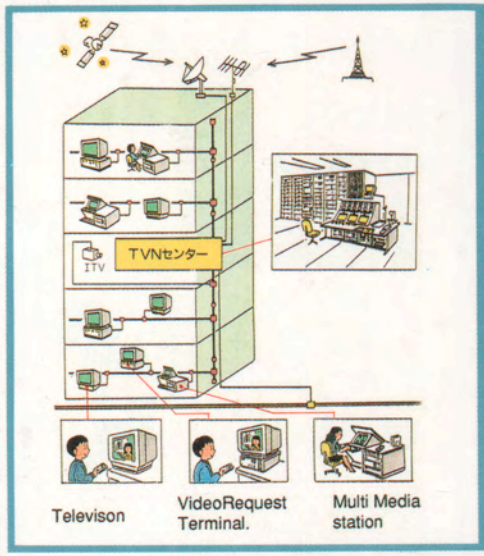
Information Technologies for Maintenance and Management of the Urban Building Stock

CNR
Italian National Research Council

ICITE
Central Institute for Building Technology



Edited by
Annalisa Morini

Information technologies for buildings in a changing society

Proceedings
Capri, October 1992

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INFORMATION TECHNOLOGIES FOR MAINTENANCE AND MANAGEMENT OF THE URBAN BUILDING STOCK

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Abstract

Information technologies and advanced software can be crucial for an appropriate maintenance and management of urban building stocks. The paper focuses on a building expert maintenance system, based on a Neural Network Pattern Associator Technique (NNPA), which associates the information on the building to be 'identified' with the information and data stored into a statistical building database module.

1. INTRODUCTION

Maintain comes from *manutenere* or *manu tenere*, lit. to hold in the hand, fr. manu (abl. of manus, hand) + tenere, to hold. It means to keep in a state of repair, efficiency or validity; preserve from failure or decline. Now, the maintenance activity is becoming more and more a softainance activity, from soft (contraction of software) + tenere, to hold, due to the large use of computerized system for assessing, forecasting and programming the building maintenance. We can identify three kinds of software based tools for building maintenance (softainance):

b. self evaluation tools for building degradation auditing

The purpose of self-evaluation tools and software is to assist the auditor in dealing with 'how' to initiate a building maintenance program. Checklists and rating scores assist in determining the type of corrective action required. Recommendations to improve any faulty conditions and cost analysis are generally included in this type of tools (Figure 1).

c. decision support systems for building maintenance through expert systems

In this area, the research activity has just started, and there are few examples of operational applications.
Most of the effort has been devoted to the development of 'expert' software on specific topics: i.e., selection of facade paintings, energy efficient building design, technical performances of roofs, etc. However, the area of expert systems for building maintenance is of strong interest for institutional building owners, private real estate corporations, insurance companies, public housing authorities, etc.; and major efforts in the future can be easily expected, as the one here presented.

2. BUILDING EXPERT MAINTENANCE SYSTEM

SEMPER is a demonstration program oriented towards the development of knowledge based software for maintenance audit of buildings.

SOFTECH is developing SEMPER under a three years contract with the Italian National Research Council Building Program.

The method of SEMPER consists of the full expression of a knowledge based recognition system of maintenance needs of buildings.

The current field of application of the demonstration software is the maintenance planning on residential housing stocks, but future developments of the database modules would permit different application fields to the software.

The tool operates to select Building Maintenance Opportunities (BMO) and to predict the effects due to candidate BMOs, in account of the 'experience' coming from the results of a high number of building audits stored in the system, which constitute the knowledge reference. The model can be considered a decision support system based on the 'experience'. Software implementation on DOS platforms, C language, Microsoft Access Windows as interface, can provide for the system the necessary evolution and future expansion.

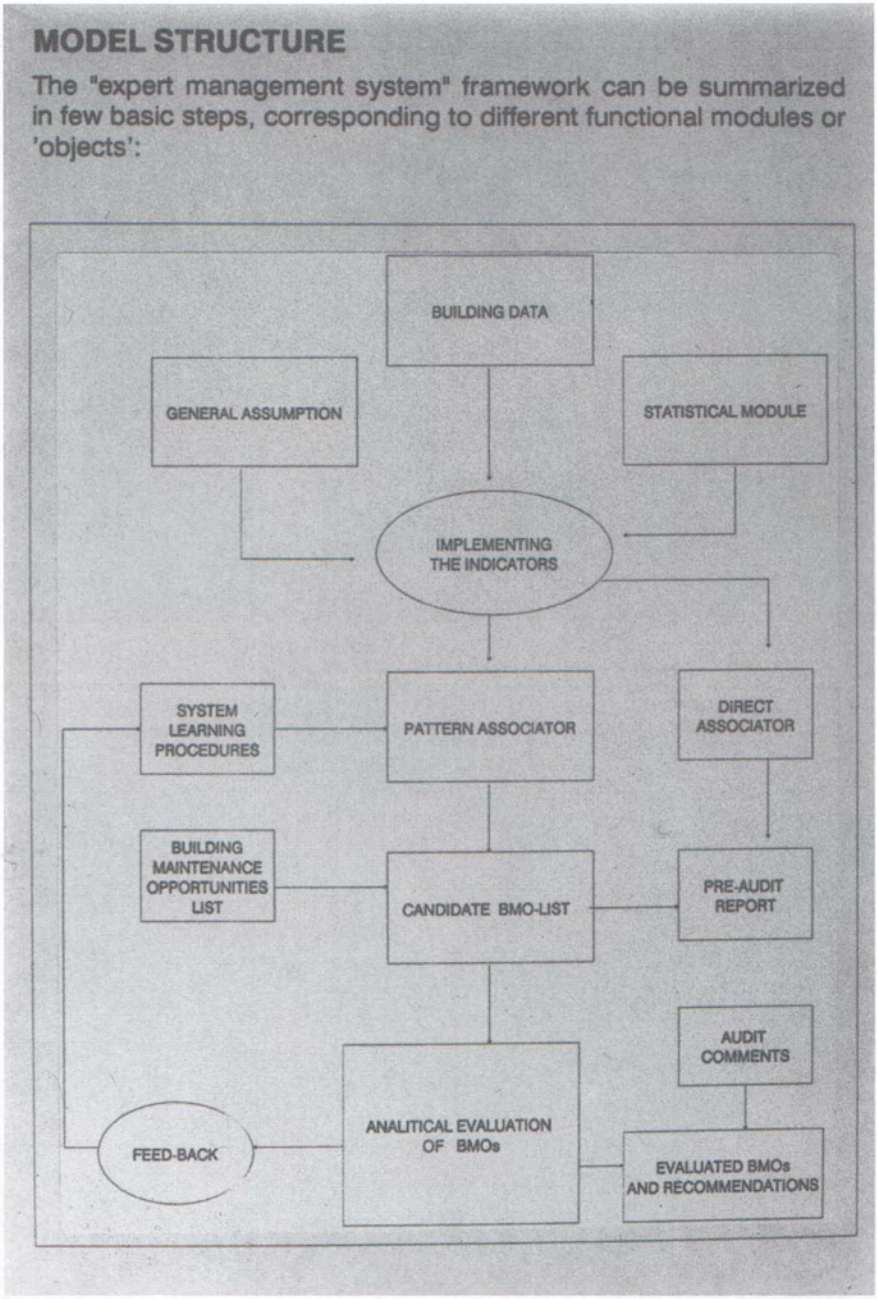

Figure 2. Structure of SEMPER model

maintenance opportunities forecasting (i.e. unitary consumptions, surface/volume ratios, etc.).

• Pattern associator
It is the 'core' of the model. It relies on a Neural Network Pattern Associator Technique (NNPA) which associates the information on the building to be 'identified' with the set of data stored into the building database (statistical module) (Figure 4).

SEMPER system uses a NNPA to guess plausible recommendations and an appropriate subset of Building Maintenance Opportunities that are very likely to be suitable for the case under investigation.

This guessing is drawn from the previous experience of similar audits.

• Direct associator
The model allows to enable the pattern associator, by inserting the type of association of the examined building with the set of buildings included in the statistical module.

• System learning procedures
It consists of an algorithm that re-calibrates the network of the association mechanism, between the examined building and the set of building data stored into the statistical module.

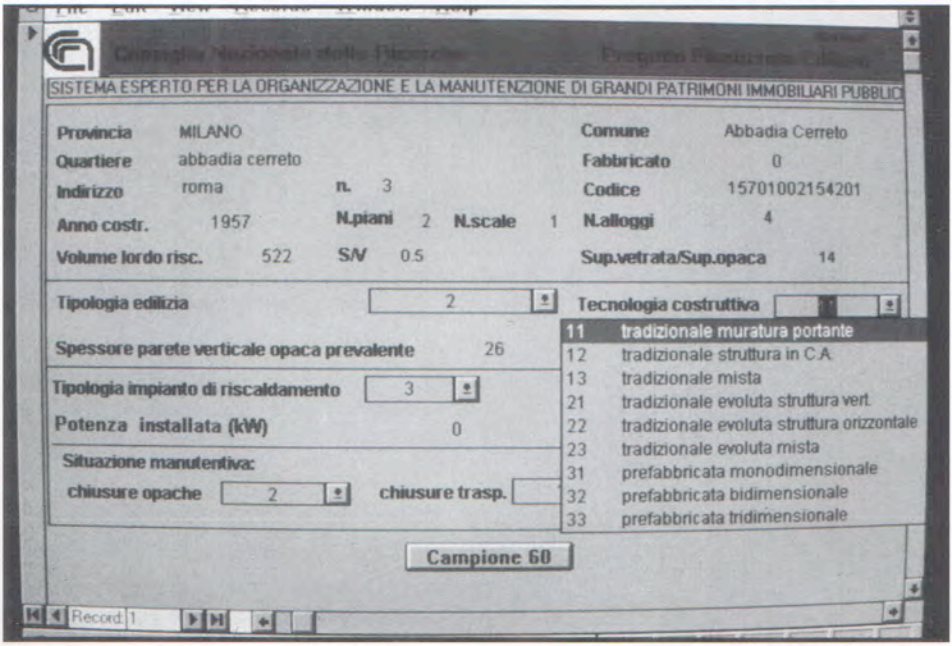

Figure 4. Building data: input data and information to be processed by the 'pattern associator'.

• System consult
A routine allows the auditor to access to an HELP module (Figure 6), which can be consulted at any step of the procedure. Once fully developed, the 'consult' module will contain the basic items of a source book for building maintenance, with the following framework:

- List of Retrofit technologies
- Audit Procedures
- Measurement Techniques

• Analytical evaluation of BMOs
This module provides basic assumptions, data sheets, and analytical procedures for the evaluation of Building Maintenance Opportunities. As a result, the procedures intend to give useful information for the design phase.

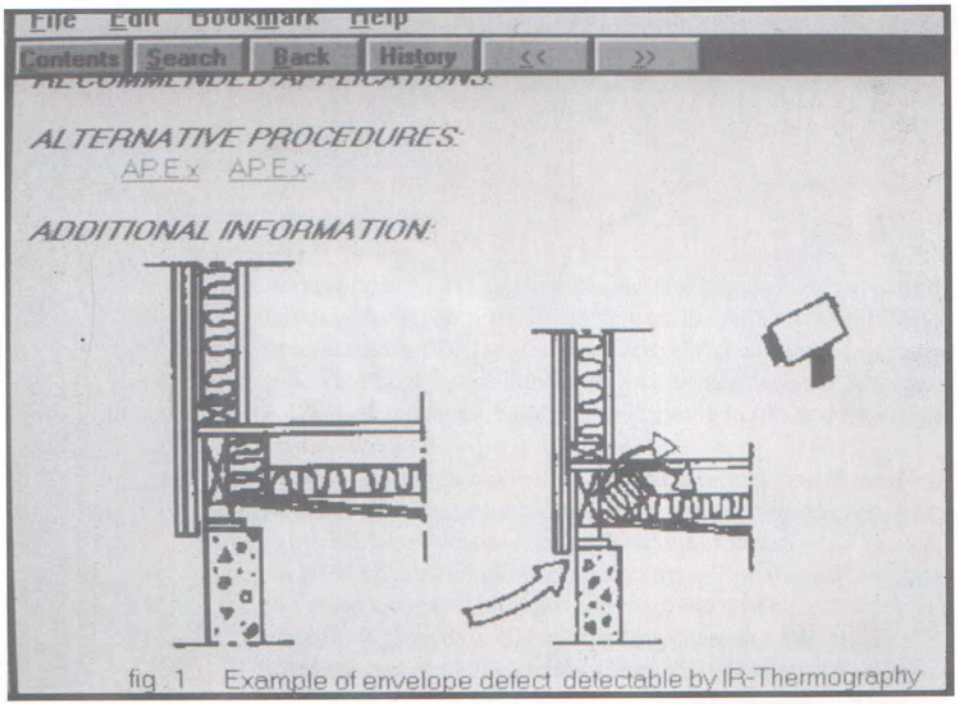

Figure 6. Example of help information in the 'consult' module

a. tools for managing the maintenance activities on large building stocks

They belong to the category of decisional support systems, which allow the management of building stocks, through effective and comprehensive databases. We are talking of conventional information systems devoted to management of maintenance activities and administrative data implemented with some interesting results by many public and private housing authorities.

SELF - EVALUATING CHECK LIST FOR : WINDOW

EVALUATOR

DATE

UNIT NAME

SHEET No.

			WINDOW CONDITION													
			Storms	Solar Protection	Tight Fit	Minor Infiltration	Major Infiltration	Cannot Be Opened	Can Be Opened	Weather Stripped						TOTAL POINTS
No.	Location	Dating Value														
		Max = 10	2	2	2	1	0	3	0	1						
1	Bldg. 4, Room 401		2			1			0	1						4
2	Bldg. 4, Room 402			2	2			3		1						8
3	Bldg. 4, Room 609					1			0	1						2
4	Bldg. 4, Room 102		2	2	2			3		1						10
5	Bldg. 4, Room 104,W1		2			1			0	1						4
6	Bldg. 4, Room 104, W2		2				0		0	1						3
7	Bldg. 4, Room 104, W3		2		2				0	1						5
25	GRAN TOTAL															36

$$\text{RATING SCORE} = 100 \times \frac{36}{(7)\ (10)} = 51\%$$

Figure 1. Example of self-evaluating method.

The model, once fully implemented, will operate in a quite innovative way. Instead of a conventional building auditing software, where data and information have to be fully gathered in order to predict maintenance opportunities, the expert management system acts with the same knowledge mechanism of a human expert, collecting only the information strictly needed to develop preliminary ideas, sort elementary conclusions and provide the subsequent request for information.

This is to reach, as soon as possible, the candidate list of Maintenance Opportunities, by minimizing the cost for getting the information.

The model is driven by a 'pattern associator', for examining the characters of the building and comparing this information with the set of data stored into the 'statistical module'.

3. MODEL STRUCTURE

The 'expert management system' framework can be summarized in a few basic steps, corresponding to different functional modules or 'objects' (Figure 2).

• Statistical module
It maintains the essential information on a sample building stock, (currently more than 100 buildings, in perspective 2000 bldgs of the Milan Low Cost Housing Authority), giving the basic knowledge to the pattern associator.

• Building data
Consists of input data and information on the new building (Figure 3a and 3b) which shall be evaluated by the 'pattern associator'.

The input information is classified in the following data sheets:

- general information
- main building characteristics
- geometry & typology
- technology
- degradation
- occupancy
- heating plant
- air conditioning
- hot water
- other plants
- energy bills

• Implementing the indicators
Using the preliminary information gathered in the building data module, the model develops some significant indicators, which allow the building classification and the

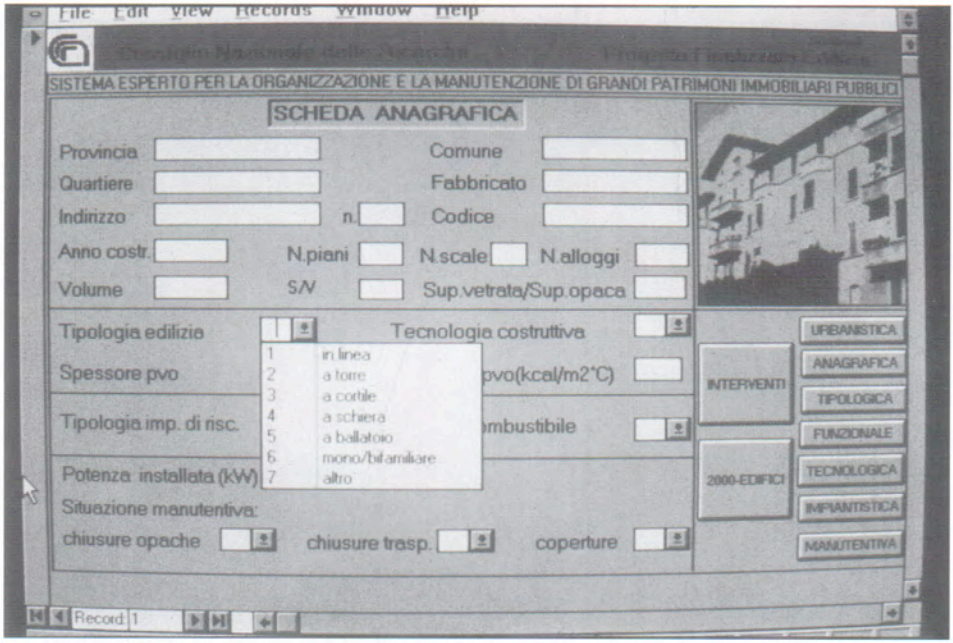

Figure 3a. Example of building information sheet included in the 'restricted' statistical module.

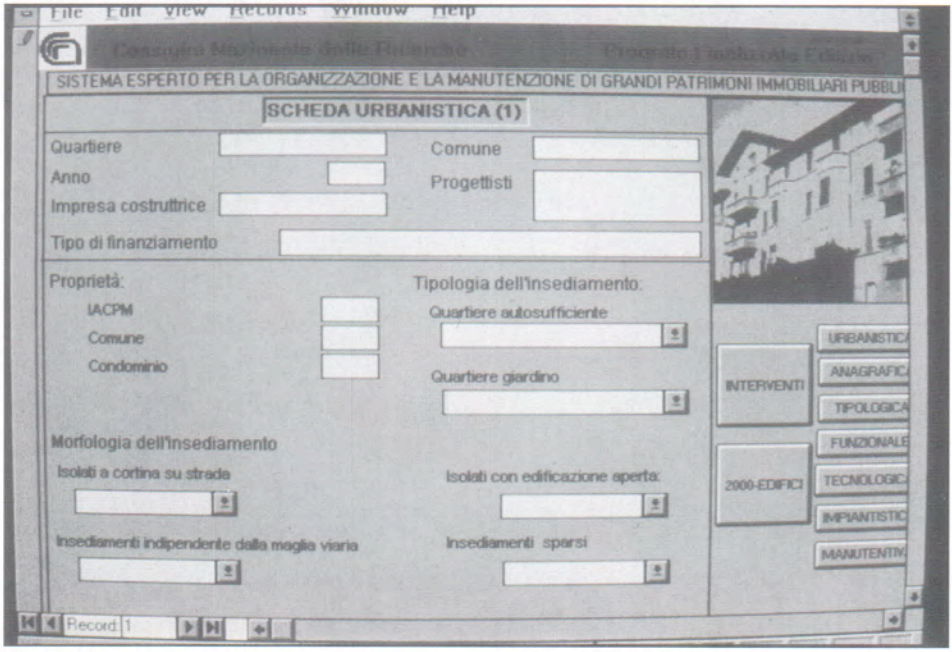

Figure 3b.

The use of a NNPA technique adjusts the quality of the guessing by a sort of statistically settled knowledge on what predicted previously on similar cases. This mechanism needs a 'Supervising Authority' to confirm that the association between the PreAudit information and the whole set of results for the examined building is a good and meaningful association.

A System Learning Procedures module will be provided for such adjustment. For now, this module is under study and not yet available on line: the learning procedures are carried out by the research team outside the SEMPER System, by means of a back-propagation algorithm on some test cases.

• List of Maintenance Opportunities

The pattern associator and the learning algorithm produce, as output, a list of candidated measures, that is the BMO list showing the best fit with the test case (Figure 5). The model allows the user to introduce the measures not included in the list of candidate BMO, when one knows the positive result of them, in order to let the model processing the new information within the learning algorithm.

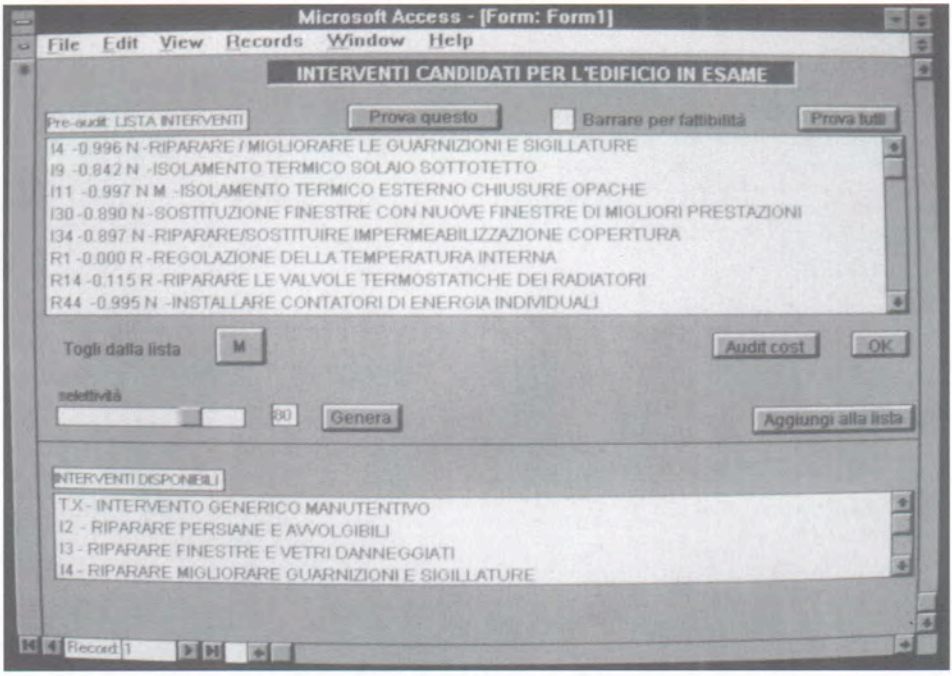

Figure 5. Candidate list of maintenance opportunities for a sample building.

• Preaudit report
Final output of SEMPER, consisting of the presentation of the list of candidate BMOs and related building quality improvements. Referring to planned maintenance operations, the key results listed in the preaudit report will be stored in order to select the maintenance actions to be implemented. A free digitable space for comments of the auditor is also available.

4. OUTCOMES

The procedures here presented are under development and the first release of SEMPER software will be available within the end of 1993. Some preliminary runs of the program and the learning mechanism allow the research team to be optimistic on the quality of processed information and results. Before the research and software completion, a major effort will be devoted to verify the possible application of the tool to interested building stock owners, as well as the future implementation of new modules concerning tertiary and commercial buildings.