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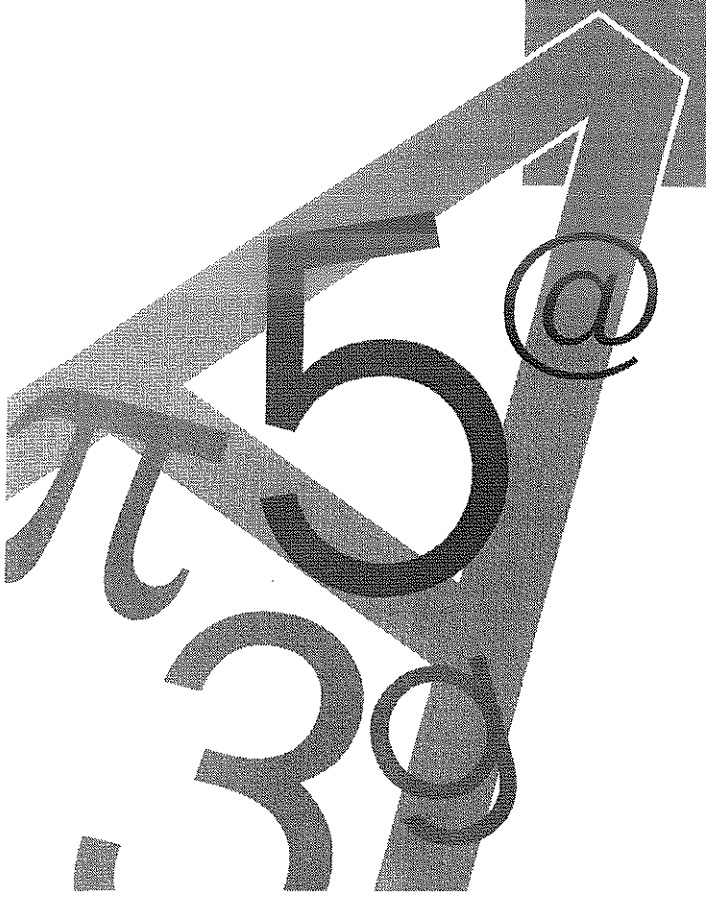

# MIAOW: An Object Oriented Multimedia DB application on the WWW for the stone market

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## *Abstract*

*This paper presents the MIAOW system, a comprehensive information system now available on the Internet. This system acts as the main component in a reorganization of the marble business process aimed at rendering the exchange of information widespread, up-to-date, timely, reliable and cost-effective. It consists of an Illustra DB and a WWW application on top of it. The former stores both technical data and visual characteristics of the stony materials. The latter supports browsing, information retrieval and data storage on the underlying database by offering the most sophisticated functionalities for architects, consultants and suppliers.*

**Categories and Subject Descriptors**: H.2.1 [**Database Management**]: Logical Design – *Data Models*; H.2.6 [**Database Management**]: Database Applications; H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval; H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces

## 1. INTRODUCTION

The Marble Industry Advertising Over the World (MIAOW) system was developed in 1996 as an ESPRIT project partially funded by EEC, with two main types of objectives: *market* and *technological*.

The market objectives originated with the aim of improving the marble business process that at present has enormous potential given the vast appreciation and use of stony materials throughout the world. This business involves many actors, ranging from stone building providers and consultants to building industry professionals, such as architects, documentalists and general contractors. The information exchanged by these actors is mainly devoted to answering queries on aesthetic characteristics and technical parameters of stony materials.

This information is delivered by means of brochures, on-paper catalogues and stone samples. The exchange occurs under the supervision of consultants who work mostly through personal contacts and participation to international trade-fairs.

The aim of the MIAOW project, proposed by a consortium of IT and stone-consultant farms, was to re-organize the marble process so as to render the information exchange widespread, up-to-date, timely, reliable and cost-effective.

The MIAOW system was designed as the main component in this re-organization. This system consists of a comprehensive information system available on the Internet, capable of supporting information about both the stone market actors and their related activities and about stony materials. It also provides for a multimedia client application for obtaining up-to-date information and co-operating with material/services providers.

The realization of this system carried a number of technological objectives. In particular, the following:

- to combine the user oriented interface of the client applications with sophisticated algorithms and techniques on the server, to allow the users to retrieve information based also on the visual characteristics of the stone materials;
- to find a suitable solution for satisfying performance, client application, data quality and retrieval system requirements.

The architecture of the MIAOW system consists of an Illustra DB and a WWW application on top of it. The former stores both technical data and visual characteristics of the stony materials (images at different levels of detail, colors, grain, veins, etc.) and information about their suppliers. The latter supports browsing, information retrieval and data storage on the underlying database by offering the most sophisticated functionalities for both the users and the administrators of the system. In particular, a very friendly interface that extends the most common information retrieval techniques with the choice of a material by its similarity to a colour in a 64-entries palette is provided.

The presentation of the MIAOW system is organized as follows. Section 2 provides an overview of the system analysis and requirements; Section 3 lists the main functionalities of the MIAOW system by focusing on the search and on the visualization of the results; Section 4 introduces the architecture of the system and discusses the two main components: the Database Server and the Application Server. Finally, Section 5 contains the Conclusion and a brief list of the planned improvements.

## 2. OVERVIEW OF THE USER REQUIREMENTS

The business process of the marble market is structured as shown in figure 1.

The main actors of this process are:

- Architects, building companies, interior designers, etc., looking for the most suitable material for their realization;
- The marble suppliers whose primary interest is to quarry and process the materials, and who place one's trust in trading companies to sell them;
- Trading companies which act as an interface between customers (building projects and architects) and stone building suppliers, acting also as consultant in order to guide customer towards the best choice of materials in terms of physical characteristics, costs, availability, etc..

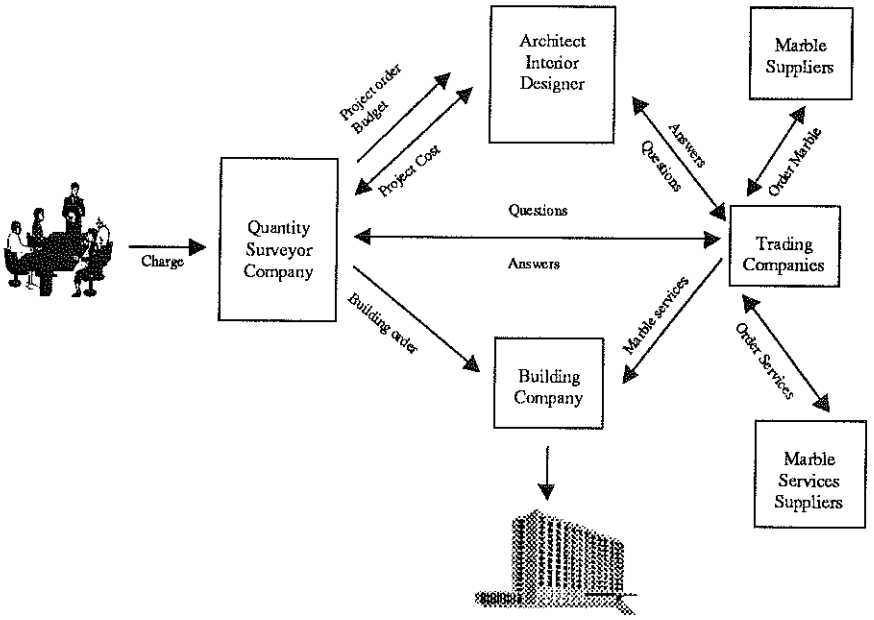


*Fig. 1 : Marble Business Process*

The drawback of the above business is that all the information exchanges are, presently, based on personal acquaintances, periodic international trade-fairs, brochures and catalogues of materials. No one of these vehicles support widespread, up to date, timely cost-effective and reliable information dissemination.

The idea of the MIAOW Consortium[1] was to overcome the above limits by providing an automatic support for the work of the stone industry professionals. This consists of a comprehensive information system available on Internet under the form of a WWW application that can be accessed by the different actors of the stone market to easily communicate and exchange information. The Consortium is responsible for the updating of the information stored and the maintenance of the system. This means that the stone suppliers deliver information about themselves and on their products to the Consortium. This acts both as a supervisor, checking the correctness and consistency of the data, and as a system administrator, physically loading the data.

The major difficulties encountered in achieving this aim were originated by the specificity of the user requirements, especially for what regards the expectations of the features provided to support the search operation.

Stated in brief the requirements of the MIAOW users are [9]:

### Architects

They need to easily gather information on stony material based on aesthetic requirements. They have no particular expertise on materials or/and computers so they need a friendly interface able to support browsing and searching on materials based on non-technical criteria. The colour of a material is the most frequent search criterion, but also searches of materials by name of the material, type of the material (i.e. marble, granite, stone, etc.), suitable use (i.e. interior, exterior, etc.) or visual characteristics (i.e. background, vein, etc.) are very frequent.

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[1] The MIAOW Consortium comprises the industrial patners of the MIAOW project, i.e. IME (trading company), Governor (architect studio), Intecs and Intracom (IT farms).

Very important are also searches by similarity to an already selected material since this is a very effective way to look for something similar to what one has in her/his mind. An help-dictionary, available in different languages, that explains the meaning of technical terms, such as «flamed», «direction-sewed», is also very often required. In order to reduce as much as possible the exchange of stones samples between potential customers and producers accurate images of the material are expected as result of queries.

**Marble suppliers**

They require to be able to link their company's Internet window, Web site or simply e-mail address, to the materials in the MIAOW virtual warehouse, and to make it immediately available to the building stone community. An electronic mail service able to accept free text or predesigned forms requesting promotional materials or product specific information is also required to decrease the business negotiation time.

**Trading companies**

They need to have quick access to a complete set of technical information about stones and their producers. Moreover they must be able to communicate with the producers in a short time span.

In the next sections we describe the system that has been implemented to satisfy the above requirements concentrating mainly on the features provided to support the query process. A detailed description of the other functionalities can be found in [7].

## 3. FUNCTIONAL SPECIFICATION

As already mentioned the MIAOW system provides sophisticated functionalities for accessing through Internet an information system that maintains detailed information on stony materials, suppliers, manufatures, etc.. It also provides a working evironment in which it is possible to compare the results of the queries, to refine them and to follow the link toward the material suppliers.

The general architecture of the MIAOW system is shown in figure 2.

The MIAOW end-user can, through HTML pages containing Javascript functions and embedded data for plug-in and Java applets, send the request of information to the MIAOW Server that forwards it to the local Database Server. MIAOW Server sends the answer, obtained by the local Database Server, to the user that receives the data in the form of an HTML page.

This section describes the functionalities that the MIAOW system offers to the end-user focussing mainly on those related to the search and retrieval of stony materials. The description is given following the way in which they are made available through the interface. As the interface is defined as a collection of HTML pages the user interact with, the presentation will be given referring to these pages.

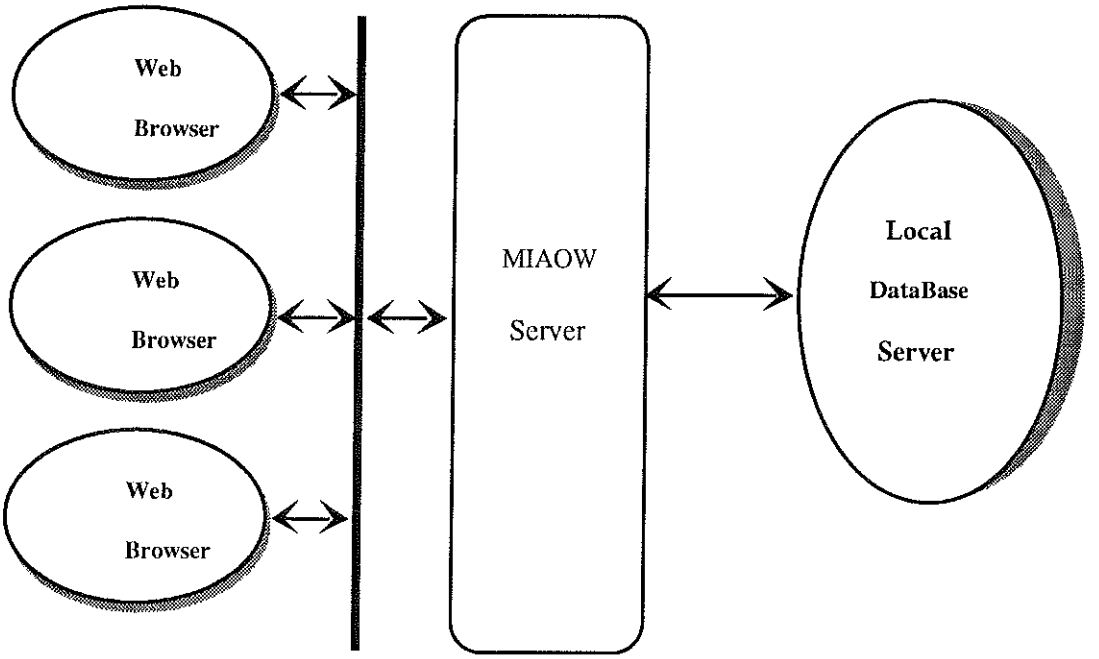


*Fig. 2 : MIAOW General Architecture*

### 3.1 MIAOW Search Pages

The purpose of a search operation is to retrieve a material from the stone database. Once this material has been selected information about it can be accessed. The search terms that can be specified in a query correspond to properties of the material. Among these: Type of Material, Colour, Use Mode, Origin (where it is quarried), Aliases, Colour Hue, Pattern, Background and Finish. Moreover, a searching for colour similarity is also possible.

In order to fulfil the requirement of flexibility of the searching engine, the MIAOW query formulation environment is separated into five pages. Each page provides for entering query terms for a specific class. The query classes are: Basic, Aspect, Finish, Technique, and Price.

A series of navigation buttons allow the end-user to move among the search windows of each class. In each window a set of input fields that define the specific class query terms are available (see the right half of the page in figure 3).

End-users can build a query incrementally, by progressively specifying a value for the terms defined in one or more of the above classes, according to the material characteristics they are interested in. The simple conditions specified in each class are AND-composed when the query is explicity submitted. Until this point, the end-user has the possibility of clearing the query, i.e. of undoing what has been specified in the previous classes. This incremental approach to the query construction has the twofold advantage of presenting a simplified interface to end-user (e.g. people interested in searching material with certain technical characterisics will not be prompted out with interface components for the definition of visual characteristics of the material) and providing for a simplified approach to the visualization of the answers from the MIAOW system.

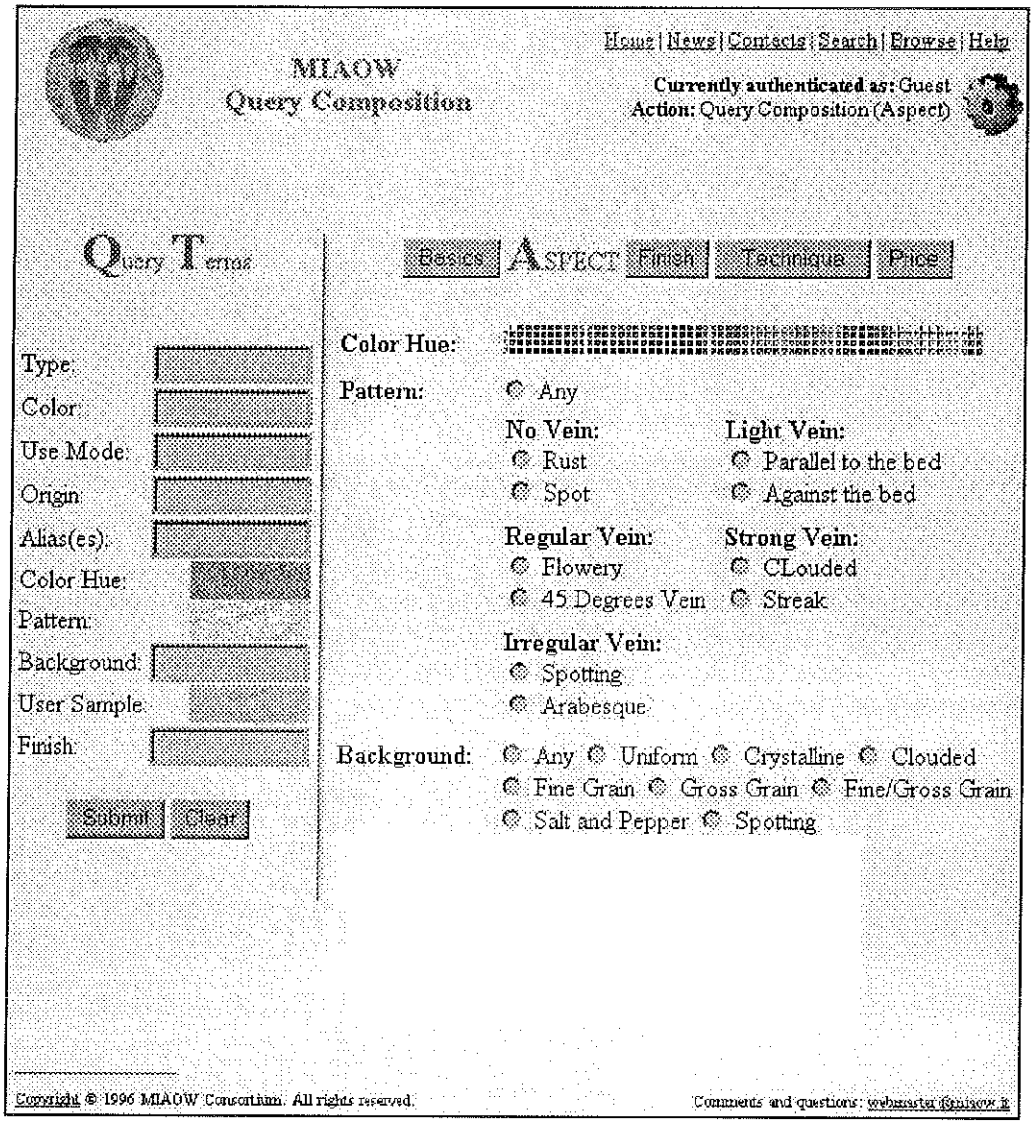


*Fig.3 : Aspect Page*

The values given to the terms in a query must satisfy the consistency rules established in the database. For example, only particular backgrounds apply to each type of material. The interface forces the consistency by dynamically restricting the possible choices of values for a term according to what has been specified in the previous pages.

A feedback of the terms of the query which have already been specified starting from any of the query composition pages is maintained and shown in the leftmost area of the page.This helps the end-users to have full visibility of the state of the query composition.

Moreover, by simply clicking on the tag of each of the input fields, a help window pops-up with a description of the attributes, and of how the end-user input will be processed by the system.

Due to the shortage of space it is not possible to describe all the options provided to entering the query terms by each of the five windows. A detailed description of them can be found in [7]. As an illustrative example let us present the options associated with the Aspect page: Pattern, Background and Color Hue (see figure 3).

Pattern and Background are two visual characteristics of the material. The possible values for these two terms are shown in the page. The specification of a value for Pattern can be done

by selecting one of the radio buttons. More than one button can be instead selected for the Background. In this case the query will result to contain all specified values connected with a logical OR operator.

The set of values proposed for the two terms is constrained by the Type of Material term possibly specified: if no material type is selected, the system will prompt the end-user with all possible Patterns/Backgrounds. In case one or more than one material types have been selected the list of possible Patterns/Backgrounds will be restricted accordingly.

The Colour Hue term allows to select the materials, among those stored in the datatabase, that have a dominant colour «more similar» to the one that has been specified. The dominant colour is defined as the most frequent colour value in the image of a given material.

In the effort to give the system more friendliness and a higher degree of immediateness, a 64-entries palette of the dominant colours of the materials is shown in the page. The end-user specifies a value for this term by simply selecting one of the 64 tiles that are presented on the screen; the system will consider as similar to the chosen one all of the materials whose dominant colours fall in the same class.

The 64 colours visualized in the palette are not static but they are functionally dependent on the Material objects that are stored in the database (see the discussion about the Palette class in section 4.1.1). It is this peculiarity that allows to return, each time a query is formulated, the set of materials more similar among those stored.

## 3.2 MIAOW Query Result Page

The results of a search operation are shown into an appropriate page (see figure 4).

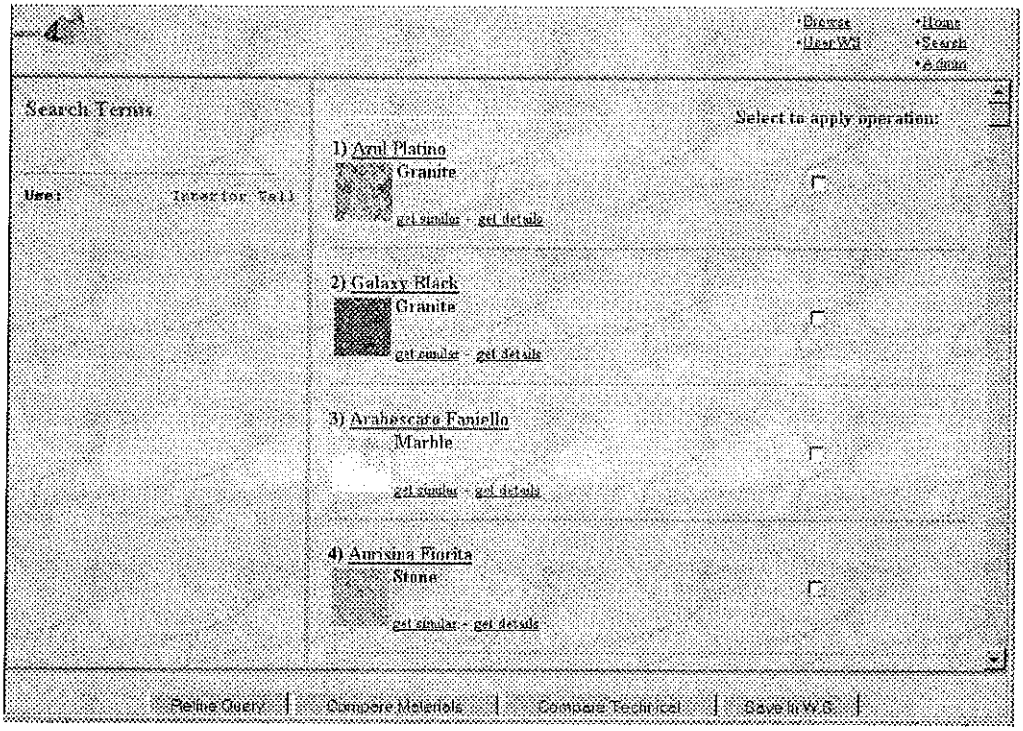


*Fig. 4 : Result Page*

The area at the right contains the hits returned by the MIAOW server. All materials returned match the simple conditions on Type of Material, Background, Pattern, Colour and Finish, if indicated. Other conditions, as those on technical tests values, may not be verified by

the materials returned. In that case how many values are satisfied by each material is also shown.

For each material selected summary information about it are provided: thumbnails of the material image; Name; Type of Material. More detailed information such as Colour, Origin, Background, Vein Pattern, Finishes, Price, Technical Tests, Suppliers, Manufactures and Full Scale Image of each returned material must be asked esplicitly.

In order to remind to the user the last query its terms are shown in the left most area of the page. The user can then decide, if he is not satisfied of the result, to refine the query terms bringing back to the Query Composition environment by means of the functionality "Refine Query".

Alternatively the user can execute a search by similarity to a material among those returned by the query. This operation is executed as regards values as texture, local and global colour and structure of the downloadable image of each material.

It is also possible to compare either the technical data or the images of at most four among the materials brought back by the query. This operation is useful if the user is not completely sure of which of the returned materials is more suitable for his needs.

MIAOW offers to the end-user then the opportunity to save his favourite materials in his own private Work Space. The user will be able to access his materials time after time, according to his needs. He may add new materials to his Work Space, or delete materials he is not interested in any longer.

### 3.3 Other functionalities in brief

In addition to the search and visualization functionalities illustrated above, the MIAOW system provides a number of other functionalities to support the work of the different stone actors. Among these the followings:

- Browsing: A browsing environment can be accessed from the main page. In this environment the end-user can navigate in the MIAOW database by browsing on Type of Material, Background, Vein Pattern attributes. This functionality is addressed to those end-users who have only a vague idea of what they are looking for, and which becomes more precise as they start to obtain information from the system.
- Glossary: A glossary environment, accessible from the main page, supports for seaching technical term definition, either by keywords and wild-card.
- Advertisement: Advertisements and information on the companies registered in the MIAOW system can be accessed.
- Accounting: An end-user registration form can be accessed and filled. Alternatively a Guest Book for users, who are not registered end-users, that want to get into contact with the MIAOW Consortium can be shown.
- Support: A communication with the stone building experts of the MIAOW Consortium can be initiated by sending her/him an e-mail.

## 4. MIAOW SYSTEM ARCHITECTURE

This section defines the details of the abstract architecture described at the beginning of section 3. It also describes features of standard technologies that has been used to implement the architecture.

The MIAOW system architecture is implemented as a three-tier client-server architecture to overcome the database dependencies problem of typical client-server applications. Figure 5

compares the two frameworks, and shows how the three tier provides an intermediate level for placing application logic independently from the database used.

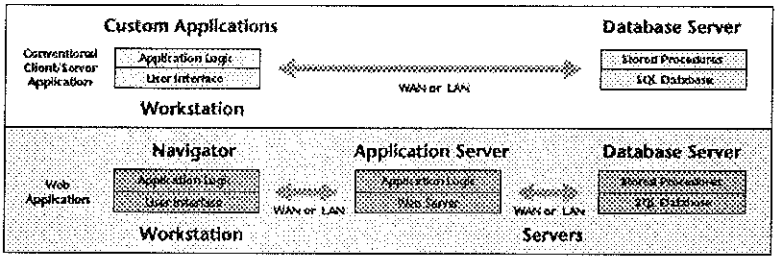


*Fig. 5 : Client-server architectures*

In the MIAOW system the three tiers are the followings:

- Netscape Navigator WWW client: This tier provides a cross-platform end-user interface to the application. It also contains some application logic, such as data validation rules implemented in JavaScript.
- MIAOW application server/database client: This tier consists of a Netscape Fastrack server. It contains the MIAOW application logic, manages security, and controls multiuser access to the application. This tier allows clients both on LAN and WAN to access the application. It also acts as a client to the database server.
- Database server: This tier consists of Illustra database server, running on high-performance workstations. It contains all the data, metadata, and referential integrity rules required by the application. This tier runs inside the corporate firewall and provides a layer of security in addition to the WWW server.

The following two sections present respectively the MIAOW database (the third tier) and Application Server (the second tier).

## 4.1 MIAOW Database Server

The MIAOW database relies on the Object-Relational Database Management System Illustra [3, 11]. Illustra offers modeling capabilities of both relational and object models. It supports standard SQL data types, functions and queries. The Illustra model distinguishes from a relational model for the possibility of representing object identity, composite objects, multivalue attributes, extending basic data types, etc.. Moreover, Illustra allows to package a collection of data types, their associated functions, operators and access methods into "DataBlades modules" [2, 4, 5]. In this project the VIR (Visual Information Retrieval) Datablade has been used. This relies on two essential technical features to perform complex graphical searching: *segmentation* (reduces the essential features of a graphical file to a feature vector) and *fuzzy matching* (makes it possible to retrieve images that are similar to a given image).

The next two sections illustrate, respectively, the schema of the underlying database and how the server processes queries submitted to this database.

### 4.1.1 MIAOW Database Schema

The database was planned to store all the information regarding the world of the materials used in building industry, of their suppliers and of the quarries from where they are quarried

[1, 8]. The requirements on this database have been collected by interviewing several stone actors, both internal and external to the MIAOW Consortium [9].

The information on materials, maintained in this database, ranges from the material visual characteristics, as dominant colour, background and vein type, to the material images, and from descriptive terms, as name, type of materials, type of use, to technical characteristics, as the International Standard and ASTM tests.

All this information is organized into a form that is suitable for a faster evaluation of the queries that the actors of the business process of the marble market have indicated as the most frequent.

The database so modelled is completely independent of the MIAOW Application Server and it can be the used to support different versions of the MIAOW Application or even different applications.

The schema of the MIAOW database is illustrated in figure 6 using the Object Modeling Technique graphical notation [10].

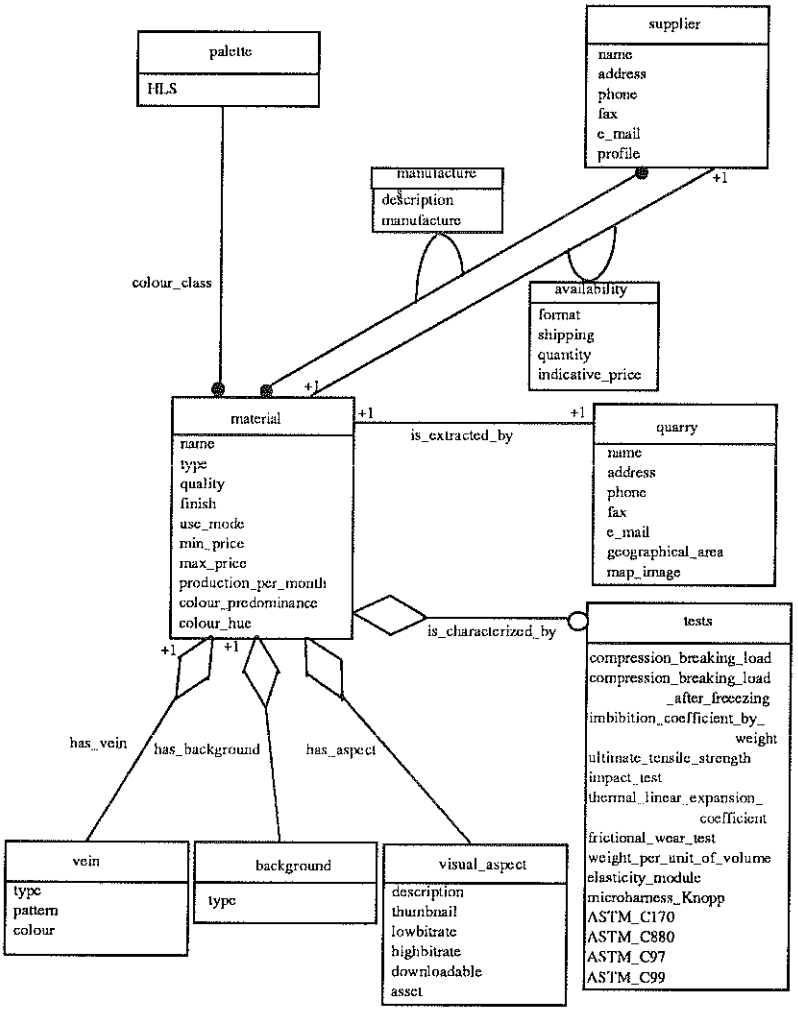


*Fig. 6 : MIAOW database schema*

*Material* is the "main" class of the schema. It models the materials that are stored in the MIAOW database. On the material class a series of attributes is defined:

- *name*: the name of the material;

• *type*: the type of the material. It can take one among the values 'Marble', 'Granite', 'Stone', 'Quartzite' and 'Travertine';

• *quality:* the type of stone. It can take, if the type is 'Stone', one among the values 'Limestone', 'Sandstone' and 'Slate';

• *finish*: the possible material workings. It can take as a value a subset of {'Polished', 'Flamed', 'Sand Blasy', 'Hammered', 'Split Face', 'Jet Liquid Honed', 'Honed', 'Acid Finishing'};

• *use_mode:* the uses that can be made of the material. It can take as a value a subset of {'Interior', 'Exterior', 'Ground', 'Wall', 'Pedestrian', 'Carriage-heavy-traffic', 'Carriage-light-traffic'};

• *min_price* and *max_price*: respectively the lowest and the top price at which the material is sold;

• *production_per_month*: the material total monthly production;

• *colour_predominance:* the dominant colour of the material;

• *colour_hue*: the dominant colour of the material computed from an image of it.

The *material* class has four components:

1) The *tests* class, that maintains a series of possible technical tests to which materials can be submitted;

2) The *visual_aspect* class, that contains for each material: a small size image, to be shown in the records of the retrieved data (*thumbnail*); a medium size image, to be shown in the comparison of the visual aspect of selected materials (*lowbitrate*); a large size compressed image, to be displayed along with the material descriptive and technical data (*highbitrate*); a large size uncompressed images, for downloading (*downloadable*); a description of the photo (*description*) that is represented with different definitions in the four attributes above; and a feature vector (*asset*) used to store visual attributes (as texture, local and global colour and structure) extracted from the downloadable image of a material by means of functionalities offered by the VIR Datablade when the image is inserted.

3) The *background* class, that models all the possible materials background types chosen among 'Uniform', 'Crystalline', 'Clouded', 'Fine Grain', 'Gross Grain', 'Fine & Gross Grain', 'Salt & Pepper', 'Spotting';

4) The *vein* class, that models the possible materials veins, showing the vein types, as 'No Vein', 'Light Vein', 'Regular Vein', 'Strong Vein', 'Irregular Vein' (*type*), the vein characteristics as 'Rust', 'Spot', 'Parallel to the bed', 'Against the bed', 'Flowery', '45 Vein', 'Clouded', 'Streak', 'Spotting', 'Arabesque' (*pattern*) and the vein dominant colour (*colour*).

The schema is completed by two other classes: *supplier* and *quarry*.

The *supplier* class contains, besides the name and a card with a presentation and a photo of the society, a series of information useful to contact the supplier, as the address, the telephone and fax numbers and the e-mail address.

The *quarry* class contains an indication of the geographical area and a photo of the area where the quarry is located, besides the information necessary to contact the quarry (information similar to those given in *supplier*).

The *material* class is related to both the *quarry* class, through a relationship that binds each material to the quarries from which it is extracted, and the *supplier* class, through the two relationships, *manufactures* and *availability*. The former describes the works made with each material, showing images of works already realized and their descriptions, and the latter models the availability that a supplier has for a given material, whether for formats available for sale (Blocks, Slabs, Tiles, Cut to Size, Base or Skirt, Artwork), or shipping constraints, available quantity and indicative price.

Finally, each material is bound to one object of the *palette* class. This relationship allows to group the materials into colours' classes concerning the material dominant colour computed on its downloadable image. The *palette* class has the attribute *HLS* that maintains the coding of colours in the HLS system (hue, lightness, saturation). This system has been used to arrange the colours in the palette, because in the MIAOW application it is extremely important to group in the same class those materials with similar tints (although lighter or darker) rather than those with a particular percentage of a single component (red, green or blue).

The *palette* class contains 64 objects: this implies that the materials are clustered into 64 equivalence classes. All the classes are equally spaced intervals as regards the hue. Each of the objects loaded in the *palette* class is the representative colour of a class. Considering that choosing the material having colour nearest to the mean value of the class could not certainly be the most representative tint in the class, the colour of the material that has an equal number of material on the right and on the left inside of a class has been chosen as the representative colour of the class [12, 13].

The choice of the 64 objects to be inserted in the *palette* class is function of the dominant colour of the materials loaded in the database. When a new group of materials will be added or deleted from the MIAOW database, the 64 objects of the *palette* class and the relationships from the class *material* to the class *palette* are recomputed.

### 4.1.2 Query processing

All the user queries submitted to the MIAOW database are processed as standard SQL queries, except for the execution of a search by similarity to a given material.

The execution of this query causes the invocation of a function that evaluates the similarity of each material loaded in the database to the given material. The similarity is computed as regards *texture*, *local* and *global colour*, and *structure*; these characteristics are kept in the *asset* attribute of the *visual_aspect* class and extracted from the downloadable image of each material.

## 4.2 MIAOW Application Server Architecture

The following figure depicts the principal components of the MIAOW Application Server and their functionalities.

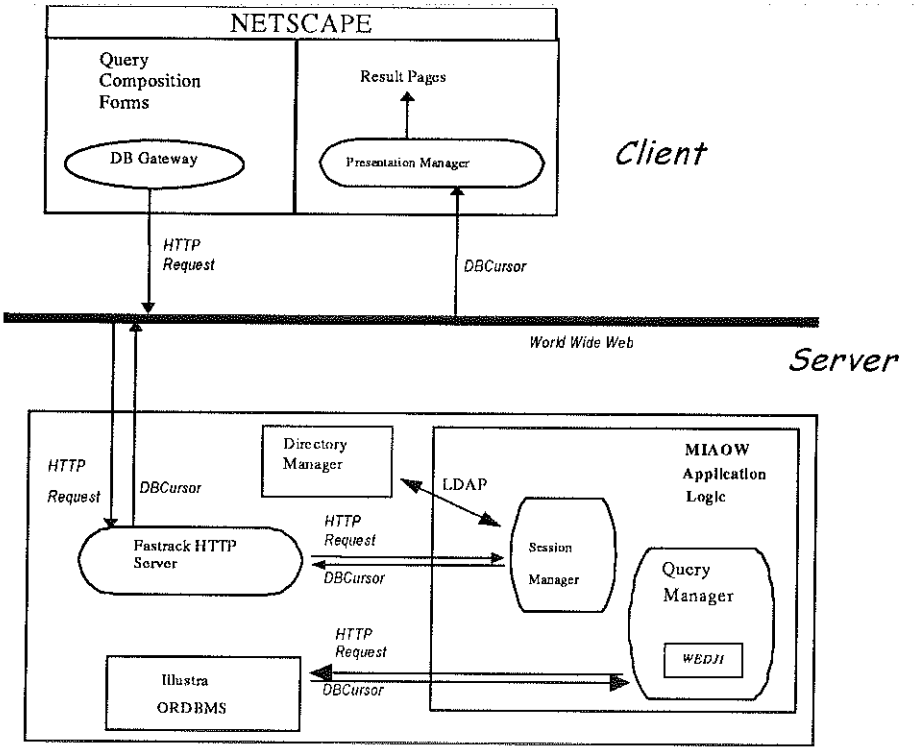


*Fig. 7 : MIAOW Application Server Architecture*

The MIAOW Application is executed partly on the client and partly on the server.

The client part is composed by:

- Query Composition Forms: This allows user to construct his/her query;
- Presentation Manager: It decides how to compose the HTML pages out of the DB cursors received from the MIAOW database;
- DB Gateway: Is a Java applet based on the WEDJI ITG classes which manages the user defined queries and sends them to the system DB via the WEDJI driver.

The server part is instead composed by:

- Netscape Fastrack: It is a second generation HTTP server supporting JavaScript and Java server, and HTTP protocol on Secure Socket Layer.
- MIAOW Application Logic: It consists of the Web Environment Database Java Interface (WEDJI) [6] that enables user to issue queries to an Illustra database from within a Java program. In particular, it imports the Internet technology gateway (ITG) package into user Java program, enables him/her to invoke methods that issue queries to an Illustra database and manages communication between the ITG and the Illustra database. Moreover, it includes features provided by the following subclasses of functionalities:
  - Session Manager: This verifies through the Directory Manager the users' access rights to the MIAOW functionalities and checks login information provided when entering the application. It uses the database server, instead, to store an archive of registered users.
  - Query Manager: It supports mechanisms to perform searches on the database of materials. It also defines functions embedded into the query pages to perform pre-processing of Query Terms.

Running the MIAOW application begins with a client request for a main page. When the Netscape server receives the client request, it first performs authorization. This step is part of the basic server administration functions. If the request fails server authorization, then no subsequent steps are performed. If the request passes server authorization, then the user can formulate a query. A Java program (an application or applet) issues database requests using the ITG classes. They send the database requests from user Java program to the fastrack HTTP Server using the HyperText Transfer Protocol (HTTP). The Fastrack invokes the Query Manager that issues a request to an Illustra database; this returns the results of the query to the Fastrack, which in turn passes the results to the Java program in the MIAOW Presentation Manager residing in the client application. This application composes the results into HTML pages before displaying them.

## 5. CONCLUSIONS AND FUTURE WORK

This paper has illustrated the MIAOW system. This system answers to a specific market requirement raised by the stone actors. It is the main component of a re-organization of the marble business process aimed to make the information exchange widespread, up to date, timely, reliable and cost-effective.

The paper has outlined how in order to overcome the present limitations of the stone business a simple catalogue of stone materials available on the Web is not sufficient, but a more comprensive information system is required. Moreover, it has outlined the importance of combining specific user-oriented search and retrieval facilities on the client with sophisticated algorithms on the server.

The MIAOW project is currently under the assessment phase. Several actors, external to the MIAOW consortium, are evaluating the system from different quality points of view. We expect from them suggestions for improving the set of provided functionalities. In the meantime, several improvements to the current version of the system have been planned for the next future. In particular:

- There will be a set of database servers, geographically distributed, that will maintain the information about materials, providers and consultancy agencies. Users will be able to select explicitly, if they wish, the information server they want to use.
- The query and browsing facilities will be improved. It will be possible, for example, to formulate queries that return a provider, and to browse with respect to a colour indication.
- New communication services, as video-conferences, will be added.
- A newsgroup service will be established.

Information about it can be found at: http://www.pisa.intecs.it/projects/miaow

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