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Intelligent Methodological Support of Building Recovery

Support méthodologique pour la réhabilitation des bâtiments

Computerisierte Vorgehensweise für die Sanierung von Altbauten

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SUMMARY

The increasing activities for the recovery of existing building patrimony have led to studies on the organization of activities with computerized tools. The research pursued two aims: a) the analytical identification of the various stages, operation duties and relevant operators involved in the restoration process; b) the implementation of the specific expert system. The main results have been: definition of an Intelligent Methodological Support System for Building Recovery, which controls/coordinates the interplay of single restoration stages by means of different tools and computerized or non-computerized methodologies, and the elaboration of a Building Computerized Card.

RÉSUMÉ

La généralisation des travaux de réhabilitation dans le domaine des bâtiments existants a entraîné des études approfondies, relatives à l'organisation des interventions à effectuer à l'aide de moyens informatiques appropriés. La recherche s'est développée en suivant deux objectifs: a) la détermination analytique des phases successives, des diverses modalités d'exécution et du personnel chargé des travaux de rénovation; b) la mise au point d'un système expert spécifique. Les résultats principaux sont traduits par la réalisation d'un prototype de ce système et par l'élaboration d'archives de données informatiques spécifiques au bâtiment.

ZUSAMMENFASSUNG

Die zahlreichen Sanierungsarbeiten des gesamten baulichen Erbes haben vertiefte Studien hinsichtlich Organisation der verschiedenen Eingriffe mit computerisierten Hilfsmitteln mit sich gebracht. Diesbezüglich hat sich die Forschung in zwei Richtungen entwickelt: a) die analytische Definition innerhalb des Sanierungsprozesses der aufeinanderfolgenden Phasen, der verschiedenen Ausführungsarten und der damit Beauftragten; b) die Entwicklung eines spezifischen Expertensystems. Als Hauptergebnisse gelten die Realisierung eines Prototyps dieses Systems und die Entwicklung eines computerisierten Datenarchives der einzelnen Gebäude, in dem man alle gespeicherten Informationen, Texte und Zeichnungen, aufrufen und z.B. für ein Wartungsprogramm oder einen Arbeitsauftrag zusammenstellen kann.

1. INTRODUCTION

The European Charter of the architectural patrimony, promulgated at the end of the european architectural patrimony congress, held in Amsterdam in 1975, and adopted by the committee of the European Council Ministers, states: "The European building/architectural patrimony is formed not only by the most prestigious monuments, but also by all the buildings which make up our cities and our traditional villages in their natural and constructed enviroment.... For quite some time, only the most important monuments have been preserved and restored, regardless of their context. They may, however, lose a great deal of their value if their context is altered. Moreover, groups of buildings, even without outstanding architectural features, may have enviromental qualities which contribute to give them a diversified and articulated artistic value. These groups of buildings must be preserved as such."
Such a principle is recalledby with the Italian law 457/1978 which specifies in the Fourth Title the General Rules for the rescue of the existing urbanistic and building patrimony; in the article 31 of this act, ordinary and exstraordinary maintenance, restoration and recovery, building and urbanistic restructuration fall within the interventions aimed to the building rescue. They are not simple interventions but specific processes characterized by specific, common aspects: the preexistence of the constructed object which must be investigated, measured, checked, i. e. known in-depth, before starting any building activities.
In the present paper, we do not address the specific terminology questions, rather we address the even more complex theoretical questions underlyng the rescue process. In particular, we have singled out and systematized the stages of the recovery process. The latter process was deemed methodologically more appropriate to exemplify a rescue activity which is supposed to be, on the basis of several statistical data, widespread represented across the entire nation.
The process of building recovery is made up by four main stages:
A- Pre-project stage: the building knowledge.
B- Planning stage: the project of interventions for building recovery.
C- Implementation stage: the interventions for building recovery.
D- Preservation stage.
The first stage encompasses the acquisition and synthesis of all the data relevant to the general identification of the building and to the identification of its degradation characteristics.These data will be used in the subsequent planning stage. The stage A is so important for the proper operation of the whole process (Restoration and Recovery) that has been acknowledged by the Italian Charter for Restoration, enclosed in recently approved building codes of historical cities, and also constitutes the main basis of the Territorial Informative System of the Enviromental and Architectural Property of the Central Institute for Catalog and Documentation for Cultural and Enviromental Patrimony. It can be easily seen that, for restoration and recovery, the knowledge stage entails absolutely new and specific characters and features as compared to those which inform the process of new constructions. In the latter case, it is necessary only to know both internal and external bonds, geotechnic and hydrogeological characteristics of the soil (soil conditions) and interactions with adhering buildings, if any.
The second stage constitutes the project of building recovery, i.e., the plan of those interventions deemed necessary for the preservation of the buiding or of some of its portions.
The third stage is made up by the actual activities of the construction site, carried out with particular methodologies and technologies which put into effect all the interventions planned in the second stage.
The fourth stage, which in theory lasts for ever, in other words until demolition, refers to the preservation of the building, i.e., constant control of the conservation state of the buiding or of some of its portions, ordinary and extraordinary maintenance.

2. THE SMIRNE SYSTEM

The methodological knowledge, the control and coordination of the four stages (delineated above), necessary to carry out the building rescue are the functions of the System for Intelligent Methodological Support of Building Rescue (the italian acronym, SMIRNE, will be used throughout). SMIRNE relies upon different tools and either computerized or non-computerized methodologies and is planned as the structure which unifies several rescue tools, which can really implement a support for many activities to be carried out. Some of these tools are knowledge based systems (KBS), others are simple programs.
The four main stages of recovery consist of several activities; each activity is performed by an agent, is supported by a tool, requires information and produces information, utilizes archives of knowledge.

The system's first task is, thus, to coordinate all the activities, assign them relevant agents and tools, connect activities and knowledge bases, control type and quality of the required and produced information.
Description of the four main stages of Recovery, of required and produced information, of supporting agents and tools, of background knowledge bases, constitutes a General Model of the SMIRNE System's domain (Fig. 1). For each stage, the system sets the relationships between knowledge bases of classes and knowledge bases of instances, which contain specific information about the given building and intervention patterns.
We talk about instance since the system sets relationships between a type of agent that can perform an activity and a particular agent that will perform it; between one type of required information and the specific information relative to a given building; between one type of recovery intervention and the particular intervention of a given building; between one type of technology required to carry out an intervention and the particular technology peculiar to a given building site, ecc.

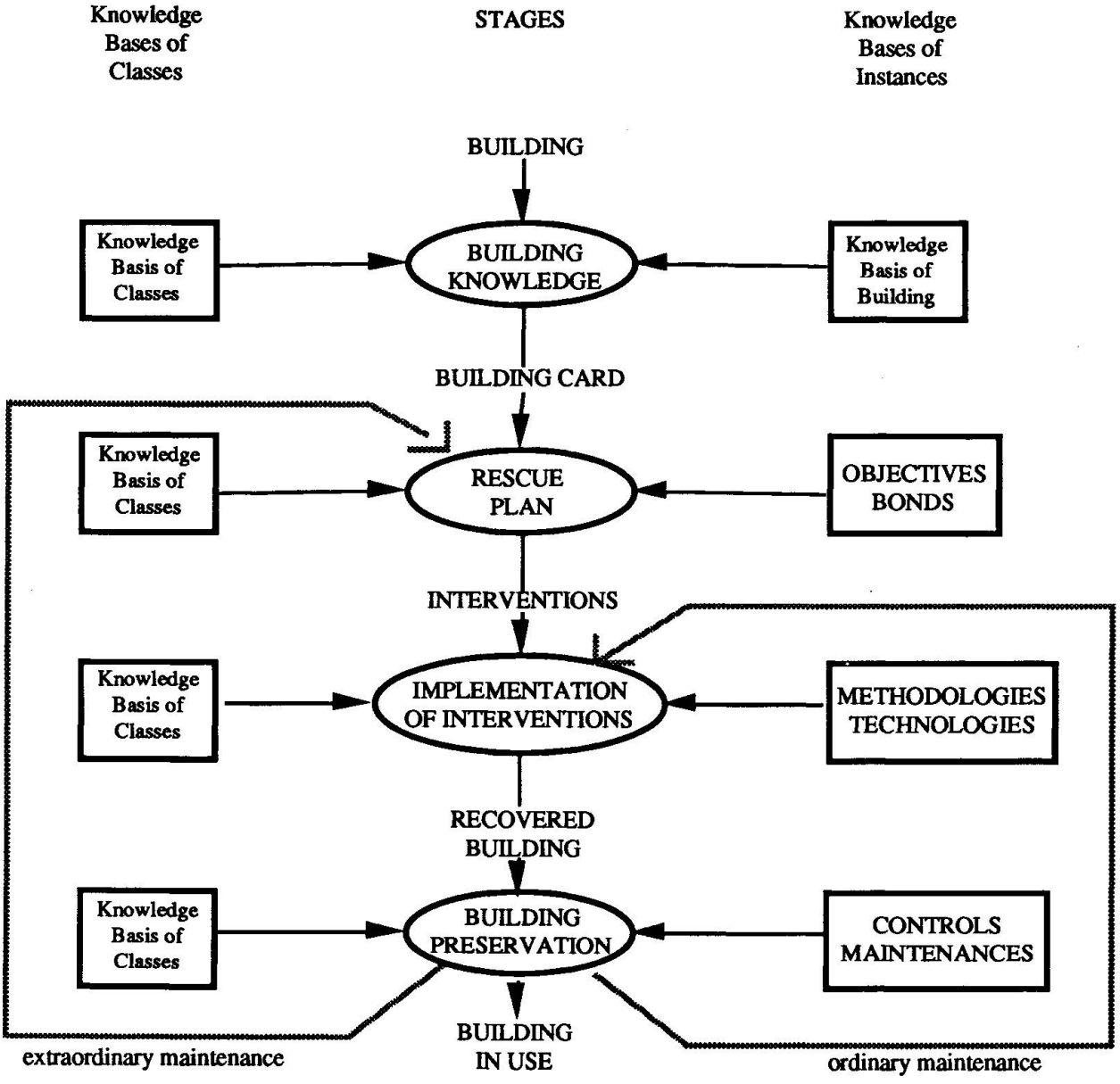

fig. 1 General Model of the SMIRNE System's domain: the model of recovery stages

In this model, each stage is related to a knowledge basis of classes; such knowledge bases contain description of the stage subdivided in activities and subactivities, of types of performing agents, of types of required tools, of types of information required and produced by these subactivities.
The knowledge bases are, thus, the main source of information for the fulfilment of the control tasks and coordination activities of the system.
Computerized tools supporting the activities of these stages are essentially traditional systems (CAD systems, data management systems, calculation programs) and intelligent sytems (knowledge based systems and more specific expert systems for diagnosis and planning).

2.1 The Model of the Building Knowledge Domain. Concepts and their relationships

The study carried out in this section of the project concerns the definition of the model of the building knowledge domain, i.e., concepts and their relationships.
The model of a generic information system is made up by some elements which can be led back to five typical concepts, and by the relationships among such concepts. The concepts are the following:
C1. Activity.
C2. Agent.
C3. Tool.
C4. Information (Data and/or Document).
C5. Archiv.
The concepts of Activity, Agent, Tool, Information, Archiv can be defined as "metaclasses", because they are generalizations of types of Activity, Agent, Tool, Information, Archiv which can be defined as "classes". The relationship between metaclasses and classes is an instance relationship, since one type of Activity, one type of Agent, one type of Tool, one type of Information, one type of Archiv, are instances of the concepts Activity, Agent, Tool, Information, Archiv (Table 1).
A peculiar Activity, a peculiar Agent, a peculiar Tool, a peculiar Information, a peculiar Archiv are, in turn, instances of classes or of types of Activities, Agents, Tools, Information, Archives.

METACLASS	CLASS	INSTANCE
Activity	Topographic finding	Topographic finding of the X building located in Y
Agent	Topographer	John Smith
Tool	Theodolite	Theodolite Zeiss T 500 model
Information Document	Cadastral Map	Cadastral Map of the X building located in Y
Datum	Topographic network point	P1(X1,Y1,Z1)

Table 1 Example of relationship involving metaclasses, classes and instances

A model which portraits a generic information system describing the five concepts (metaclasses) and their relationships can be thus, defined as Model of metaclasses; this model is a semantic network as far as the information structure is concerned (Fig. 2).

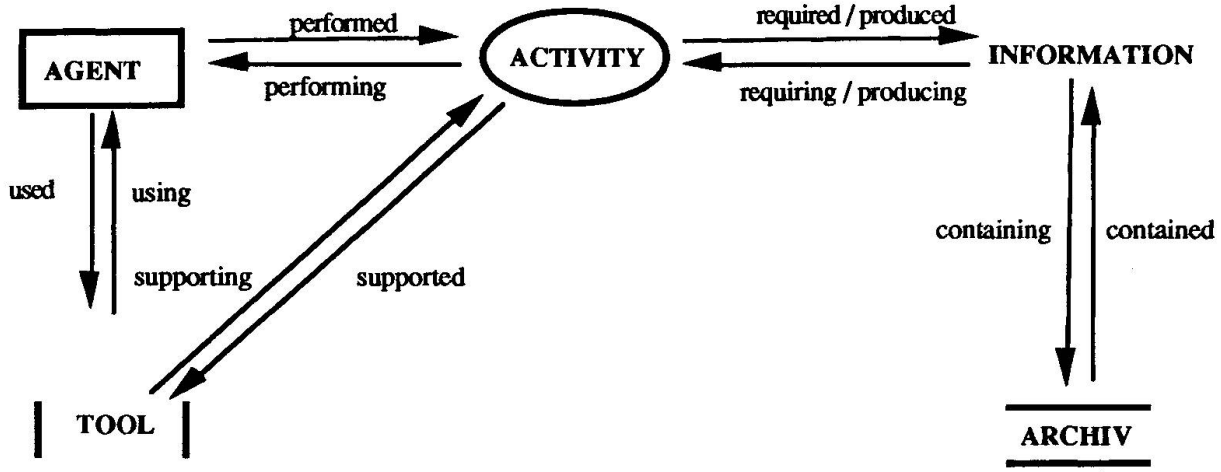

Fig. 2 Model of metaclasses as semantic network

The Activities are processes capable of accepting Data and/or Documents, manipulating them and otputting again Data or Documents.
The Agents have the task to carry out the Activities. In general, they can be people (e.g. the user, the planner, the historian, the physicist, etc.), programs (traditional programs, knowledge based system, expert systems, etc) or parts of the system.
The Tools support the Activities. They can be of various types, and can be classified as traditional tools and innovative tools, or as mechanic tools, electronic tools and computerized tools.
Document is any set of information which must be found or produced during the various Activities. Certificates, cartographies, regulations, to be found in agencies and libraries, as well as papers elaborated by the planner or by any other agent, fall within this concept.
Datum is any elementary information, generally rapresented by aggregates and classified as documents. For example, identification data of the building and of people who are legally bound to it, as well as evaluations made by the planner on the building preservation state, fall within this concept.
The Archiv is the original source (Documents and Data). For example, it can be a traditional archiv, (as municipal archiv, General Land Office archiv), or a data processing center, a library.

2.2 The stages of recovery process

A - The Building knowledge
The knowledge basis of classes is made up by description of the activities which concern the building knowledge and their relationships, and by description of the types of agents, tools, archives and information involved in this stage.
The knowledge basis of instances is made up by description of all the information on the particular building, by description of particular agents, tools, archives and information involved . The building knowledge is targeted to the compilation of the Building Computerized Card (Fig. 3).

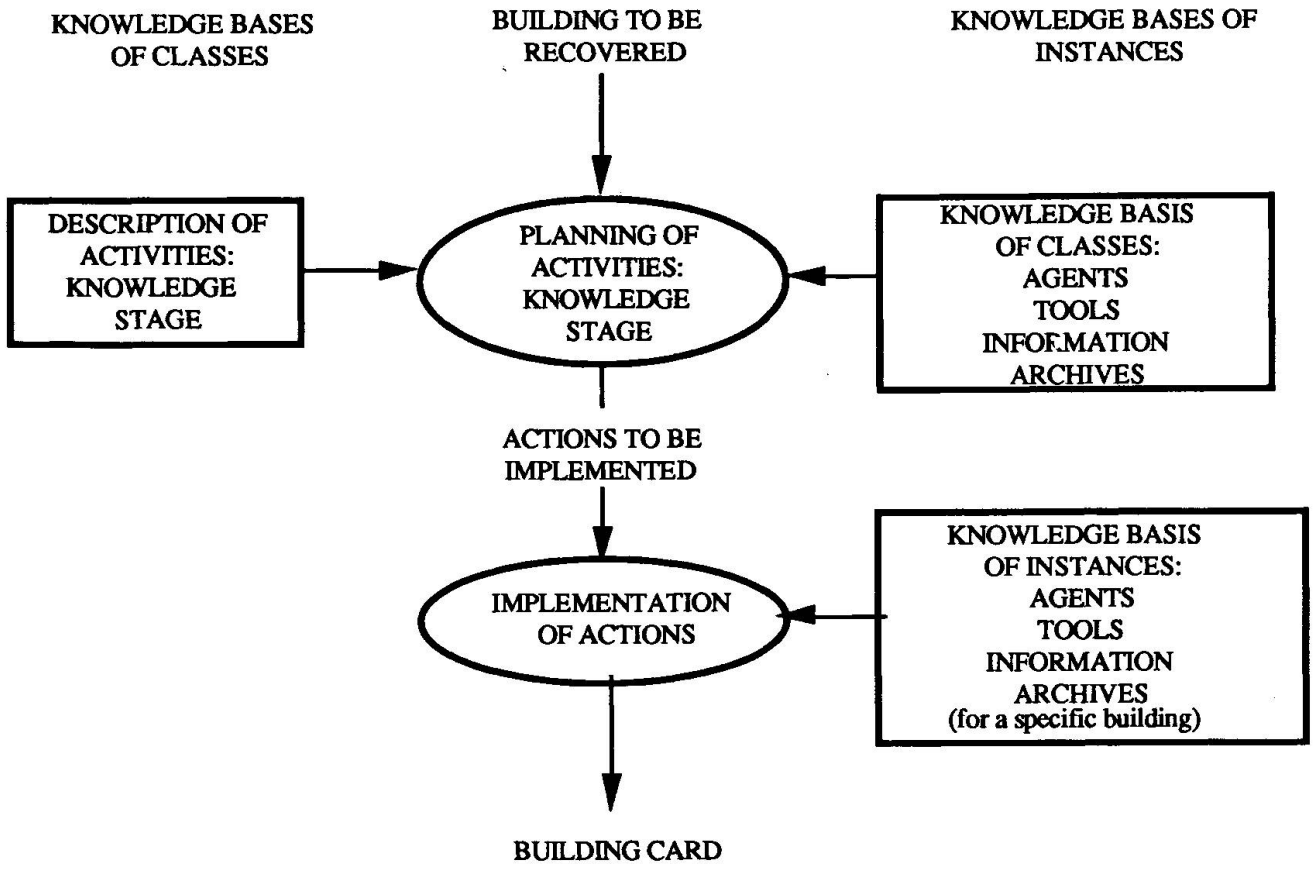

Fig. 3 The system model concerning the building knowledge stage

B - Planning of the recovery interventions

The knowledge basis of classes is made up by description of the activities which concern the planning of the recovery interventions and their relationships, and by description of the types of agents, tools, archives and information involved in this stage.

The knowledge basis of instances is essentially made up by description of recovery interventions and of internal and external bonds to the specific building. The planning of recovery interventions utilizes the Building Computerized Card, result of the previous stage and is targeted to the formulation of a list of recovery interventions.

C -Implementation of the recovery interventions.

The knowledge basis of classes is made up by description of the activities which concern the implementation of the recovery interventions and their relationships, and by description of the types of agents, tools, archives and information mainly involved in the accomplishment of the building site activities.

The knowledge basis of instances is thought to be made up by specific methodogies and technologies for the building site. The implementation of the interventions uses the description of interventions and is targeted to the production of the recovered building.

D - The building preservation

The knowledge basis of classes is made up by description of the activities which concern the building preservation and their relationships, and by description of the types of agents, tools, archives and information involved in this stage.

The knowledge basis of instances is basically made up by particular controls and maintenances which must be performed on the building during this stage.

In the case of ordinary maintenances, the system will resume the control at the stage of implementation of interventions.

In the case of extraordinary maintenances, the planning of the interventions should be probably reconsidered.

2.3 The system model concerning the building knowledge stage

Planning activities of the knowledge stage yields a description of the actions to be performed which represent activities to be developed (in sequential and/or parallel way) in order to yield the building card (Figs. 4, 5), the finding out the informations necessary to the activities, the supporting agents and tools required for the activities.

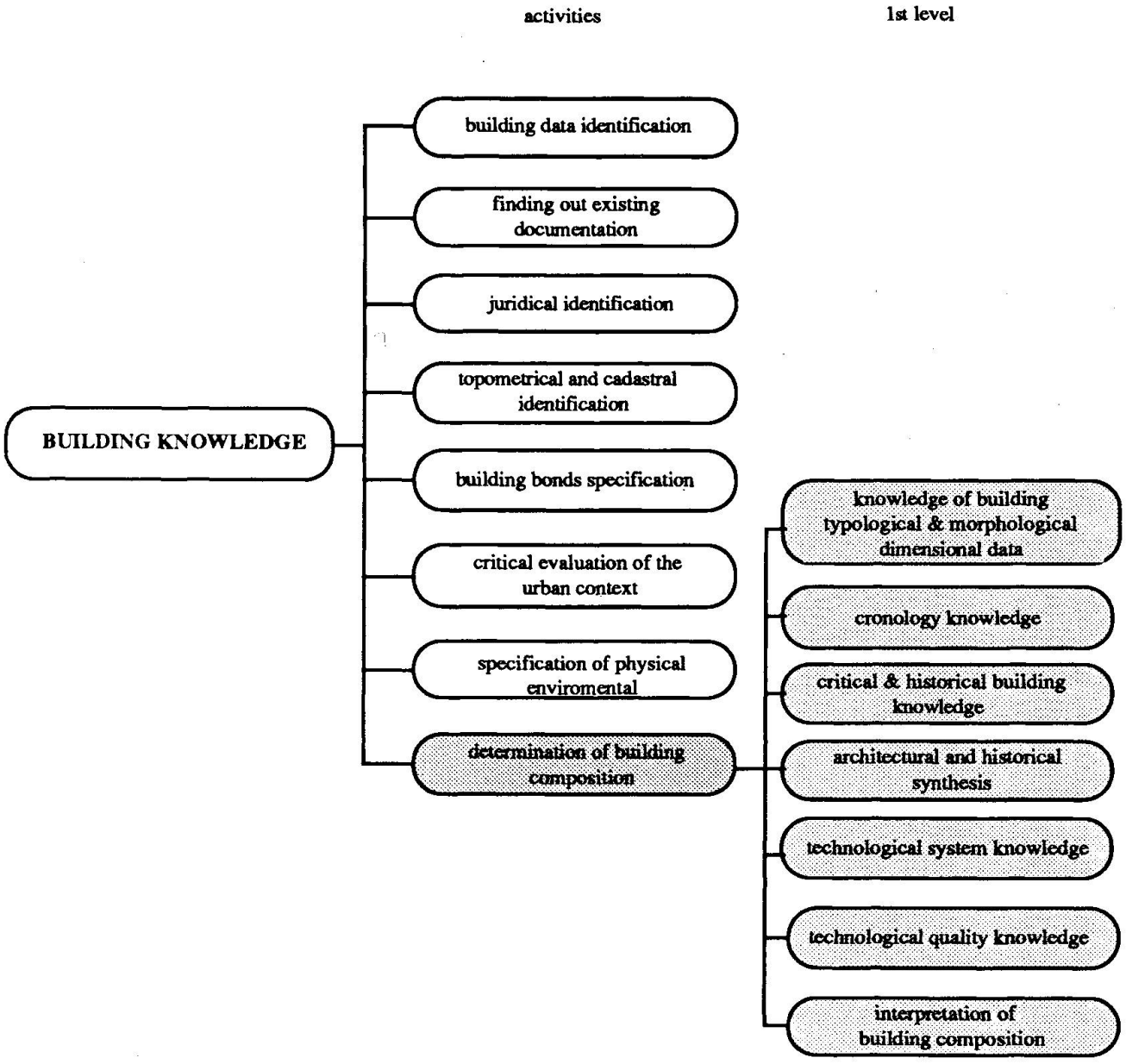

Fig. 4 Taxonomy of activities. Division in 1st level subactivities

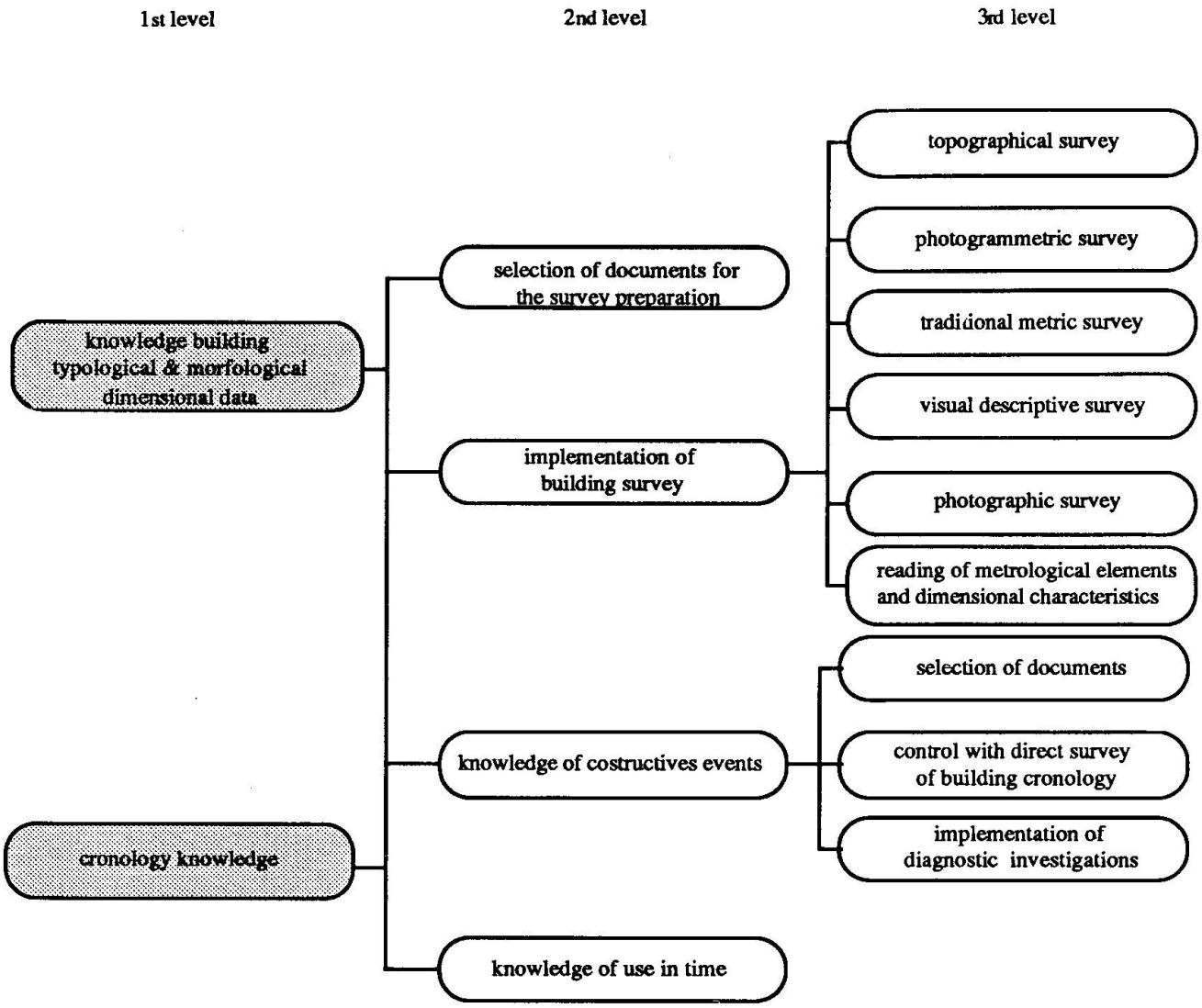

Fig. 5 Taxonomy of activities. Division in 3rd level subactivities

During the implementation of the action, a corrispondence between the knowledge base of the classes and the knowledge base of the instances is accomplished: types of information required by activities, types of agents, types of archives and types of supporting tools (knowledge basis of the classes) become information relative to the particular building and context, to specific agents, specific archives, and specific supporting tools (knowledge basis of the instances).

In particular, the system should fulfil, for a given activity, the following tasks among those concerning the building knowledge stage:

- Identification of the type of agent(s) which can perform the activity.
- Identification of the type of tool(s) supporting this activity.
- Identification of the type of information requested and yielded by the activity
- Identification of the container of the requestested information (usually a type of archiv).

Based on the particular building under consideration and on the particular context where it is placed, the system should provide:

- Identification of the particular agent(s), belonging to a given type, which will perform the activity.
- Identification of the particular tool(s), belonging to a given type, which will support the activity.
- Identification of the specific requested information, belonging to a given type and of the specific container (e.g,. a particular archiv), where it is placed.

Once accomplished such operations, the system will control the proper development of the activities.

2.4 Conditions for computerized filing of knowledge

It is necessary to lay out the computerized procedures for filing and for subsequent finding out graphical, pictorial and textual information relevant to a given buiding, in order to create a Building Computerized Card. The Card will help to transform fragmentary knowledge in systematized and aggregated knowledge, targeted to the use of the information for the planning stage, for the management of the building patrimony, for historical or typological studies.The computerized archiv should perform as vital archiv, i.e., in continuous growth and modifiable in time. In particular, the archiv must function as support to stages subsequent to that of knowledge, in the context of the recovery process (Tables 2, 3).

ACTIVITIES	DATA and/or DOCUMENTS	ARCHIVES FORMAT
topographic finding	topographic survey	Vectorial Drawings
photogrammetric finding	photogrammetric survey	Vectorial Drawings
traditional metric finding	table of traditional metric survey	Vectorial Drawings Alphanumerical Data
visual descriptive finding	descriptive report	Alphanumerical Data Raster Pictures
photografic finding	inventory of photografic cards of actual conditions	Raster Pictures Alphanumerical Data
reading of metrological and dimensional characteristic	synthesis report of dimensional characteristic	Alphanumerical Data Raster Pictures

Table 2 Correspondence among 3rd level subactivities, yielded data and documents, and their format filing: implementation of building survey

ACTIVITIES	DATA and/or DOCUMENTS	ARCHIVES FORMAT
selection of documents	pre-existing building list historical regest historical constructive tables tables of restorations tables for use in time tables of actual use	Alphanumerical Data Raster Pictures Vectorial Drawings
control with direct survey of building chronology	chronology survey	Alphanumerical Data Raster Pictures Vectorial Drawings
implementation of diagnostic investigations	certificates of diagnostic investigations	Alphanumerical Data Raster Pictures
knowledge of use in time	regests of tables with use in time	Alphanumerical Data Raster Pictures Vectorial Drawings

Table 3 Correspondence among 3rd level subactivities, yielded data and documents, and their format filing: knowledge of constructive events

There is not a single data base, rather there are several and smaller data bases closely related to each other, so that they can be more easily modified or integrated, should new requirements occur; they are easily managed by a medium-power graphic station because the whole system is lighter and allows shorter response times; finally, they make up an easily repeteable structure.
In the specific case, however, the division takes place in the following data bases, according to this distinction:
1 - alphanumerical data
2 - vectorial drawings
3 - raster images of: maps, historical drawings, old regests, historical and contemporary pictures.
The major advantage of the data base is to establish relationships between bodies of information also coming from different archives and, as in this case, to emphasize possible interactions among structural, historical and technological data, in a more immediate fashion than usual paper sources. The program however, with respect to its external interface, attempts to keep an approach comparable to that of normal paper information, by leading the hypothetical user to the various possibilities presented by the data base with the simplest menus and with an always available help function.

3. CONCLUSIONS

We chose the buildings of the Botanical Garden (built in 1545), destined to become headquarters of the University of Padua Scientific Museums, in order to test the prototype of the computerized archiv.
A preliminary evaluation of consulted documents has made possible to recognize the condition/format of filing and to test a preliminary draft of computerized archiv.
In the archiv, all available data are arranged in a structure compatible not only for filing but also for the systematic and comparative research of data, targeted ether to the understanding of historical and architectonic features of the building or to provide cognitive support for a possible intervention of recovery of maintenance.

4. NOTES

Throughout the text we made use of several words whose meaning is detailed as follows:
Rescue refers to the global process, whereas restoration, recovery, preservation and restructuration refer to individual steps of the rescue.

5. ACKNOWLEDGEMENTS

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