CAD FOR THE ANALYTICAL DEFINITION OF RELIABILITY IN BUILDING PROCESSES

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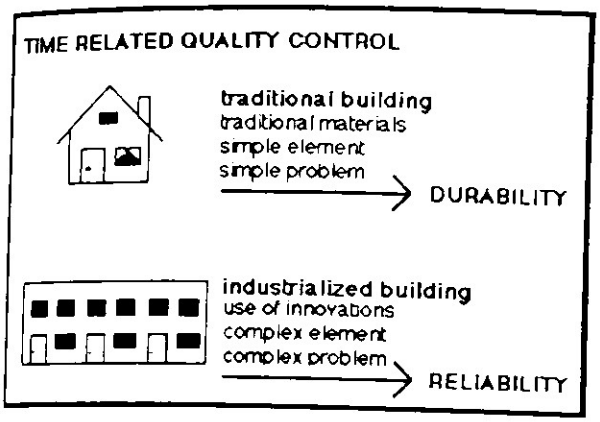


FIG.1 The increase in the complexity of construction involves the necessity to overcome the concept of durability and deal with reliability in order to obtain a quality control during the lifetime of a building. A study regarding reliability is therefore necessary in the design phase within the limits and possibilities of the building field.

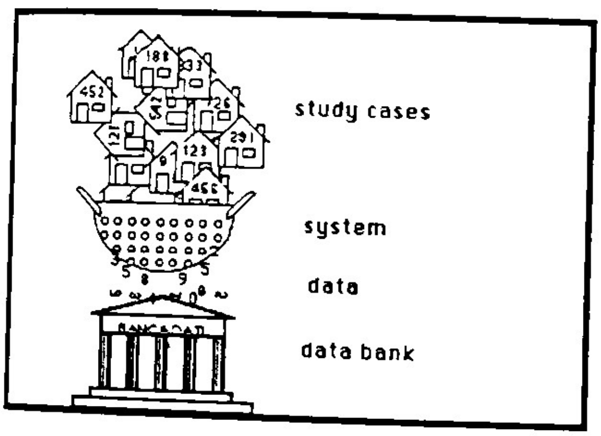


FIG.2 Until now quality control depended on the designer's experience which was able to foresee the duration of what had been conceived on the basis of traditional building concepts. With the introduction of technological innovations a wider analytical knowledge of the durability data has become necessary. The system studied deals with the problems of systematically obtaining and gathering data for defining the reliability of a building.

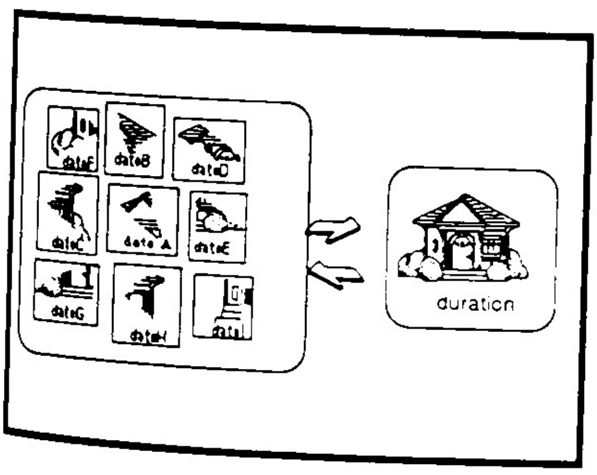
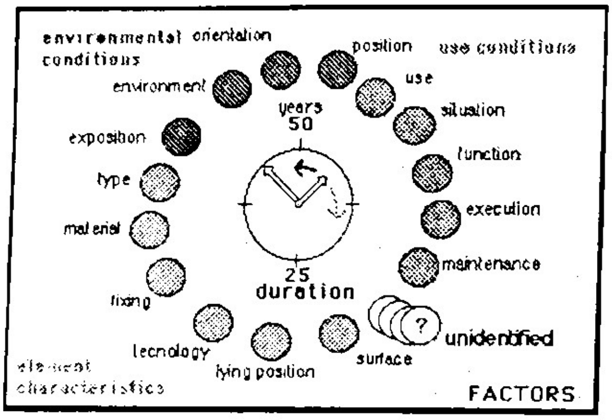
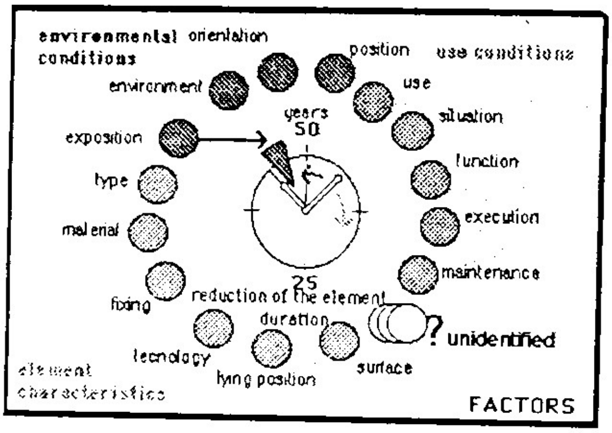
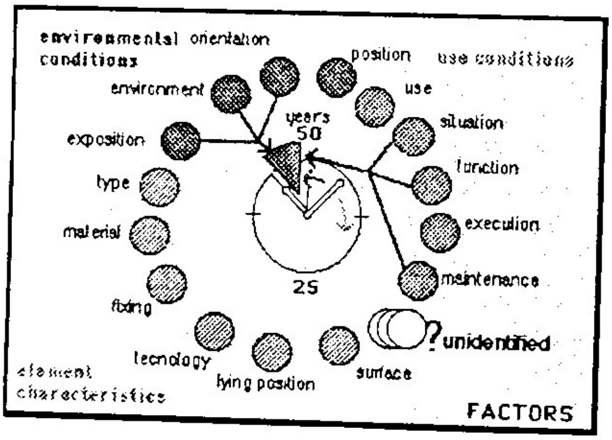


FIG.3 The system has been developed on the following three principal hypotheses in order to find a link between the data collected and the reliability of the components .
It is possible: - to relate the duration of a building to the factors which can identify the object itself in its environment and conditions of use, for example: - to synthetically express the effect of factors on duration by means of a corrective value of theoretic or observed duration; - to distribute the effect by corrective values which are assigned to co-factors identified in the study of each case.







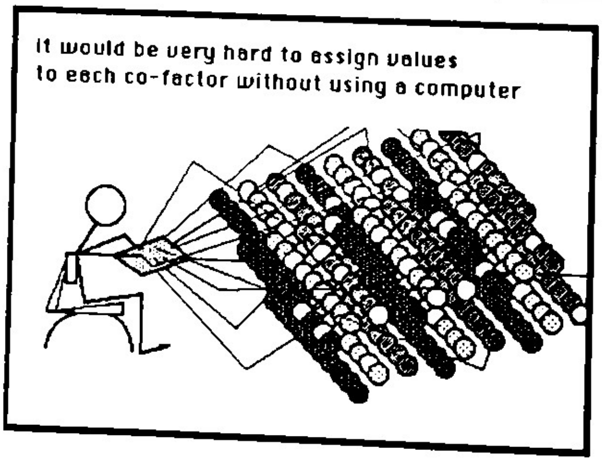
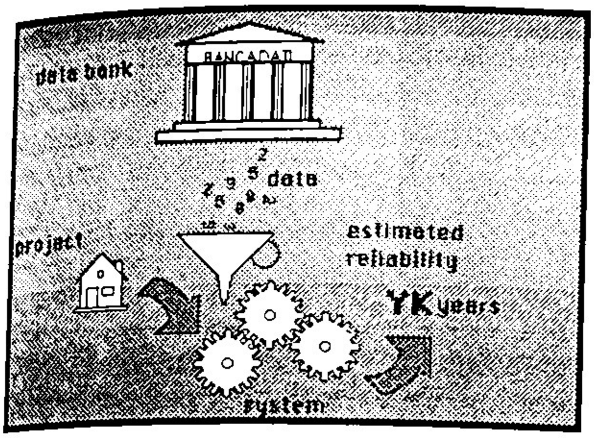


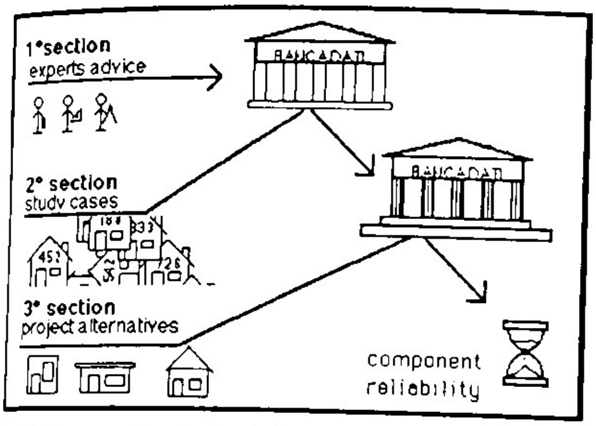
FIG.4 The theoretical formulation arises from the observation that the factors that influence the reliability of building are all different, some known and some unknown and others linked to the object or to the environment. Each of them can influence duration of the element and therefore they must be considered as causes of the phenomenon being studied.

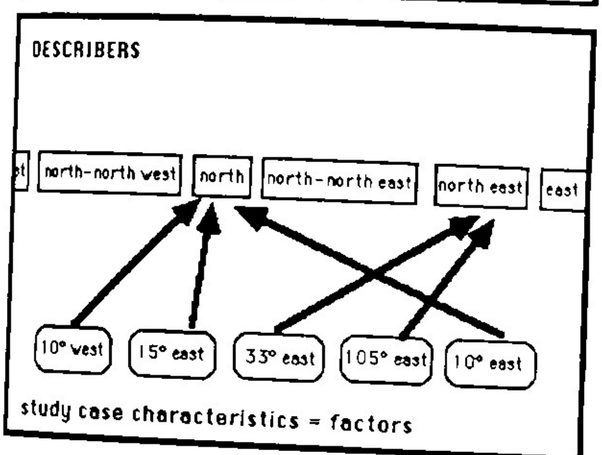
FIG.5 In order to connect the cause to the effect it is necessary to read the phenomenon in such a way so as to identify the cause which has influenced the duration in the particular conditions and evaluate its importance. In the same way it is necessary to recognize the causes which have not influenced the duration of the object being analyzed.

FIG.6 It is known that the shortening of duration cannot be assigned to a single cause but to various interacting causes. It follows that the number of evaluation equal to the number of factors considered will not be sufficent, but it will rather be the number of a series of possible combinations.

FIG.7 Supposing that all the combinations could be considered , for each case a considerable number of evaluations had to be carried out which consequently invalved a lot of work. In the same way when the collected data is used a long period of research would be necessary both on the data and the way of using them.







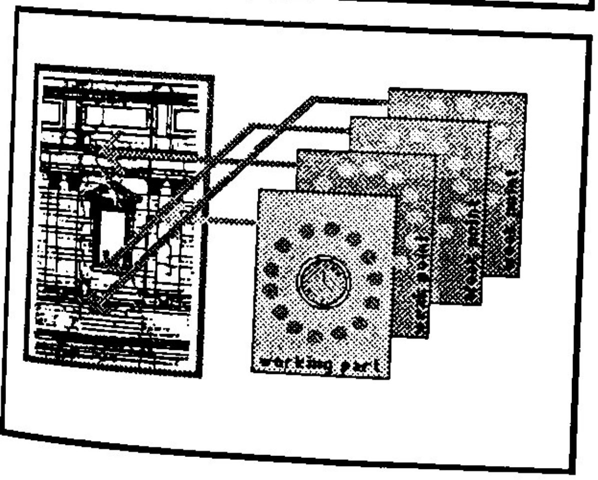


FIG.8 For this a system was studied that permits a computerized analysis of the cases studied, as well as a systematic collection and updating of the data and a pratical and simple procedure of utilization.

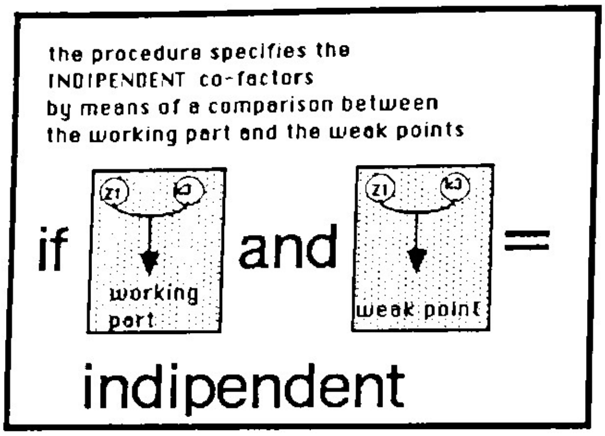
FIG.9 The system is composed of three sections.

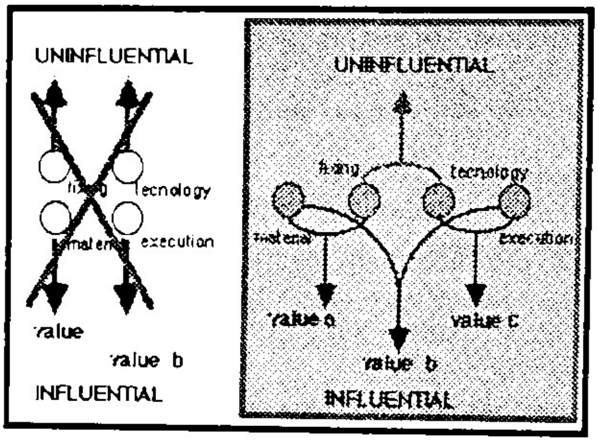
The first section, regarding the creation of the initial model, permits the rapid production of a data bank by means of expert experience, laboratory tests, ect. The second section, which regards the analysis of the cases, stores the corrective values in the data bank. The third section which is conceived to be used in the design phase of the project, calculates the reliability of the building component or element described .

FIG.10 The building model is the first step necessary for each component studied.The model is built on the definition of:

- the *categories* of all the co-factors studied
- for each category, of the *describers* which are codes that make it possible to return to the actual situation.

FIG.11 The collection of data is accomplished by means of the analysis of the cases studied according to the rules of reliability. The observations on the building element will be carried out both on the*working parts* and the *weak points*, which are described using the chosen codes, and collecting the duration values obtained. The data from each study case will be elaborated together at the same time.





After a SURVEY it will be possible to calculate:

Co-factors AB x Co-factors AC x Co-factors AD x Co-factors AE x ....x Co-factors WX x Co-factors WZ = = observed duration : theoretical duration

On a new PROJECT it will be possible to calculate:

Probable reliability = theoretical duration x Co-factors AB x Co-factors AC x Co-factors AD x Co-factors AE x ....x Co-factors WX x Co-factors WZ

FIG.12 The reason for this elaboration is the comparison that the system effects in order to verify whether or not the co-factors influence duration. In fact, if the combination of certain co-factors is present both in the *working parts* and *weak points*, then it would be considered non-influential.

FIG.13 The basic principle of the system which is to consider the data connected with pairs of the co-factors ; renders it possible to mantain an ideal relationship among the data of the cases studied.
It follows that, even if a certain datum is absent in the bank because it is connected to a non-influential pair of *describers*, it can be equally recollected through the evaluation of the data of influential *describers* .

FIG.14 The data are considered as corrective values of a theoretical duration of the examined components. For this reason and for each study case we try to attribute a group of values to all the pairs of co-factors that describe the case, so that is possible to calcolate the theoretical duration to that observed in actual situations.
In a forecast data management, the values stored in the bank which correspond to *describers* of the design solution, are used to relate the theoretical duration to its probable requested value for the conceived design hypothesis.

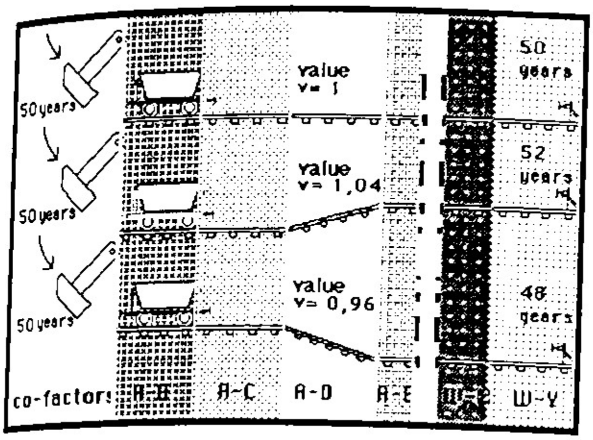
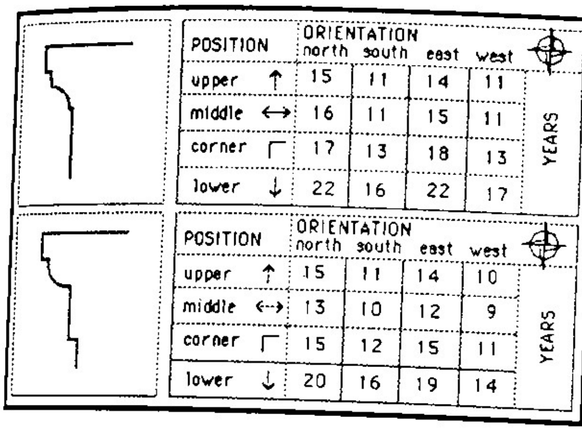


FIG.15 If we want to visualize the relation between the reliability of a component and the data collected to calculate it, we could imagine a trolley which, driven by an impulse (the theoretical duration), covers an area defined by sections of tracks that correspond to the values of the data assigned to the co-factors.
The rail track on a level ground does not influence the period of time to cover the distance and, therefore, represents the non-influential co-factors to which a value equal to 1 can be attributed . On the contrary the downhill track reduces the time and corresponds to co-factors with values inferior to 1. The uphill track increases the expected time and corresponds to co-factors with values which are superior to 1.



POSITION	ORIENTATION north	south	east	west	
upper ↑	15	11	14	11	YEARS
middle ↔	16	11	15	11	
corner ┌	17	13	18	13	
lower ↓	22	16	22	17	

POSITION	ORIENTATION north	south	east	west	
upper ↑	15	11	14	10	YEARS
middle ↔	13	10	12	9	
corner ┌	15	12	15	11	
lower ↓	20	16	19	14	

FIG.16 On the basis of the collected data we accomplished a normal application of the system on an architectural element: the building eaves of a masonry construction.
In varying the different situations according to the *Orientation* and the *Situation* of categories of describers we obtained the evaluation in years of the reliability of eaves .

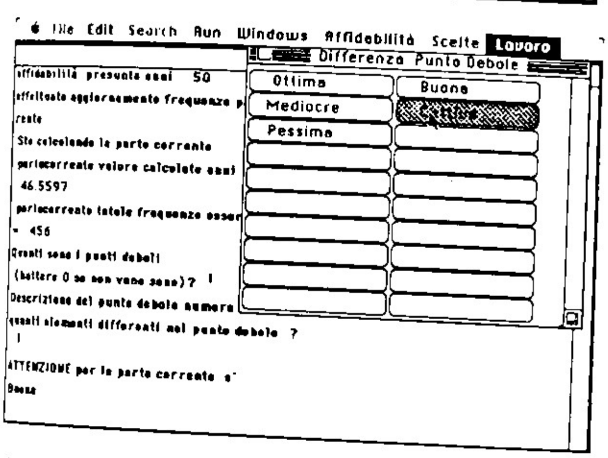


FIG.17 The system has been developed on a MacIntosh Computer exploiting the friendly interface with interactive window procedures and buttons.

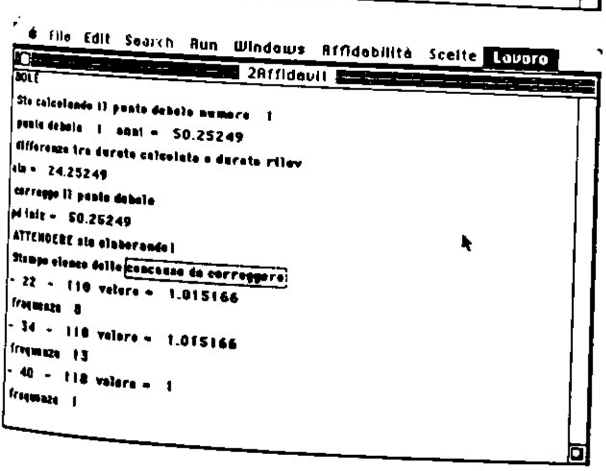


FIG.18 The data input has been simplified by index cards that can collect the necessary information from the system according to its established rules.

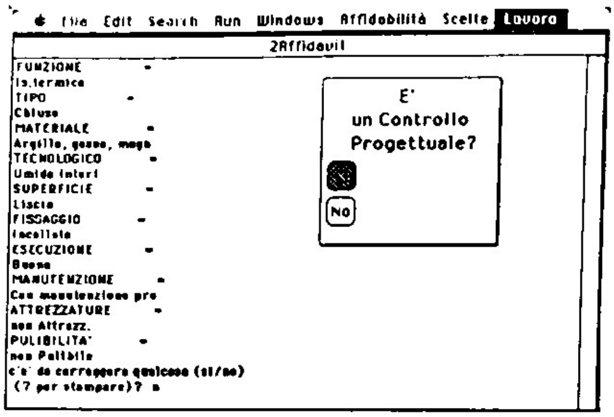


FIG.19 In the design phase the system elaborates its own reliability evaluation specifying identifying the danger that certain choices could produce on the solution.

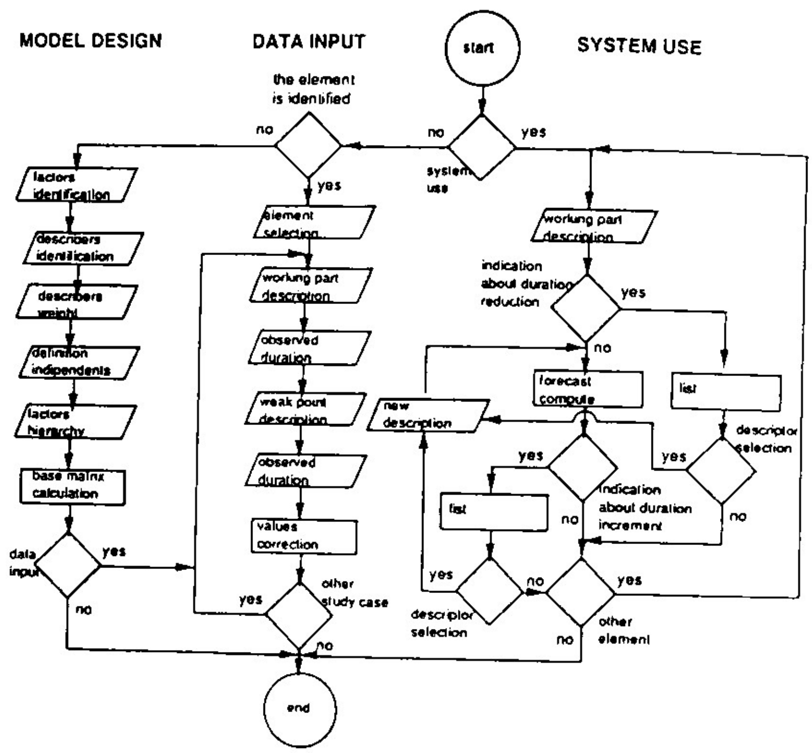


FIG. 20 The system flowchart shows the substantial independence of the three sections as their links are present only at the extremes of the elaboration procedure. The use of the system allows the designer to obtain information about his project choices. After having described the *working parts* of one particular project the system recollects in its bank the data concerning similar solutions and elaborates the reliability forecast.
If the system should indicate duration reduction the user is able to point out which *describer* variations and determine the probable *weak points*. In the same way an indication regarding duration increment research allows the designer to point out the *describer* variations that cause a reliability increment. This survey can be achieved by the research of alternatives with contemporary changes in one or more categories.