The painter Candido Portinari lived in a period of time which is very significant in the development of modern Brazilian culture. His work and his interaction with other artists, poets, writers, architects, journalists, educators and politicians reflect the essence of the aesthetic, artistic, cultural, social and political concerns of 20th-century Brazil.

The broader the goal of the Portinari Project is, in addition to documenting all the painter's artistic production, to provide a view of Brazilian culture during his lifetime. Capturing all the information related to his work and making it available to new generations is a challenge.

One of the first phases of the Portinari Project was to locate and document the works and documentary material. In a second phase, this information has been catalogued. A third phase, currently initiating, will make the material that has been gathered and documented as widely available as possible.

As a first step in this latter direction, the Portinari Project is presently undertaking the design and production of the Catalogue Raisonné of the painter's work. It is the first publication of this kind in Latin America. In order to support the Catalogue Raisonné, a database has been designed, whose model and implementation guidelines are presented. A second effort is also underway to extend the material in the database to provide a hypermedia application to access the collected material; this application will later be used in the scope of a planned multimedia museum.

This paper describes the present achievements and planned goals of the Portinari Project. The second section briefly reports the Project's history and the process of collecting and cataloguing information, as a starting point for the Catalogue Raisonné. The third Section deals with the database and hypermedia models conceived for supporting both the Catalogue Raisonné and the hypermedia museum. In the fourth Section, we discuss some interesting research problems raised by the Project and the fifth Section draws some conclusions.
Brief history of the Portinari Project

The Portinari Project was started in 1979, at the Pontifical Catholic University (PUC) of Rio de Janeiro. It is engaged in research and other activities related to the work, life and times of the Brazilian painter Candido Portinari.

Since 1979 the Project has been able to locate, document and catalogue about 4500 works and 25000 documents. The works, which include paintings, drawings and prints, have been photographed in colour and black & white. Among the documents there are 6000 letters exchanged with the major writers, poets, musicians, architects, artists, journalists, educators and politicians of Portinari’s generation. An Oral History Program interviewed 65 of the painter’s contemporaries, totalling 130 hours of recordings. More than 12000 clippings from publications, from 1920 to the present, 300 exhibition catalogues, 1200 epoch photographs, films and videos, and various memorabilia now make up the Portinari Project’s archives. This material is a true synthesis of all aspects of Brazilian life during that period. Images, texts and sounds, highly correlated, form a large multimedia database of the main aesthetic, artistic, cultural, social and political concerns of one of the most creative and important periods in the history of Brazil.

The Project has been supported, throughout the years, by several government agencies, as well as by private institutions.

The three phases of the Project

Before the Portinari Project started it was nearly impossible, in Brazil, to have access to information about the painter in a centralised and systematic way. Indeed, the New York Museum of Modern Art had more information on Candido Portinari than all the Brazilian institutions we had visited.

To produce a systematic, detailed and comprehensive listing of the complete works of a visual artist, together with the establishment of his biography and of the profile of his generation is an undertaking that necessitated the development a specific methodology, which evolved during the actual execution of the work.

This methodology makes the Portinari Project a pilot project, an example that can be followed by similar endeavours, even outside the sphere of the visual arts - it is applicable to poets, writers, architects musicians, scientists, educators, journalists, or politicians whose lives might provide a cross section of their times.

In order to arrive at this model, the Portinari Project went through three phases, each with its own clearly differentiated characteristics: locating and documenting, researching and cataloguing, and dissemination.

The first task was to locate and document the works and the documentary material. This included a visiting programme in order to list and photograph “in loco”, in colour and black and white, works and documents scattered throughout Brazil and in more than 20 countries in the Americas, Europe, and the Middle East. In addition, a group of personalities were interviewed in the Oral History Programme.

The second phase involved research and cataloguing, indexing, establishing various controlled vocabularies and a thesaurus of the material collected, cross-referencing all the data and complementing, through a survey of all the documentary material, the information gathered in the visits. Various lines of research were developed in this phase: the study of the authenticity of the works attributed to the painter; the establishment of the chronology of his complete output; the survey of all the technical, bibliographical and historical references concerning each of the nearly 4500 works surveyed; and others.
The third phase is concerned with the dissemination of the information. As such, several complementary instruments are being considered, the foremost being the Catalogue Raisonné and its supporting database.

In addition to the Project's thematic comprehensiveness, there is also its methodological comprehensiveness. As a pilot project, it led to a new methodology, ranging from museology and documentation to high technology areas, particularly in computer science. Examples of such areas are non-conventional databases, hypertext, multimedia, image processing and techniques in artificial intelligence, neural networks, pattern recognition and automatic object classification, among others.

Among the activities that the Portinari Project is conducting at present, two are mutually complementary and are given top priority: preparation of the Catalogue Raisonné and its supporting database.

**The Catalogue Raisonné**

Of all kinds of monographs and studies, the catalogue raisonné is the most definitive and complete source of references for an artist's work. It is, in the words of the art historian Francis O'Connor, "... primarily an inventory of existing holdings, and illustrated listing designed to serve as the basis for further critical and scholarly exploration".

*Candido Portinari - The Complete Works* will probably be the first publication of its kind in all of Latin America with such characteristics of comprehensiveness and detail. The catalogue, to be published in eight 250-page volumes in a bilingual version, will contain an average of three reproductions per page. Portinari's almost 4500 works will be presented one by one, each with its technical, historical and bibliographical descriptions. A typical page of the Catalogue Raisonné can be seen in Appendix 1.

Clearly, in this sort of specialised reference work, it is of crucial importance to ensure the reliability of the information contained in each entry: technical, historical and bibliographical data, as well as the reproduction - as faithful as possible - of the work in question.

The design is being implemented electronically, so that each of the 4500 works must be digitised and colour-corrected according to the standard scales of colours and grays recorded together with each work. This digitisation will also be useful for the preservation of the visual record.

We also intend to publish the work electronically, a CD-ROM which will contain the same material, with nearly instantaneous information retrieval, as well as make it available through networks such as the Internet.

**The Portinari Project database and hypermedia models**

The Portinari Project is divided into two sub-projects. The first refers to the information related to the artist's works. It may be seen as the essence of the Catalogue Raisonné. The other, which is much more vast, deals with the information related to the personal life of the artist and his contemporaries, and is a true initiative in the sense of preserving one of the richest periods of the Brazilian cultural life.

All this information is meant to be organised in a database and to be made accessible through hypermedia interfaces. In this section, we show an overview of the models developed to support both the database and the hypermedia applications for the project.
The database model

To develop the conceptual database model, we adopted the inside-outside strategy (Ceri, Batini and Navathe, 1992), where the main ("inside") concepts are established at the first moment (works, medium, theme, for instance) and, moving towards the "outside", we gradually concentrate on new concepts (friends of the painter, Brazilian cultural events in a specific period of time and so on).

The starting point for the full understanding and further modelling of the artist’s work was the Work Description Card (FCO, Ficha de Catalogação de Obra in Portuguese). All works have been previously identified and described through the FCO’s and this is the starting point to design the conceptual DB model. Each FCO is associated to one and only one work of the artist and contains all the relevant data about that specific work.

We chose an extension of the Entity-Relationship Model (ER) (Chen 1976) to design the conceptual DB model. The ER diagram is shown in Fig.1.

This ER model was then translated into the relational model, since this model is widely accepted and available in different hardware and software platforms. The latter is an important point as we wish to evaluate, in the future, the database accessibility through computer networks by users using different platforms.

A last consideration about the database model refers to its bilingual version (Portuguese and English). As we intend to make all information available to every researcher and, being sure that Portinari’s works are spread all over the world, it is mandatory to have data in an idiom more "universal" than Portuguese. This, in fact, poses an interesting problem whose solution we have not yet agreed on, since the mere duplication of the text attributes affects negatively the performance, due to the considerable increase in size. The
creation of distinct databases, each of them containing one idiom, implies in redundancy of all non-translatable attributes that can result in database inconsistencies. Our current thinking is that the more interesting alternative is the creation of synonym tables containing only the primary key and the translatable attributes in the original table.

The hypermedia model for the Portinari Project

The Portinari Project provides an ideal background for hypermedia applications. It deals with multimedia information, such as photographs of the works, related documents and recorded interviews. On the other hand, it also provides an interesting context for database applications, because of the great amount of data treated within its scope.

Two approaches are possible to integrate hypermedia and database applications. The first one, adopted in previous works (Zdonik and Smith, 1987), focuses mainly on the hypermedia component and considers the database only as a support for it. Another viewpoint, adopted in Portinari Project, is to start from an existing relational database application and to develop hypermedia front-ends to it. In this case, the database is accessed independently of the hypermedia interfaces, the data stored in the database being retrieved either through the usual DBMS interfaces or through the hypermedia ones.

Integrating the two paradigms and preserving the autonomy of the DBMS applications poses some problems. Consistency must be enforced: changes in the database must be automatically perceived in both environments. Another difficulty is due to the fact that hypermedia systems work on graph structures, composed of nodes and links, as opposed to relational databases, that deal with tuples and relations. Our approach was to start from an existing relational DB model and from a conceptual model of the hypermedia application (Marques 1993b).

Hypermedia browsing and authoring

Hypermedia applications involve the managing of data under the form of graphs, composed of nodes and links between them. Two different needs arise in these systems. The first one refers to the navigation and information retrieval, also known as browsing. Browsing allows the navigation through paths previously established in a step called authoring. The ease of use of an hypermedia application strongly depends on its author ability to capture the semantics of an application and to adequately organise the structure of the hypermedia graphs.

The clear and rational organisation of hypermedia applications is thus much more critical as the more complex is the application. The complexity of an application is measured by the amount of data to be managed or by the intrinsical complexity of the data itself.

The authoring or hypermedia applications project is composed by distinct aspects: authoring-in-the-large refers to the design of the structural and global aspects of the applications; and authoring-in-the-small refers to the development of the contents of the nodes.

We have used the HDM methodology (Garzotto, Paolini and Schwabe, 1993) to design the hypermedia application. Briefly, an HDM model consists of a schema, composed of the following components:

Entities, Components, Perspectives - a conceptual or concrete kind of object within the application domain; for example, "WORK", "OWNER" and "EXHIBITION" are HDM entity types. Each instance of an Entity type is a hierarchy of Components. Each component may be represented in any of several Perspectives.
Links- relationships between the previous concepts. Links types may be classified in one of the following groups:

*Application Links* connect an entity type to another entity type; they are defined by the author taking into account the semantics of the hypermedia application; for example, between "WORK" and "EXHIBITION", there is an application link shown in, referring to the fact that an instance of WORK was shown in an EXHIBITION.

*Structural Links* connects the parts (Components) that make up an entity.

*Perspective Links* connect the different representations of a component (Perspectives).

A particular hypermedia application in a given domain is specified by instantiating the schema, i.e., by instantiating its entity and link types.

The primitives above give the structural aspects of a hypermedia application. The application behaviour must also be specified, i.e., how the application objects are shown to the user, how he can activate a link and which is the feedback he gets when a link is activated. These aspects constitute what is called *browsing semantics*, and is mainly related to the user interface with the hypermedia application. A final important point to be made is that a given HDM model may be implemented in several different software and hardware platforms.

We present next part of the hypermedia model for the Portinari Project, depicting its main entity and link types (see Fig.2). In the diagram, the oval elements represent the entity types. The link types are denoted by the arcs connecting the nodes. All the links are bi-directional (Portinari's "WORK" is shown in "EXHIBITION", as well as "EXHIBITION" shows Portinari's WORK, for example), although they are drawn only once.
After the definition of the schema and further instantiation, it is possible to implement the model using any hypermedia system. When implementing, the authoring-in-the-small aspects of the application are specified, for example the presentation screen for nodes, the buttons, feedback, etc. We have already chosen HyperCard System to implement one version of the Portinari Project hypermedia application. An example of an instance of a Work entity, including both its textual and its photographic perspective is shown in Fig.3.

**Future scientific research and development**

Besides the database and hypermedia applications, two research projects are under way.

**Digital preservation of colour slides**

This project stems from the necessity of preserving our 4500 colour slides, the only visual registry of Portinari’s complete work. This material was obtained through substantial investment of funds and effort, locating and visiting each of Portinari’s 4,500 works, which were scattered throughout Brazil and in more than 20 countries in the three Americas, Europe and the Near East. It would not be viable to reproduce this fourteen-year endeavour. Therefore it is justifiable to look for state-of-art solutions to the problem of preservation.

We are planning to use high-resolution colour scanners and image compression techniques for storing the images in some optical media. There are still many problems to be solved, especially in connection with effective colour control.
The second project deals with the problem of determining the authenticity of the artist’s works. Such questions lie at the heart of our concerns, since we must claim full responsibility for the works included in our Catalogue Raisonné, and our staff have already identified more than 400 false attributions among the works we have catalogued.

It is well-known that both pure connoisseurship and physico-chemical technique approaches can fail to identify a forgery, and we have some spectacular examples of this, as in the case of the famous false Vermeers, done by the master forger Van Meegeren in Holland, during the fourties.

The Portinari Project currently investigates the hypothesis that a significant sample of brush-strokes taken from paintings known to be authentic should possess some kind of “fingerprint” of its author, in the sense that no other painter would produce the same sample. At the moment, automatic techniques to classify brush-strokes and other features of paintings are under research, including the possibility of training a neural net to identify authentic brush-strokes. Such classification focuses on "profiles" obtained from the brush-strokes through the application of Fourier analysis to extract significant features that involve both the artist’s “calligraphy” and the colour distribution in the brush (longitudinal and transversal components). This is illustrated in Fig.4.

Digital analysis of the authenticity of paintings

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The Portinari Hypermedia Museum

In a large sense, hypermedia applications and museums serve the same purpose. Both can be understood as information systems, since they aid people to acquire knowledge or, in a minimal sense, increase the information on some domain. Modern museums can be of many different types; in our case, we envisage a museum in which people will be able to access the information in diverse ways, with a strong emphasis on electronic formats.

The Portinari Museum’s technical arm will be an imaging and media laboratory, which is currently under development, dedicated to the application of science and technology to art and culture. A first example of the activities of this laboratory is the use of HDM model, combined with traditional database design techniques, to build the applications described above.

Conclusions

Throughout this work we investigated how science and art team up together to assist cultural projects. The Portinari Project can be thought of as the research platform because of its great "multimediality", as well the intricacy of the information it has gathered.

The main contribution of this article has been the description of how we have used computer technology to aid in the methodology adopted in all phases of the successful attempt of rescuing Candido Portinari’s work. We have shown the data model that was developed to support the Catalogue Raisonné; this model can be extended as well to provide the basis for a class of hypermedia applications that will be used as one of the possible accesses to the information surveyed by the Project.
The work done so far by Projeto Portinari is in fact the first step of a larger endeavour: the establishment of the Portinari Hypermedia Museum. This will include the construction of a building whose project has already been designed by the famous architect Oscar Niemeyer - a contemporary and co-author with Portinari of many important works - to physically house the museum, its laboratory and further multimedia developments that will be accessible to the general public (Fig. 5).

We hope that this work may also be a methodological example to be adopted for the retrieval and documentation of the work of any artist.
Appendix 1  Sample page from the Catalogue Raisonné

1331

Portrait of Dona Dominga
1941
Charcoal drawing/paper
Brodosqui- SP
44 x 31cm
Signed and dated on bottom right-hand corner
"Poninari 1941"

Collection:
Júlio Candido Portinari – Rio de Janeiro – RJ (artist’s gift)

Remarks:
Study for painting “Dona Dominga e Seu Baptista”
(Cat. n° 1333)
On the back of the sheet, manuscript inscriptions: "DN 184", 
"N° 469" and authentication by Maria Portinari, artist’s 
widow.
A portrait of Dominga Torquato, the artist’s mother
Exhibitions:
* EX48 (126), EX49 (45), EX106
* LVII, pp. 22, LVIII, pp. 31, LVIII, pp. 17, LVIII, pp. 11, 
  LVIII, pp. 37.
* CO306, ref.; CO336, ref.; CO487, ref.
* PR1127, ref.; PR4160, ref.; PR4800, ref.; PR5112, ref.

1332

Portrait of Seu Baptista
1941
Charcoal drawing/paper
Brodosqui- SP
45 x 31cm
Signed and dated on bottom right-hand corner
"Poninari 1941"

Collection:
Júlio Candido Portinari – Rio de Janeiro – RJ (artist’s gift)

Remarks:
Study for painting “Dona Dominga e Seu Baptista”
(Cat. n° 1333)
On the back of the sheet, manuscript inscriptions: "DN 94", 
"N° 684" and authentication by Maria Portinari, artist’s 
widow.
A portrait of Baptista Portinari, the artist’s father
Exhibitions:
* EX48 (111), EX49 (59), EX103 (41)
* LVII, pp. 23, LVIII, pp. 246, LVIII, pp. 31, LVIII, pp. 16, 
  LVIII, pp. 43.
* CO487, ref.
* PR743, ref.; PR752, ref.; PR1005, ref.; PR4660, ref.; 
  PR9665, ref.

1335

Dona Dominga e Seu Baptista
(1941)
Watercolor painting/cardboard
Brodosqui- SP
22 x 23cm
Neither signed nor dated.

Collection:
Júlio Candido Portinari – Rio de Janeiro – RJ (artist’s gift)

Remarks:
Project of a portrait not carried out.
Stamped signature on lower right “PONINARI”.
On the back of the cardboard, manuscript inscriptions: "DN 
185", "N° 684" and authentication by Maria Portinari, 
artist’s widow.
A portrait of Dominga Torquato and Baptista Portinari, artist’s 
parents.
Exhibitions:
EX48 (126); EX92 (55); EX103 (44); EX106

References:
LVI, pp. 28; LVIII, pp. 31; LVIII, pp. 17; LVIII, pp. 11, 
LVIII, pp. 37.
COY%, ref.; CO307, ref.; CO487, ref.
PR1127, ref.; PR4160, ref.; PR4800, ref.; PR5112, ref.

1334

Portrait of Baptista Portinari
(1941)
Etching and aquatint/paper
24,5 x 19cm (PA), 20 x 25cm (S)

Collections (1st edition):
Banco do Estado do Rio de Janeiro – Rio de Janeiro – RJ
(O/C)
Perry Deer – Rio de Janeiro – RJ (non numbered)
Ennio Marques Ferreira – Curiúva – PR (non numbered)
Collections (2nd edition):
Yamagata Engenharia – Rio de Janeiro – RJ (1/50)
Rafael Benchimol – Rio de Janeiro – RJ (2/50)
Gabin da Veiga Engenharia – Ba (3/50)
GESC/Secretaria Social do Comércio – Rio de Janeiro – RJ
(A/50)
Vânia Maria Virgílio Benício de Magalhães Senna – Rio de 
Janeiro – RJ (5/50)
Octavio Scaiano – Rio de Janeiro – RJ (6/50)
Reginó Forzado Moreira – Rio de Janeiro – RJ (7/50)
Iaino Coelho – PR (8/50)
Sérgio Margulis – Rio de Janeiro – RJ (9/50)
Marina Christina Scarronato Gabaglia Penna – Rio de 
Janeiro – RJ (10/50)
Angélica Marla Ceza Chagas – Rio de Janeiro – RJ (11/50)

Remarks:
Size: brase plate, 25 x 19.6 cm
1st edition: Unknown number of printed copies. One 
HC copy and one non numbered copy were found out.
2nd edition: 30 special copies printed, in 1987, at the 25th 
anniversary of Portinari’s death. An initiative of the 
Portinari Project. Printing supervised by Marília Rodrigues with 
the assistance of Marlene Hort. Copies printed in brown, on 
“Villon Arches” paper, numbered and authenticated by Júlio 
Cândido Portinari, the artist’s son.
Dona Dominga e Seu Baptista

1941
Pintura a aquarela/cartão
Brodosqul - SP
22 x 23cm
Sem assinatura e sem data

Coleção:
João Candido Portinari - Rio de Janeiro - RJ
(presente do artista)

Observações:
Maquete para retrato não executado.

Assinatura e data em verso, indicação de Maria Portinari.

Exposições:
Nº 58 e autenticação de Maria Portinari.
O casal da maquete e Dominga Torquato e Baptista Portinari, pai do artista.

1354

Retrato de Baptista Portinari

1941
Gravura a água-forte e água-dileta/papel
24,5 x 19cm (C.I.) 28 x 23cm (S)

Coleções (1ª edição):

Banco do Estado do Rio de Janeiro - Rio de Janeiro - RJ (H.C.)

Cecy Deca - Rio de Janeiro - RJ (Prio)

Eno í Maiores Ferreira - Caricatá  - PR (Prio)

Colecções (2ª edição):

Yamagata Engenhista - Rio de Janeiro - RJ (1/90)

Raphael Benchimol - Rio de Janeiro - RJ (2/90)

Cabeça da Ponte Agnecuária - MA (3/90)

SESC/Serviço Social do Comércio - Rio de Janeiro - RJ (4/90)

Valentia Maria Vidguí Baselha da Magalhães Ferreira - Rio de Janeiro - RJ (5/90)

Octavio Sculfero - Rio de Janeiro - RJ (6/90)

Rogério Fratão Menezes - Rio de Janeiro - RJ (7/90)

Hilda Countinho - PE (8/90)

Sérgio Marques - Rio de Janeiro - RJ (9/90)

Martha Christina Sarabia - Gama Ferraz - Rio de Janeiro - RJ (10/90)

Angela Maria Negra Chagas - Rio de Janeiro - RJ (11/90)

Observações:

Matriz: chapa de lastra, 35 x 45,6cm.

1ª edição tiragem desconhecida. Foi localizado um exemplar "H.C." e um exemplo sem numeração.
