Hypertext for building rehabilitation. A didactic use of an innovative methodology of diagnosis of the building decay.

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Abstract

In the paper presented in the last ECAADE conference in Palermo we described a first hypertext for the analysis of ancient buildings. One section of the hypertext was devoted to show diagnostic procedures and specific instrumental tests for building rehabilitation. We can consider that the hypertext represent the best answer to the request of an organised knowledge coming from students of the schools of architecture and public operators. So we describe how the proposed arrangement of the diagnostic tests can become a real operative tool for technicians of public agencies and powerful means of building technology knowledge for students too. The diagnostic procedures are related to the specific needs of the architectural design; changing ways to archive the tests are showed. The goal is to allow the architects, operating in the rehabilitation field, to operate the right choice of diagnostic methods to avoid doing many unnecessary, expensive tests.

Introduction

In the last ECAADE conference in Palermo I have illustrated, with I.Amirante, the prototype of hypertext for the knowledge of the Goldoni theatre in Livorno and its restoration. This theatre is an impressive building designed by the architect G. Cappellini and built in 1847. That hypertext has been realised using the software PC Toolbook 3.0 in order to facilitate both the technical administrators and others users, in our case students or common citizens.

That work has represented the opportunity to Join together three different worlds: research (National Council of Research "CNR"), teaching (Second University of Naples) and professional activity (Technical Department of Livorno Council). These three particular points of view implied a strong work to elaborate a common language useful for different operators and pressed the authors to define the model of the building and its relation with the environment. The aim is to elaborate an informative structure to support the decision and to help the activity of the building maintenance [1].

Just because of the presence of the teaching needs, we intended to use hypertext not only in real world but also as tutorial tools for didactic applications. So the system is conceived very flexible in its structural logic and friendly in exhibition of data.

Particularly the new regulation of Schools of Architecture in Italy allows the students to test and practice specific parts of the entire system by attending Technology of Building Teaching where multi-disciplinary approach is pursued. The use of the hypertext facilitates the students in managing a great variety of different information, so they could recognise their capability of implementing data, picking these from real case studies.

However this methodology could show them, by practice, the need of multi -disciplinary work, which is nowadays one of the main characteristics of architects and civil engineers. This methodology could also teach the student the assumption of the systemic logic in the classification and organisation of building, introduced by international standards organisations of building in Europe, for the quality control of the building construction process [2].

The didactic point of view also distinguishes the approach to the systematic of diagnostic tests that is a specific part of the hypertext. In fact our real experiences showed that one of the main aspects of building restoration is the knowledge phase; moreover the diagnosis is the principal activity of this phase.

In the hypertext this topic is illustrated under the section devoted to the description of the building conditions of degradation before intervention. This section include two parts: prediagnosis and precision diagnosis.

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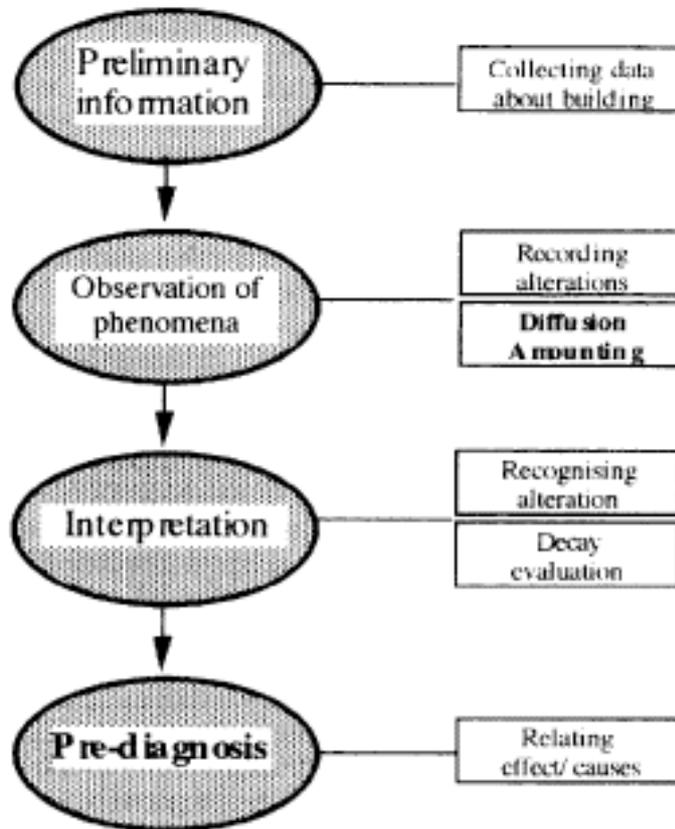
Fig.1 Pre-diagnosis knowledge process

Degradation analysis

In the rehabilitation sector, it is very difficult for the operators to choose among the actual methods for building decay analysis, because of their increasing number and variety. In various situations it could be not easy to select the appropriate methods as regard as the different goals. So it is necessary to review the traditional and innovative methods for building analysis in a systematic way, in order to create an interactive instrument for the orientation within building and its sub-systems.

Collecting data on conditions of degradation include various investigative fields, allowing the user to have a right knowledge about the construction and its components which come close to the situation that exists at the present time.

In the hypertext on building rehabilitation the information, survey and measurements describe typology, quantity and distribution of degradation and the obsolescence phenomena, related to spaces, materials and functions of the building. This analysis represents a basic point for diagnostic and intervention strategies. It is very important that the data on the conditions of degradation are available to the user starting from any point of the hypertext. Environmental, technological and structural fields are properly linked to the specific section devoted to investigate the conditions of degradation.

Consequently we have individualised three main groups of information about typologies of degradation which are:

- environmental degradation
- structural decay
- technological and service installations degradation.

On the basis of the information collected from this three groups, the user is able to know the conditions of degradation, diffused or localised. This kind of representing information is very useful for the user in order to elaborate hypotheses on the progression of phenomena and to verify these hypotheses in accordance with degenerative typology, receptive actions, and conditions of context.

The environmental degradation gives information about the compatibility between the building and the frequency of use of the inside spaces. The evaluation of the living conditions can be made using the micro-climatic data, when possible measured scientifically, but always elaborated in a simple form.

The section about technological and service installations contains information related to the decay of constructive components and installations in the building.

Into the analysis of the technological sub-system it is very important the phase of pre-diagnosis because it is not possible to make the instrumental measurements all over the building; so the pre-diagnosis analysis could have the role of selecting the zones useful as a significant sample of each case of degradation.

Particularly if we take in consideration the external walls, the system provides a methodology of visual analysis and a decay representation with a sort of map showing a grid scheme of different degradation phenomena, each one with its own percentage. This way to show the visible degradation phenomena, used in the pre-diagnosis phase, is based on direct observation "in situ" (at sight analysis) without using a complex equipment (Fig. 1). Phenomena are observed and listed by mean of the operator experience, but it may be very difficult to distinguish every phenomenon and to collect the probably cause to it, especially when the operator is not very experienced. So we have created a visible phenomena sets and theirs collected causes to make easier this task. Phenomena are grouped in seven classes easily recognised by their appearances (loss or increase of material, break of continuity, and so on) [3]. The phenomena sets and the related causes are showed in Fig.2.

According to this and other preliminary analysis, that we grouped under the name of pre-diagnosis, the architect may directly decide the best strategy to perform the building rehabilitation or, otherwise, he decides to carry out a precision diagnosis by scientific equipment, operating the right choice of diagnostic methods to avoid doing many unnecessary, expensive tests.
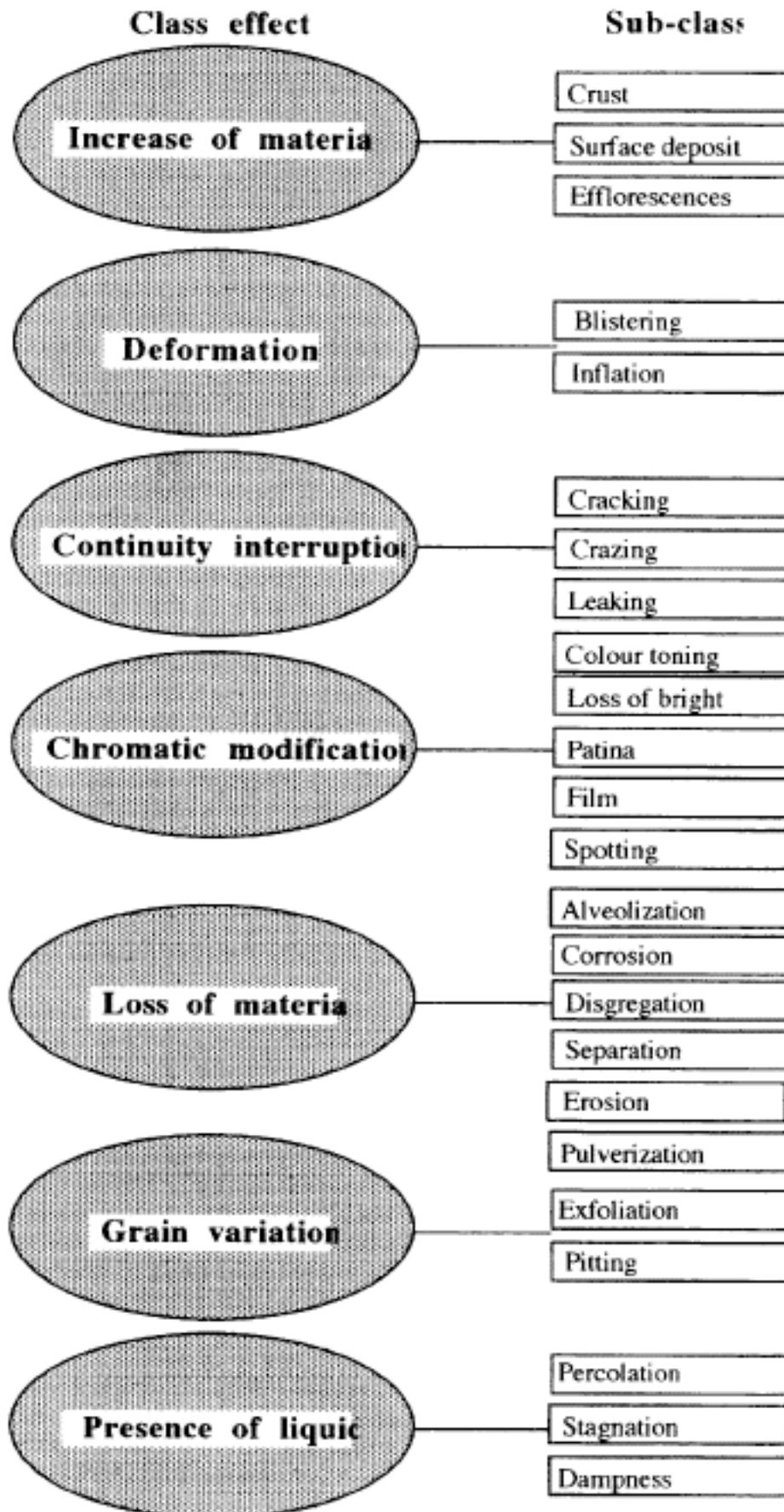
Class effect

Sub-class

Increase of material
- Crust
- Surface deposit
- Efflorescences

Deformation
- Blistering
- Inflation

Continuity interruption
- Cracking
- Crazing
- Leaking

Chromatic modification
- Colour toning
- Loss of bright
- Patina
- Film
- Spotting

Loss of material
- Alveolization
- Corrosion
- Disgregation
- Separation

Grain variation
- Erosion
- Pulverization
- Exfoliation
- Pitting

Presence of liquid
- Percolation
- Stagnation
- Dampness

Fig.2 Decay effects classification

In the last years we had the opportunity of testing with students some single sub-sections of the hypertext in order to verify how the system works with non specialised users. The methodology of visual analysis and decay representation of buildings specifically created for the hypertext was particularly useful in order to teach students the first approach to the complexity of building technology. Starting from this experiences we introduced this way to approach the problem at the first level of teaching building technology; we are now going to create a new hypertext devoted to the didactic analysis of buildings more simple than the monumental ones.

Precision diagnosis by scientific tests

The second part of the diagnostic section in the hypertext has been just created for collecting information about the use of scientific diagnosis's equipment and results. [4]. The storage of data is based on a library of more than 50 different kind of tests on building degradation and provides also a sort of methodology for the evaluation and selection of each test. The system also provide an iconic way to represent the phenomena and a method to extend the results of localised test to the entire building.

Another peculiarity of the system is that it allows the operators to look for information according to their specific needs. It considers the particular point of view of the architect: he is interested to the lack of performances relieved through the results of the test more than its usual scientific description. So each informative card shows which part of the building (named subsystem) is analysed by the test, which material or component is tested and which kind of output is get out.

It is important to outline that the collected data of building quality represents a fundamental step in the rehabilitation process; so we may define this phase of analysis a "knowledge project" [5]. This definition is almost accepted by the public administration that nowadays offers for tender both metric and diagnostic survey in building restoration. From this point of view the diagnostic survey is both a preliminary control and a work in progress check.

Beginning from these assertions we have listed the instrumental tests according to the subsequent parameters:

- representation of building as a system and its answer in terms of performances rule
- decay typology
- scientific references of the test
- difficulty of the test
- localisation of the test in the building
- output data description
- output data management

So we have realised an active and open file of the available tests for building rehabilitation; this list is a guide to choose the best method to analyse a specific constructive element in function of its specific decay. The system allow the architect to observe, first of all, the building and its parts than he could examine the level and quality of the diffused or localised decays in order to decide the design strategies. To help the architects in choosing the right tests and their localisation in the building, it is necessary to link every test to the single part of the building and to constructive materials. The next step is to give a simple way to manage and describe the output data according, to the goals of the rehabilitation project. So we offer a real support to the average operator who is not particularly expert in instrumental tests. The file in the hypertext is a database organised by cards in which the previous items are integrated with these ones:

-   equipment description
-   conditions of operation
-   technical rules reference

The conditions of operation is referred to the complexity of the analysis "in situ" and to the difficulties to take out samples from the building. The reference to the technical rules is necessary for the correct conditions of operations and for the validity of the measurements. Then this file could be associated to a list of certified Laboratories for Quality Control test responding to ISO 9000.

Organisation of the tests in the hypertext for Goldoni theatre

In the state of conservation section of the Goldoni theatre hypertext we had to collect the results of many different diagnostic tests and some computerised simulations of the behaviour of the building. In order to facilitate relationship among the single data collected and the access of these data from non expert users, we especially pointed on the subsequent main principles:

- comparison among different methods for similar tests;
- codification of a common language for different operators (laboratory engineers, geologist, architects);
- characterisation of a methodology for the description of the data, outlining the connection among the building elements, which have been tested, and the entire building;
- achievement of a diagnostic general idea of the decay formed relating the heterogeneous data collected, in order to describe the global behaviour of the building;
- opportunity of applying the results of a tests localised in single parts of the building to others elements of the system; it is possible only if these elements carry on the same task in the building.

Shortly, to give an appropriate answer to the problem of the management and description of the results of the test, we created special cards for collecting data that allow to localise the site of the test and to draw the results using synthetic representation. Moreover, this operation, made for every test, allows to compare pre-diagnosis observations with the result of the test.

In the hypertext for the Goldoni theatre the diagnostic phase is referred to the four inside environmental units (entrance, hall, stage, service rooms) whose total environment has been divided in [6]. The operative group in this phase decided to retrieve the relations among the tested elements of technological sub-system and the related inside environmental units. Tests have been divided in four classes relating to the collected data:

- tests on the inside environmental quality
- tests on constructive typology of elements
- tests on structural behaviour of the system
- tests on materials

The software employed allows us to acquire and compare text, graphics and tables, related to the test. Hyper textual links allow the users to build free knowledge paths in order to specific needs. We have also provided pre concerted paths related to the others fields implemented in the system, selecting for example survey or history of the theatre.

Into the textual description of every test we have included hot words which refer to detailed information, movies, graphics and everything can be used for diagnosis and than for correct choice of project.

The complex structure of the diagnostic tests implemented into the Goldoni hypertext couldn't be reduced to few images so I decided to invite the readers to use directly the system on the computer. Now I will say that actually very few students have just tested the system, so it is not possible to form a precise opinion of the problems that student could have in learning the building precision diagnosis methodology using this hypertext.

References

[1] The research group is financed by C.N.R. Progetto Finalizzato Edilizia and coordinated by lsabella Amirante with Ernesto Burattini; the searchers are: Antonio Bosco, Francesca Castagneto, Maria Rosaria Di Filippo, Alfonso Montuori, VandaRosa Savi.

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