on line", it would needed only* the Software standard used to prepare them by users themself. This is only a proposal which colud be better organized on the topics and increased, if used methodically.

III. HyperText Markup Language. A Web page for the actual surveyes and historic-iconographic documents of the Basilica of St. Marcus

The boom of the informatization of these years allows to always have higher number of information available on the PC. In the same way it has been felt the requirement to comunicate in a simple and organic way those informations: then the Hypertexts are born, that's to say Sofwares which are able to present text and images simultaneously, and second time, with the actual technologic progress, they are able to acquire sound and movies too. Now thanks to law costs hardware (RAM, components...), in the Hypertext we'll find programmes in the programmes, which, if connected to remote DataBases, could be answer to personal need of different users.
The HyperText have been exploited and developed when the World Wide Web (the graphical component of Internet) has been created. Everybody knows what is Internet and how it was born: born in 1968 to warrant and guarantee the connections between informatical centres in case of military attack, Internet was improved and applied to civil use. So the anarchic network begun to spread all over the world. Coming back to the WWW the scientists of CERN in 1990 needed one system to comunicate, so they invented a graphic Internet document: that's to say images and texts, initially based on the HTML: it consists of a set of connections (*link*) which connect , using simple rooles, texts to images and vice versa.
A Web page looks like a book page, but if someone observes nearly the page, he'll see also that some word or groups of words are characterized and marked with different color: if he'll go with the mouse on these words, on the *Markup word or images*, only with a "click" it will appear an image, or it will jump in another page or document, which perhaps is located on a server thousand kilometers far!.
To read a Web page, a WWW address, it's enough to have a Web Browser *(Netscape...)*, a Software which is able to show and recognize, through the telephonic or dedicated network, the data codified in HTML. To exploit and profit by WWW like a comunication way, it's necessary to use and know its native language: HTML. A text writed in HTML is characterized by having some special codes *(tag, marher):* some of those define the aspect of the document, others pointed to the Browser where to find the images or the files connected, or the URL (WWW addresses and Internet sites). Since both text and codes are composed only by standard ASCII caracters digitable from the keyboard, it's possible to use an editor *(NotePad...)* to create HTML files. One HTML page can remember the dark time of WordStar when the symbols which characterized perhaps bold characters were simultaneously visualized on the Video.
Now it is developed Java and HotJava for movies, sound and Multimedia applications. There are in course different project to extend WWW to the 3-Dimensional interactivity. The idea is touse *irtualRealityModellingLanguage* (VRML), to create 3D web sites, on which walking and navigating free.

The Web page .The Web page created for the Basilica of St. Marcus to make accessible data of Cultural Heritage on a famouse case, try to collect the recommendations of the European Commission (Directorate General XIII, Telecomunications, Information Market and Exploitation of Research Information Industry and market and language processing) in the ***Document INFO-2000***: "Draft 4-year Work Programme (1996-1999)".
"In the Cultural Heritage area the aims are to stimulate the knowledge and economic exploitation of Europe's cultural heritage through the implementation of new multimedia information services and to allow a wider access to those resources. Multimedia systems allows images, sound and text to be combined in new ways, to be transmitted in digitized formats and to be stored and reproduced or networked for wide public use. The projects supported may have different orientation:

- *the production of new multimedia information content together with new educational and edutainment tools to access such content and delive it online or off-line. These projects should aim at providing cost-effective electronic imformation, including data, pictures, texts, video, to increase uderstanding of Europe's cultural assets by its citizens;*
- *the creation of directories and guides to cultural heritage information resources that allow correspondence of information across the cultural and linguistic diversiy of the different European regions;*
- *the constitution and availability of shared digitized data resources that can be re-used by the electronic publishing industry for the*

development of value-added products and services.

Services developed should utilise delivery mechanisms that are widely available and appropriate to the purpose. They must also exhibit a high quality of data content in order to meet users' needs. The projects supported should take account of standards for the exchange and integration of cultural information and where appropriate be coherent with the objectives of the G7 Information Society Pilot Project "Multimedia Access to World Cultural Heritage".

Particularly it has been made the effort to connect the actual surveyes to the historic and iconographic documents of the Basilca of St. Marcus, on a limited number of documents and surveyes, due to allow easy access to the data in interactive modality for the users, through an open three structure. It is organized with an Index (index.htm), so that clicking on the words of the index is possible to move from the section with the numeric-graphical surveyes made in the last 20 years, with the description of the methodologies used, to the section dedicated to the static check of the floor made by the 3D model of the Floor, to the iconographic and historical one (***Fig.2***).

Some digital iconographic historical (***Fig.3***) documents and rectified digital images maps of the floor of the Basilica are connected to the four sectors of the mosaical plan. They can be linked to the description of the document itself, with the History of the Authors, of the ancient surveyes...

On the altimetric section of the Basilica are georeferenced some low resolution digital images (***Fig.4***) of the mosaics. They are marked and linked to the high resolution GIF, available by clicking on the area with mouse (***Figg. 5,6***).

It's explained the file source (.htm) of the page with the title and the link to the GIF. Obviously it would be possible to link not only to text documents and GIF, but to URL addresses (WWW sites), where perhaps it would be located the whole Historical Archive informatized of the Basilica. The limits of this kind of application is that it's not a real GIS in Internet: instead the aim to achieve it would be a real GIS in Internet to manage high number of data-bases georeferentiated*. The opportunities to obtain an Internet GIS are widespread both for teaching GIS by teleconferences, to distribute didactic material from *"remote"* site respect to the *"client"* site, and to make available data and geographic structured and related information to the public administration and to private use (with payment or not) in real time.

IV. Software opportunities for Gis and Web mapping applications.

For Internet developers, looking for tools to buid Gis and Web mapping applications one solution is *Map Object Internet Map Server* (ESRI). Map Server is an extension *of Map Object*, GIS software components. It lets create spatially enabled World Wide Web (WWW) sites for a variety of needs. The Web is a compelling and cost-effective way to share information within an organization (i.e. Intranet) or provide public access to information worldwide on the Internet.

Advances in HTML and the introduction of new technology (Java and Active X), have provided Web authors new opportunities. Web sites can now include sound, animation, movies. These developments can be applied in the GIS and mapping world and have created a flurry of ideas, activity, and opportunity. Organizations can leverage their GIS investment by publishing their GIS database on the Web, either for public access on the Internet or for intraorganizational data sharing on an Intranet.

Map Object Internet Server, GIS Internet support for Software developers, allows users to spatially enable their Web sites. There is a high interest in GIS and mapping solutions for the Internet and especially Intranets. It's possible to create customized GIS applications that will meet the needs of information from everywhere. Users can publish their GIS database on the Web, maps and informations can be served quickly on a variety of architectures where there is a single server for Intranet use or a network of many servers to handle high-volume worldwide Internet access. Through this way GIS become true interactive process on Internet. The *Internet Map Server* is built using *Microsoft's* standard *Active X* architecture. It allows the complete access to the entire suite of mapping functions avaliable in Map Objects. Supports standard HTML web *browsers (Microsoft Internet Explorer, Netscape Navigator, activeX controls...)* and *Microsoft Internet Informations Server.*

Map Object Internet Server architecture allows the Web server and mapping applications to reside on different machines and operating systems using TCP/IP connection.

System Requirements:

Hardware: Map Objects Internet Server and applications built with Map Object require Windows 95 or Windows NT operating Systems.

The minimum hardware requirements for using applications are the same as for W95 (486DX processor at 33 MHz with 8mb RAM

Software: Map Object can be used to build applications in development environments that support the use of ActiveX Controls (OCXs) such as Visual Basic, Visual C++ and Delphi.

Data: Map Object supports shapefiles (ArcView...), image formats, Arc/Info coverages, Arc/Info

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* [1]Monti C. Brumana R., *"GIS to support Restoration Project of monuments and fot Urban and Territorial Planning on Network"* International Sympusium on Global Positioning Systems, Remote Sensing and Geographic Information Systems, 40° Anniversary of WTSUM, 16-19 October, Wuhan, 1996.

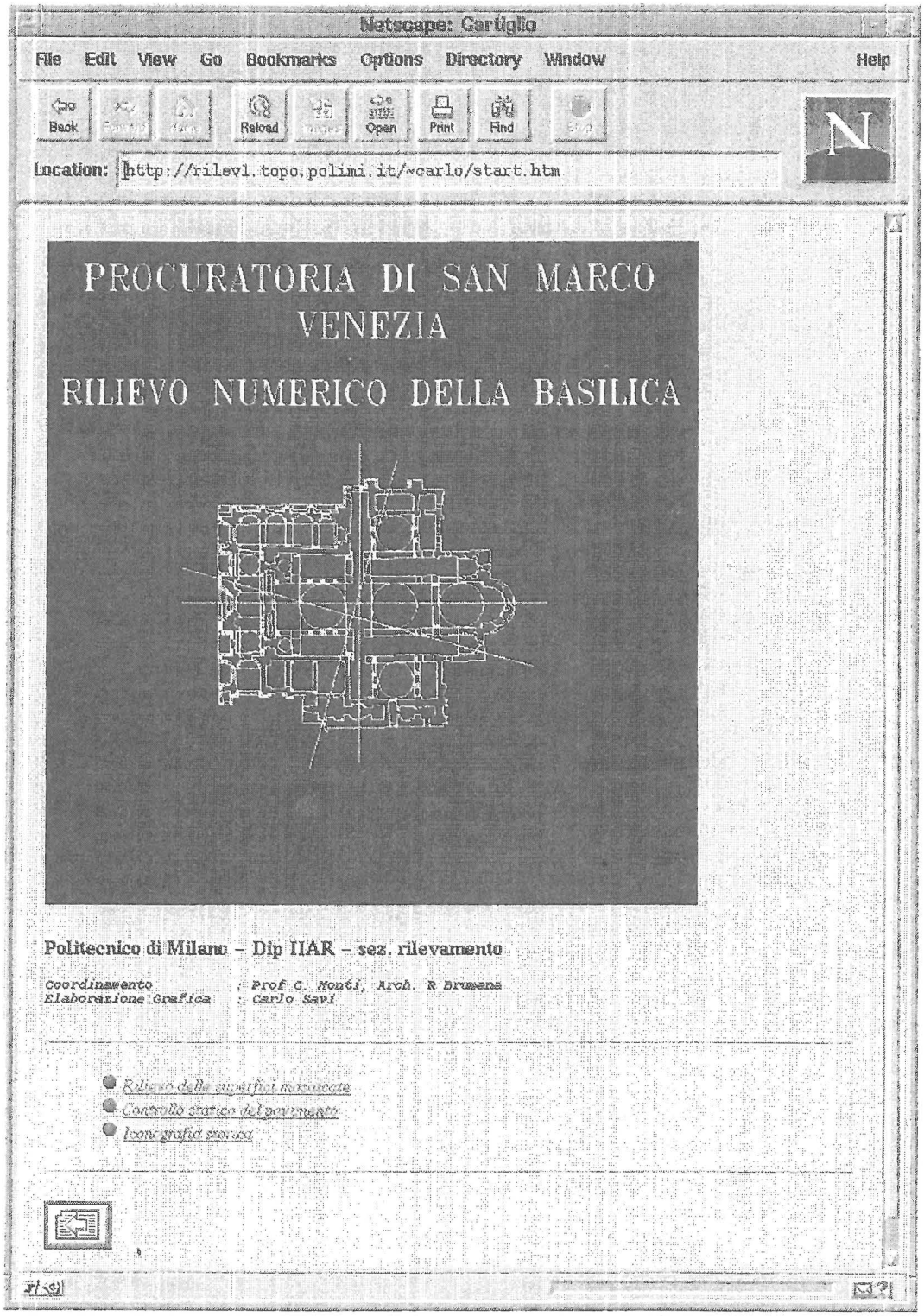


Fig.2 An example of an Hypertext created for the Basilica of San Marcus. The first page is organized with an Index (index.htm), so that clicking on the blueball is possible to move from the section with the numerical surveyes made in the last 20 years, with the description of the methodologies used, to the section dedicated to the static check of the floor made by the 3D model of the Floor, to the hiconographic and historical one.

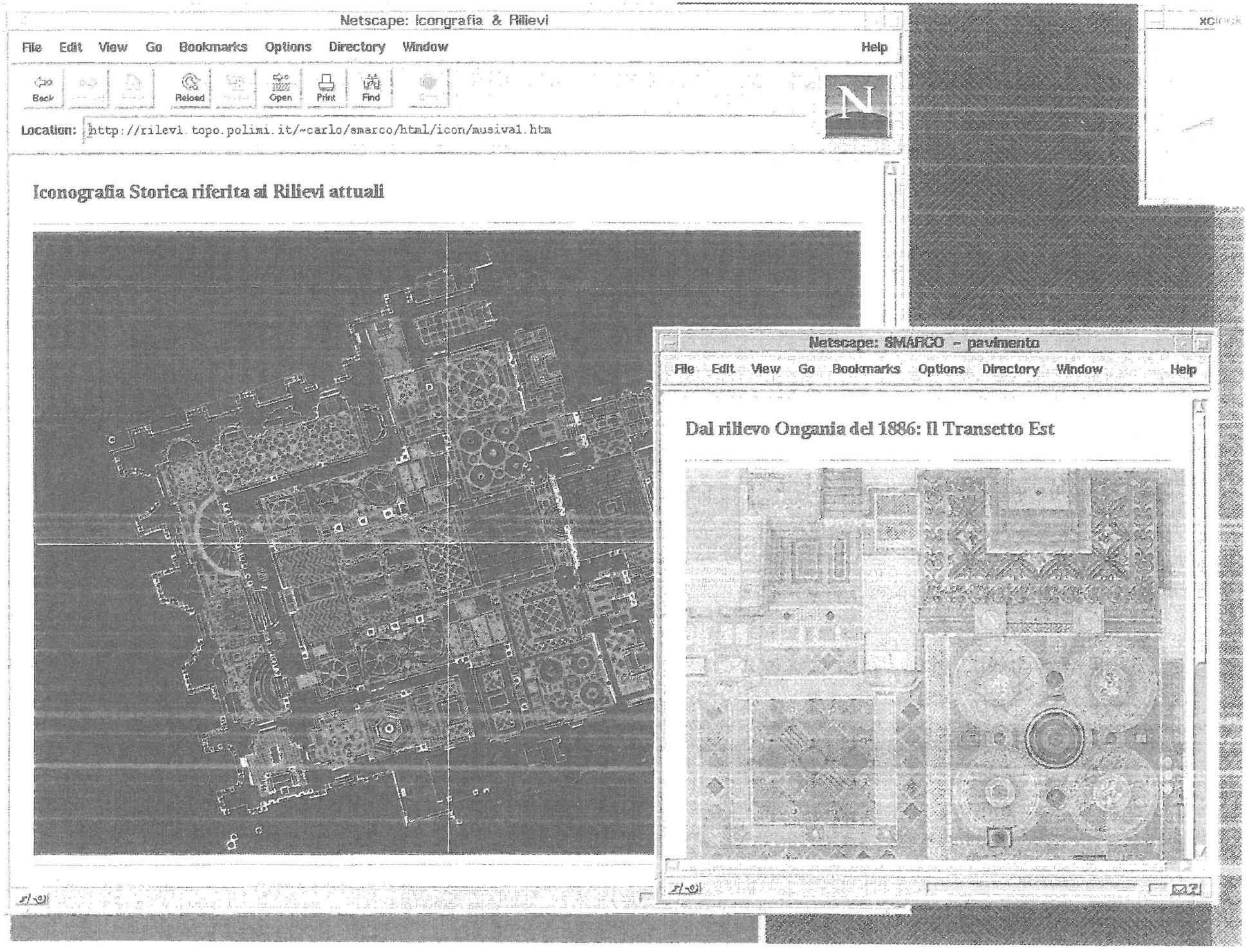


Fig. 3 Some digital iconographic-historical documents and maps of the floor of the Basilica are connected to the four sectors of the mosaical plan. They can also be linked to the description of the document itself, with the History of the Authors and other text.

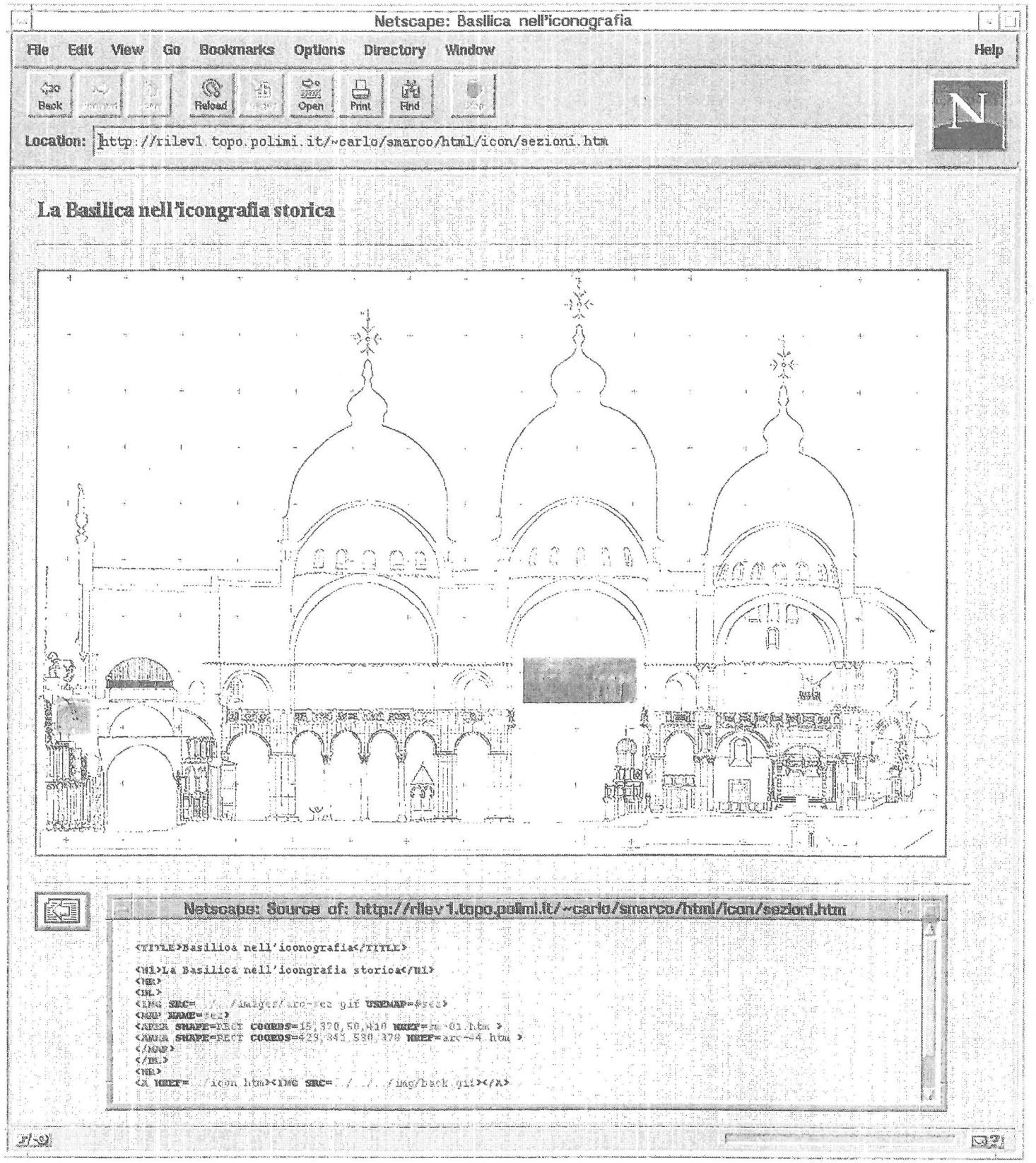
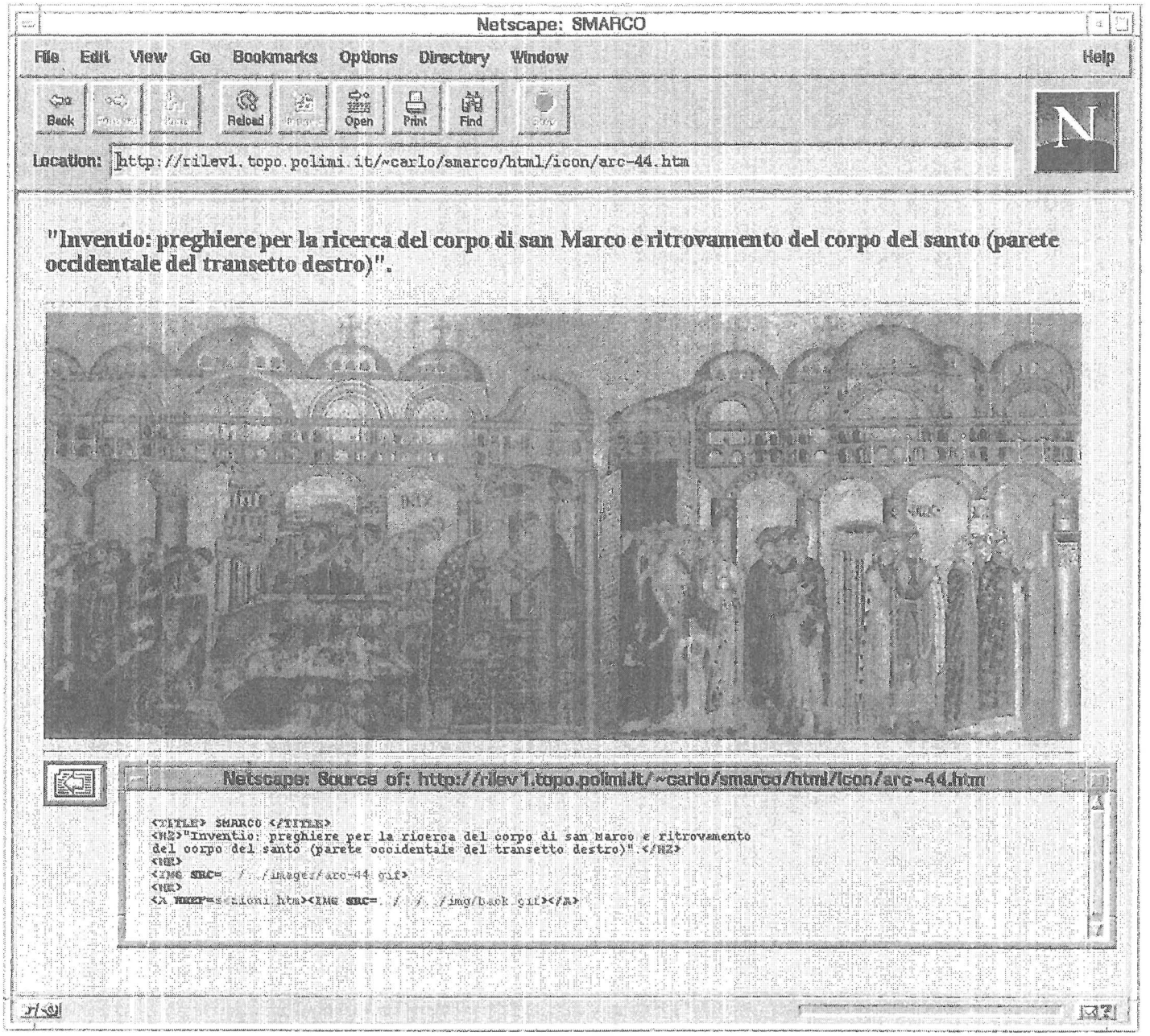


Fig.4 On the altimetric section of the Basilica are georeferenced some low resolution digital images of the mosaics.
They are marked and linked to the high resolution GIF, available by clicking on the area with mouse (Figg. 5,6)



Figg.5.6 A detail of one of the self-representation of the Basilica during its building. It's explained the file source too (.htm) of the page with the title and the link to the GIF. Obviously it would be possible to link not only to text documents and GIF, but to URL addresses (WWW sites), where perhaps it would be located the whole Historical Archive informatized of the Basilica.

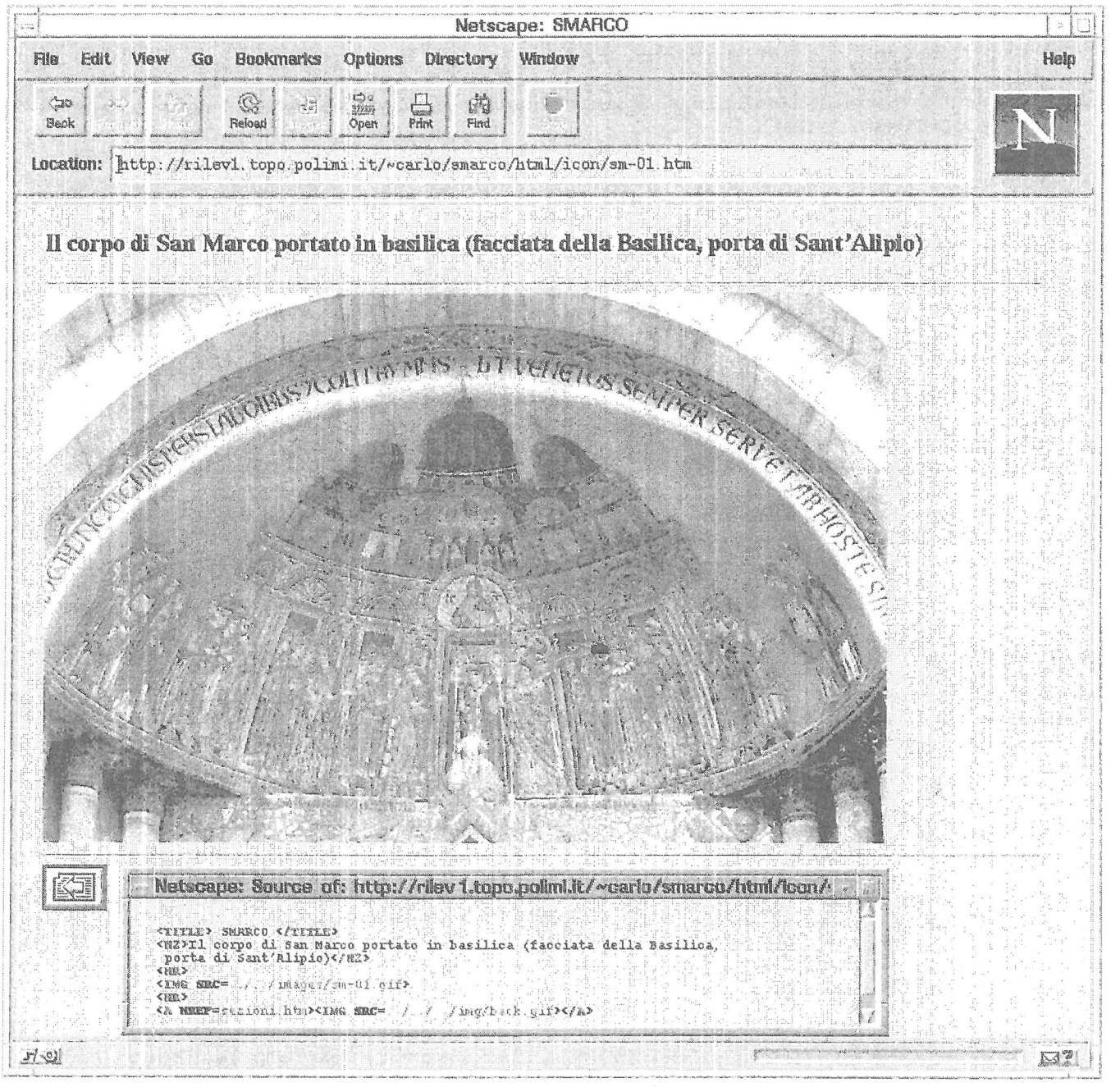

Netscape: SMARCO
File Edit View Go Bookmarks Options Directory Window Help
Back Reload Open Print Find
Location: http://rilev1.topo.polimi.it/~carlo/smarco/html/icon/sm-01.htm
Il corpo di San Marco portato in basilica (facciata della Basilica, porta di Sant'Alipio)
Netscape: Source of: http://rilev1.topo.polimi.it/~carlo/smarco/html/icon/
<TITLE> SMARCO </TITLE>
<H2>Il corpo di San Marco portato in basilica (facciata della Basilica,
porta di Sant'Alipio)</H2>
<HR>
<IMG SRC= ../../images/sm-01.gif>
<HR>
<A HREF=sezioni.htm><IMG SRC= /../../img/back.gif></A>

Fig.6

Librarian, and SDE layers. None of the thousands of estate oriented Web pages avaliable today are truly map based. One obvious application of Map Object for these pages would be to present the properties on a map in the context of census tract demographics, major strets and school locations. Public access to land records over the Internet can function to provide public access to government land records. People go to the assessor'office to check on the Cadastral indexes value of thier property or to look at a map of their property showing lot boundaries. These function could easily be done via Internet and thus cut down on a fair amount of counter traffic. A good cadastral Web site would also allow a potential home buyer, or their agent, to calculate the annual taxes that would be levied against a property.

In the higher Education several libraries are interested in a map index that would respond to queries with an intelligent search of the area of interest. A professor could put a site on the WEB with data so the students or user can get interactively local, regional, or national information. In land use planning it can be use for better public service, or to create map of risk and hazard maps showing toxic sites, seismic risk zones, and flood zones to support planning decisions.

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(**homepage:***http://www.doit.it/Addison)*