# INTEGRAL TREATMENT SYSTEM FOR CONSTRUCTION ELEMENTS. SITEC PROJECT. CLASSIFICATION STRUCTURE

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## ABSTRACT

The paper explains the way of structuring the information within the SITEC project. The model developed within these project studies the horizontal and vertical relationships and proposes a solution. The inner structure of the model is composed by attributes and clauses and the information is generated when it is needed avoiding the storage in the system. A retrieval system has been implemented in order to handle the information.

**KEYWORDS.** Classification structure. Databases. Generation. Attributes. Clauses. Reference model. Graphic representation.

## 0. INTRODUCTION

All construction processes have to create, classify, exchange and handle the information describing the process. This information has several levels of complexity in very different formats. Thus the need for a model and a classification structure of the information at any level has become obvious.

In order to answer this demand, ITEC started the SITEC project in June 1987 (Integral Treatment System for Construction Elements) based on its experience of ten years' work in the setting up and maintenance of the structurated database for construction elements, with the aim of making it the reference model in our country for the information needed to define a construction element at any level of complexity and in any type of representation.

In this paper one essential part of the SITEC project will be described: the classification structure of the information in the SITEC project.

## 1.BASIC CONCEPTS OF THE MODEL

An in-depth analysis of the construction field (architecture and civil engineering) has enabled to develop a conceptual model for handling and managing all the information necessary to undertake a construction project.

The information must be structured in such a way that it can be accessed anywhere and in any way.

The relationships generated in a project have two principal directions: Vertical relationships (TOP-DOWN, DOWN-TOP) and horizontal relationships (GENERAL-SPECIFIC).

### 1.1 VERTICAL RELATIONSHIPS

The vertical relationships are set up between the elements with a different level of complexity, for instance, the relationship between the construction detail with its components and the further relationship with their respective subcomponents and so on.

This relationship is hierarchic and may be defined by the words "is composed of".

There are two different approaches to studying the vertical relationships, the TOP-DOWN and the DOWN-TOP approaches. They both complement each other instead of excluding each other as some believe. The TOP-DOWN approach is the one most commonly used among researchers. It emphasizes more the design aspects and the main goal is to break down a global project into smaller items until the smallest element in the project is reached.

The problem arises when we descend the vertical graph (see figure 1). Here the combinatory increases making the problem very hard to work with, and it stops at a certain level of complexity.

The DOWN-TOP approach stresses the means and it builds everything from the bottom, based on the means, thus reducing the problem to a combinatory of elements. The problem arises when design concepts must be added to the model and the combinatory cannot provide a solution for this.

The SITEC project has studied the problem in both approachesand has developed an integrated model for both. The basic premise has been to consider the starting points of both approaches, (work and means) as finite sets that can be defined. Then it could be affirmed that the problem lay at the intermediate levels where the possibilities are infinite.

The integration of both approaches has given as a result the SITEC model shown in figure 1. The seven levels are as follows:

MEAN/ SIMPLE ELEMENTS: The smallest element with no further breakdown for instance,labour, materials and machinery.

COMPOSITE ELEMENTS: The element obtained through the manipulations of the means but not yet in place on the worksite -for instance, the mortar mixed on the worksite.

TECHNICAL UNIT: The element obtained through the manipulation of the means and composite elements. This manipulation is carried out by a specialist labour squad and is sited in its proper location- for instance, a brick wall placed with mortar, a concrete block, etc.

CONSTRUCTION DETAIL: The element obtained from the combination of technical units in order to solve a specific construction problem. For instance, the eaves of the roof, the hip head of the same roof, the windowsill, etc.

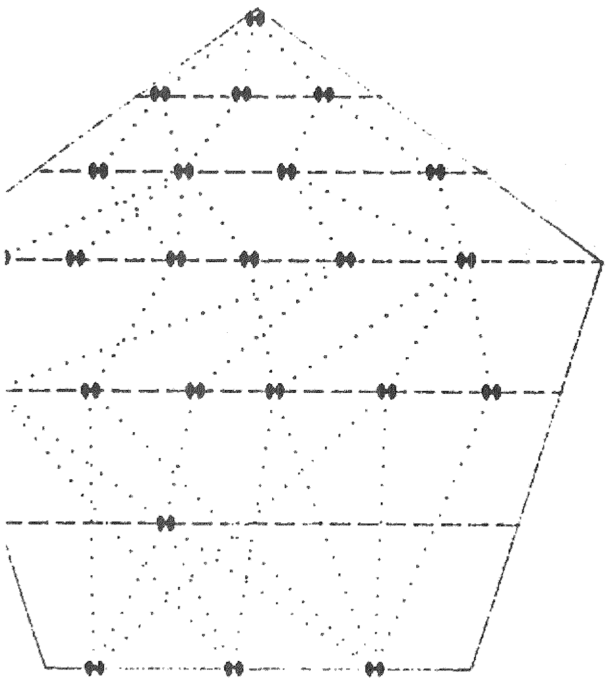
CONSTRUCTION SOLUTION: The element obtained through the combination of construction details in order to solve a specific construction typology -for instance, a tile roof, a slate roof, etc.

SUBSYSTEM: The element obtained from the combinations of construction solutions with the same functional use -for instance, the roofs of a building, the structure, etc.

WORK: The element that provides the answer to a whole program of requirements in the construction sector- for instance, a single dwelling, a road, etc

The SITEC project makes a TOP-DOWN approach in the WORK -- CONST. DETAIL direction and a DOWN-TOP approach in the MEAN --- CONST. DETAIL direction. The construction detail has been chosen as the interchange level because it is where the exchange takes place, between the construction know-how and the existing data, that is, the KNOWLEDGE-DATA EXCHANGE.

# VERTICAL GRAF



WORK

SUBSYSTEM

CONSTRUCTIVE SOLUTION

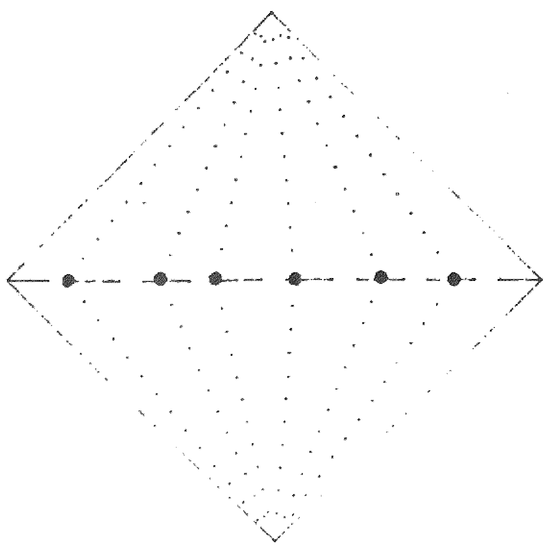
CONSTRUCTIVE DETAIL

TECHNICAL UNIT

COMPOSITE ELEMENT

MEAN/SIMPLE ELEMENT

# HORIZONTAL TREE



GENERIC ELEMENT

OPEN ELEMENT

SPECIFIC ELEMENT

## 1.2 HORIZONTAL RELATIONSHIPS

The elements of the SITEC project described in the previous paragraph are merely a set of variables with a range of variation for their values. Thus, each construction element defined has in reality, three different levels of abstraction, which suposses the existence of horizontal relationships.

The horizontal relationships enables us to define the structure completely on a specific level (See figure 2). The three horizontal levels are as follows:

GENERIC ELEMENT: This is the totally parametric representation of a set of elements with similar characteristics termed "family".

OPEN ELEMENT: This is the result of giving specific values to certain variables that define the family, without specifying all the variables and therefore without closing the element. This is termed "subfamily".

SPECIFIC ELEMENT: This is the result of expressing the specific values of all the variables of the family, thus defining the element completely.

Both types of relationships, horizontal and vertical close the conceptual model and they are the basis for developing the internal structure explained in the next paragraph.

## 2.STRUCTURE OF THE INFORMATION

The information contained in the SITEC project is composed of two different types of data:

- Attributes
- Clauses

### 2.1 ATTRIBUTES

The attributes are the properties required in order to define an element. The attributes have a name to identify them, a type of value and a range of possible values.

The code of the element is a particular example of an attribute, such as the measurement unit, the price, the date of input to the bank. In the same way, subjective attributes, such as the frequency of use of the element in the work, can be used.

Conditions or rules of existence expressing linking conditions between two attributes (interdependent attributes) can be defined. By using these rules of existence, the specific elements can be obtained from the generic element. These rules can be defined by specific conditioning factors related to the construction process of the element, with possible market alterations or with the introduction of new technologies.

One very important classification of the attributes within the bank is the following:

-Attributes without graphic representation.

-Attributes with graphic representation.

The second group form a whole subproject within the SITEC project called SITEC:graf. This is the tool for handling the graphic attributes in order to obtain the graphic display of the element in the same way the alphanumerical atributes are handled in order to obtain a price or a specification. One important concept in the SITEC projects to consider the database as a whole without differentiating between alphanumerical and graphic databases, because the information is the same, the only thing that changes being the representation.

## 2.2 CLAUSES

A clause is a sentence formed from the union of the attributes of the construction elements, and semantic particles, such as articles, prepositions and so on, in order to make the sentence meaningful and coherent. The clause permits the transfer of the information stored in the database in a format that can be read and understood by the user.

Three types of clauses can be distinguished (See Figures 3,4,5):

GENERIC CLAUSE: The variables defined in the element are expressed by the name, without any substitution in the variables for a specific value.

OPEN CLAUSE: Some, but not all, of the variables have been replaced by specific values.

CLOSED CLAUSE: There are no variables to define and the properties are all specified.

MENTS SIMPLES

ESTRES I BALCONERES DE FUSTA TIPUS 3

estra de fusta tipus 3, per a col.locar sobre l'obra, de qualitat 3 <FULL> fulla(es) <FB>__, per a un buit d'obra de <A>_X<B>_ cm, classe (S.C.) , amb bastiemnt DT <GALZE> galze per a guia

eu: <PREU>____ PTA/U

ɪdi element: <ID.ELE>

Char Mode: Replace Page 1 Count: *0

======== EA33 ========

estra de fusta tipus 3, col.locada sobre l'obra, de qualitat 3 amb _ fulla(es) fixa__, per a un buit d'obra de 60_X90_ cm, classe A0 C.), amb bastiment DT sense galze per a guia

| | | | | |
|---|---|---|---|---|
| 12A000 | Oficial 1A fuster | .65_____ | H | X 1081______ |
| 13A000 | Ajudant de fuster | .15_____ | H | X 1003______ |
| 331693 | Finestra de fusta ... | 1.000 | U | X 3182______ |
| ZG1360 | Ferramenta per a finestra ... | 1.000 | U | X 852______ |

Total Partida: 4887.1 PTA/U

Char Mode: Replace Page 2 Count: 1

| FULL | FB | A | B | GALZE | ID_ELE | PREU |
|---|---|---|---|---|---|---|
| una | fixa | 60 | 90 | sense | BA331693 | 3182 |
| una | fixa | 60 | 90 | amb | BA331695 | 3977 |
| una | batent | 60 | 60 | sense | BA336663 | 2893 |
| una | fixa | 90 | 90 | sense | BA336693 | 3182 |
| una | batent | 60 | 90 | amb | BA336695 | 3977 |
| una | batent | 60 | 120 | sense | BA3366C3 | 3970 |
| una | batent | 60 | 120 | amb | BA3366C5 | 4701 |
| una | batent | 80 | 90 | sense | BA336893 | 3824 |
| una | batent | 80 | 90 | amb | BA336895 | 4592 |
| una | batent | 80 | 120 | sense | BA3368C3 | 4330 |
| una | batent | 80 | 120 | amb | BA3368C5 | 5202 |

| FULL | FB | A | B | GALZE | ID_ELE | PREU |
|---|---|---|---|---|---|---|
| una | batent | 80 | 150 | sense | BA3368F3 | 4802 |
| una | batent | 80 | 150 | amb | BA3368F5 | 5705 |
| una | batent | 90 | 90 | sense | BA336993 | 3932 |
| una | batent | 90 | 90 | amb | BA336995 | 4782 |
| una | batent | 90 | 120 | sense | BA3369C3 | 4881 |
| una | batent | 90 | 120 | amb | BA3369C5 | 5418 |
| una | batent | 90 | 150 | sense | BA3369F3 | 4949 |
| una | batent | 90 | 150 | amb | BA3369F5 | 5876 |
| dues | batent | 120 | 90 | sense | BA337C93 | 5611 |
| dues | batent | 120 | 90 | amb | BA337C95 | 6509 |
| dues | batent | 35 | 35 | amb | BA33$001 | 4000 |

| FULL | FB | A | B | GALZE | ID_ELE | PREU |
|---|---|---|---|---|---|---|
| una | fixa | 110 | 45 | amb | BA33$003 | 8000 |
| dues | batent | 34 | 67 | amb | BA33$009 | 5767 |
| una | batent | 37 | 149 | amb | BA33$010 | 3456 |
| una | batent | 120 | 100 | amb | BA334444 | 2500 |

26 records selected.

An example of a generic clause of description for a family in the bank could be:

WALL OF <width> CM WIDE AND MAXIMUM <height> M HIGH, OF DRILLED BLOCK (smooth ! rough) OF <a>x<b>x<c> CM OF <colour> CEMENT MORTAR (to coat ! as built) PLACED WITH MORTAR <type_of_mortar> [and marble sand].

< > represents a variable with a certain value to be defined.
(option1 ! option2) variable with two options

[optative] the variable may or may not exist or not in the clause.

These clauses have a range of application depending on the vertical level where they are and their situation on the horizontal tree.

There are different types of clauses according to the data they represent, some examples being:

Description of the element. Conditions of reception of the element. Conditions of the construction process. Measurement criteria. Maintenance and upkeep operations, etc.

## 3. ACCESS SYSTEMS

This whole structure would not make any sense if there did not exist an access system to this information in order to retrieve it and send it to other more specialized software, such as structural calculations or cost estimations.

The access system designed by ITEC is based on the use of keywords which reduce the code to an inner tool of the software and avoid the need to learn numbers without any real meaning. In this access system -called Thesaurus- the user introduces the data with the concepts he is thinking of using the basic words he needs to find the element.

Once the keywords have been input, the software transforms them into a generic code and leads the user into the database to the area where he can find the element he is searching for. The options are displayed and he can make his choice by closing the element. Then the software retrieves the data linked with the element and transfers the information to the other parts of the system.

This process is fast, user friendly and very interactive and the user is able to control his search as well as the results, thus avoiding the use of manual translators with a large time delay.

## 4. CONCLUSIONS

The model outlined displays certain advantages:

The first advantage is the integration of the alphanumerical and graphical databases as well as the knowledge bases in the same storage and access structure. With a proper Database Management System (the system is being implemented on ORACLE) it is possible to centralize the information and to retrieve it for specificic jobs in specialized workstations.

A second advantage is the oportunity for the model to grow without a functional redesigning, because the structure permits the introduction of new data with the current rules of generation. In the same way it is possible to divide it into smaller parts for a specific function. One example is the subset formed with the graphic database composed of the attributes with a graphic representation.

The third advantage is the lack of hierarchy in the variables with no priorities in advance. Thus, the designer can establish his own priorities in each project and therefore the model allows the user the freedom to establish these criteria.

Another advantage is the integration of the knowledge bases from the TOP-DOWN processes with the databases from the DOWN-TOP.

As a final conclusion this is a tool to make the data exchange between the users easier and faster as is proven by the fact that a subset of the model has been chosen to become the integration model for the construction projects to be carried out in Barcelona to build the Olympic Village for the Olympic Games to be held in Barcelona in 1992.