

# The Architectural Envelope: an Assistant for Components Design Choices

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*The global envelope to day focuses on it a lot of attention from architects, progressively replacing the classical concepts of wall and roof. It is a complex component, entrusted with the delicate goal of mediating between exterior and interior space, between a space boundary and a bearing structure. Its main parts are the glass wall, a substructure resisting the loads and transmitting them to the bearing structure, and the connection of the two. The latter, in turn, comprises a fitting and a bracket. The set of relationships between these components and sub-components needs the control of many conditions of consistency. The tool presented is an Assistant performing just this task helping the designer to select in each project situation the best couple of two main envelope components: fitting and bracket. The Assistant structure lends itself to implement an intelligent commercial product catalog. It seems also fit to manage component selections strongly conditioned by consistency constrains between collaborating elements.*

**Keywords:** *Design Assistant, envelope, product selection.*

## Introduction

The actual architectural trend has induced a substantial mutation of role and meaning of the building envelope. The reassuring certitudes of wall and roof have given place to a building element whose construction entails taking into consideration many different aspects, sometimes requiring inconsistent decisions. The envelope, with its strong communication capability, is certainly one of the main concerns of architects.

The absence of a prevailing „architectural language“ leads to a multiplicity of envelope shapes and, consequently, to a corresponding multiplicity of technical solutions.

Nevertheless, in administrative, office and bureau buildings a glass plane façade both in its simple and double skin version is much frequent. In spite of their apparent flushness glass walls are rather complex building elements, comprising many sub-elements that have to match exactly. Its technology has to cope with many design problems. The often adopted double curvature shape imposes particular ad hoc structural solutions both when the envelope maintains its skin nature and when its surface receives structural or service components. Multiple comfort performances requested from it transform the envelope in a sophisticated environmental

machine. The envelope design needs to cope with the complex net of relationships linking its subsystem components to the other technological subsystems; hence it becomes a paradigm of a general design methodology. When the involved components are numerous the number of possible relationships grows exponentially and having resort to automated aids in order to master them becomes necessary. Design becomes a dialectic activity between the possibility of adopting tested solutions and innovating them for a better adaptation to a new project occurrence. As for each component many solutions are possible, each of them modifies the nets of relationships linking and limiting the reciprocal compatibility of the subsystem's elements. Innovation is valuable if it establishes a new net of consistence „isomorphic“ with the existing ones involving the remaining unmodified elements.

This paper presents a tool thought as an advising Assistant in selecting designing a component, that is crucial in a structural glass façade: the connection of the glass panels to the stiffening substructure or directly to the structure. In order to be efficient the tool has to manage the consistency of the relationships between the component parts at the next levels of aggregation.

### **The Assistant structure**

A database and its search engine should be conceived and implemented in the same time. Specifications of data in the database should go on as far as it is necessary for corresponding to the specificities of the design situations. Retrieval tools should be able to translate the design knowledge necessities into intelligent queries, leading to the best possible answers (Chiu and Lan, 2003; Colajanni, Pellitteri and Concialdi, 2000).

The Assistant manages three databases: the fittings, the brackets and the glass walls.

Fittings and brackets are a particularly delicate component. They have to guarantee the consistency

of many design parameters, in turn depending on the glass from one side, on the substructure from the other. Fittings hook the glass panels, brackets, gathering up to four heads, are fixed to substructure to which they transfer the mechanical loads.

Each instance in each database is defined by a set of parameters. Among them, the occurrences of the other databases in which the instance is present. This allows the cross referencing of the three databases. The allowed values of each parameter (or types for non numeric parameters) are separately stored so as to present a range of possibilities when components are selected or new ones are designed. The two first columns in the databases of fittings and brackets comprise the names of the producing firm and the identification of the product. In such a way every technical selection can easily be transformed in a market one. For each database there is a mask serving both for the search and for data input. The input of a new entry upgrades automatically the nets of consistencies with the existing data.

The search can be carried on sequentially, selecting successively the values of the design parameters. The search in the two first databases for selecting existing components best fit for a given design case can be eased by a search in the third one, that represents glass wall at a higher level of synthesis. Besides this task the tool may suggest possible consistencies when the designer wants to create a new component.

The proposal fits well in the frame of the actual design methodology inasmuch as its focus is on optimization of the net of relationships between components rather than on the one of the single element. Its performance is not only the quick consistency control; if fitly queried it can give back „intelligent“ suggestions. Besides this tool can be easily put on the Web and opened to all designers offering an upgradeable base of design knowledge.

### **The search function**

Let us begin with the search function.

The Assistant task is helping the designer to select the components best fit to his design problem in relationship with the restraints posed by some general choices of the project. Among the most conditioning there are glass thickness, single or double sheet glass panels, allowance of small rotation of the panels depending from the stiffness of the connection and the type of the substructure and so on. The search mechanism has to guarantee the consistency of the choices whatever be the sequence in which the values of the parameters are selected.

As soon as the procedure starts the Assistant forms a group of each type of parameters. Each group comprises all the different values of one parameter. Each group can be accessed through the corresponding button of the mask. Clicking on it opens a pop-up menu showing all the values the observed parameter can take. Choosing one

of those values provokes the exclusion from the other parameter groups of all the values present only in product instances in which the parameter has a different value from the chosen one. Hence the selection of another parameter value is certainly consistent with choice already done. The procedure can continue till the selection of all parameters values is ended. Otherwise the procedure can stop. In both cases the Assistant presents the list of all the products satisfying the choices done. If not all the parameter values have been chosen, the list of the products still „candidate“ allows recognition of the relationships between the still „free“ parameters.

### An example of search

The search can start from any parameter. Let us begin, for example, from the „Glass Type“. Clicking

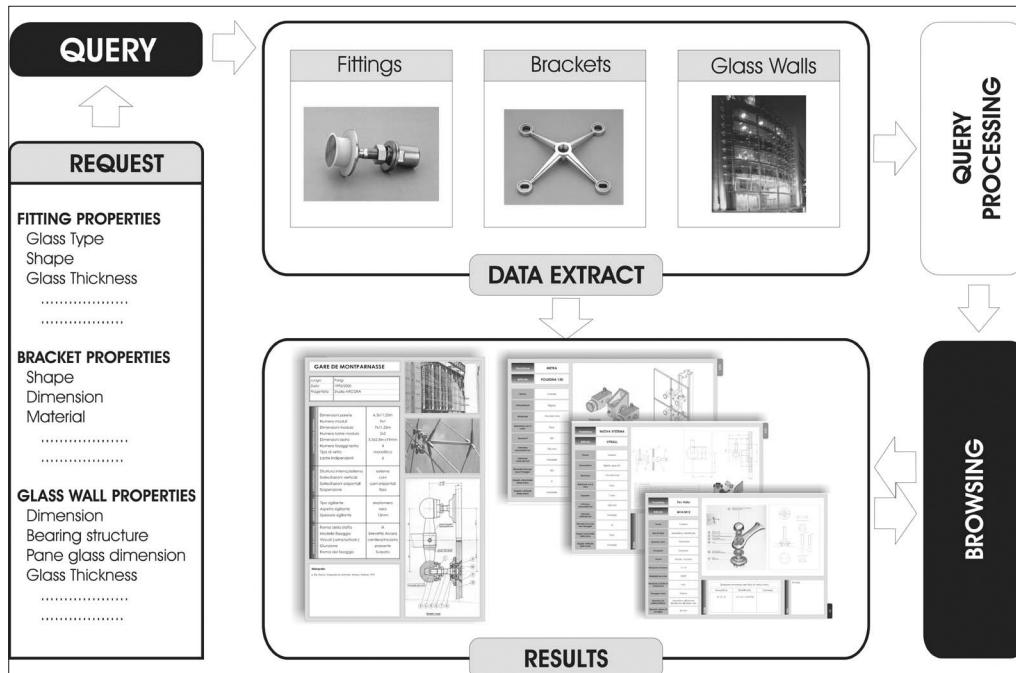


Figure 1  
Structure of the system.

on the relative button opens a menu in which the parameter values of all the products comprised in the database are listed.

Choosing a value in the menu automatically restricts the selection of the other parameters to the set of the ones compatible with the choice already done. So, for instance, choosing „laminated“ and going on with the query of glass thickness, the values obtained are the only ones compatible with laminated as glass material.

The research can be carried on till the identification of a product. Otherwise it can be interrupted after a number of parameter fewer than the total. In this case the query of the database presents all the

products respecting the choices already done without selection on the remaining parameters.

The vision of the possibilities selected by the Assistant may suggest the choice of the remaining parameters after having taken in consideration the reciprocal relationships deducible from the list of the consistent solutions.

## Database upgrade

The mask is the same. The value of some parameters of a new product that is to be input in the database can be already present in some other product or otherwise, new. For dealing with both cases

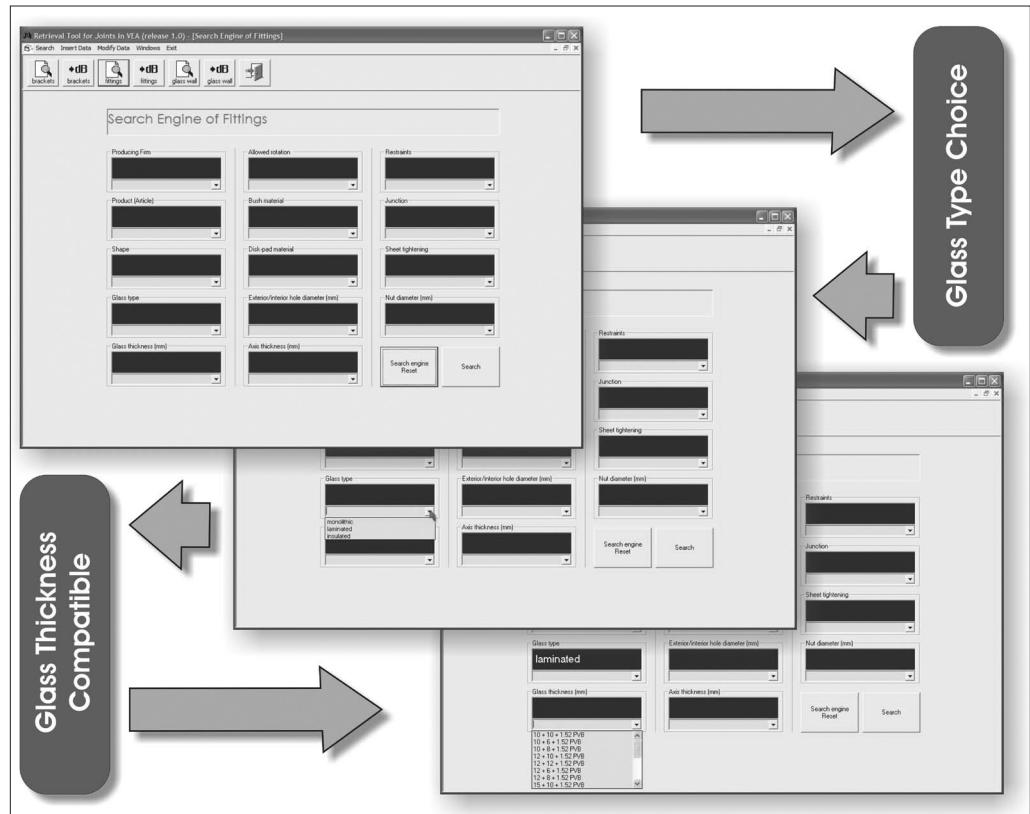


Figure 2  
Phases of search.

Retrieval Tool for Joints in VEA (release 1.0) - [Fittings Database search results]

Search Insert Data Modify Data Windows Exit

brackets fittings glass wall

Schedule

### Fittings Database search results

ID	Producing Firm	Product (Article)	Glass Type	Glass Thickness (mm)	Shape	Ext/int hole diameter (mm)	Junction	Restraints	di
1	Faraone	R22	laminated	12 + 10 + 1.52 PVB	cilindrico	36/36	passing through	rotule-restrained	
2	Fev Italia	M12 s	laminated	12 + 10 + 1.52 PVB	svasato	48/36/41	passing through	rotule-restrained	
3	Fev Italia	M14 s	laminated	12 + 10 + 1.52 PVB	svasato	48/36/41	passing through	rotule-restrained	
4	Faraone	R10	laminated	12 + 10 + 1.52 PVB	svasato	46/36	passing through	rotule-restrained	
5	Faraone	R60	laminated	12 + 10 + 1.52 PVB	svasato	46/36	passing through	fixed-restrained	
6	Faraone	R70	laminated	12 + 10 + 1.52 PVB	cilindrico	36/36	passing through	fixed-restrained	
7	Faraone	R80	laminated	12 + 10 + 1.52 PVB	cilindrico	26/26	passing through	fixed-restrained	
8	Faraone	R21	laminated	12 + 10 + 1.52 PVB	svasato	46/36	passing through	rotule-restrained	
9	Glavebel	Vision G - 50	laminated	12 + 10 + 1.52 PVB	svasato	50/40	passing through	fixed-hinge	
10	Faraone	R20	laminated	12 + 10 + 1.52 PVB	cilindrico	36/36	passing through	rotule-restrained	

STABILIMENTO GIACOMINI

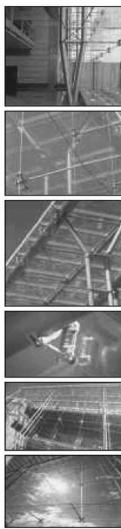
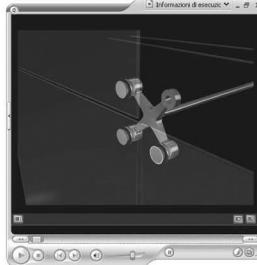
Luogo: San Maurizio D'Ospaglio (NO)  
 Data: 1998-2000  
 Progettista: Giorgio Giacomini  
 Structure: Ing. Mario Bassigiana - RFR

**CARATTERISTICHE GENERALI**  
 Destinazione d'uso: altro  
 Zona sismica: no  
 Posizione parete vetrata: verticale  
 Dimensioni parete vetrata: 21x12m  
 Numero moduli: 3x1  
 Dimensioni modulo: 7x12m  
 Numero lastre per modulo: 4x5  
 Morfologia lastra: piana  
 Dimensioni lastra: 2,5x1,7mx12mm  
 Numero fissaggi lastra: 4  
 Tipo di vetro: temprato  
 Tipologia parete vetrata: appesa

**STRUTTURA**  
 Struttura interna/esterna: interna  
 Sollecitazioni verticali: lastre di vetro a mobile  
 Sollecitazioni orizzontali: carichi orizzontali

**GRUPPO**  
 Tipo sigillante: mastice ostroso  
 Aspetto sigillante: traslucida  
 Spessore sigillante: 12mm  
 Forma della staffa: X  
 Tipo sistema di fissaggio: Polar Glass  
 Tipologia di fissaggio: snodo/incastro  
 Presenza distanziatore: si  
 Presenza snodo nella staffa: si

Bibliografia    Comportamento strutturale    Schema strutturale

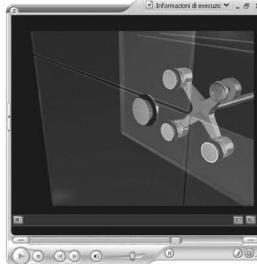
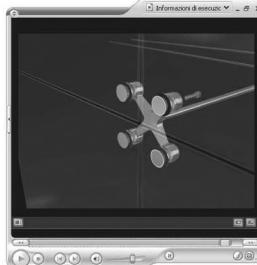



Figure 3  
Browsing result of search.

clicking on a parameter button opens the pop-up menu. It is possible either to input a new value or select an existing one. When all parameters have been introduced, the new product is added to the database.

## Conclusions

The proposed Assistant has a double value. As a specific tool it helps the designer to orient his choice in a wide market of industrial products. The choice is not easy since its optimisation depends on a combination of many parameters which are to be singled out among a multiplicity of products often presenting little but all the same crucial value differences. A production company could structure its catalogue according to the Assistant, so offering to a possible client an useful tool for facilitating the selection fitting its design problem (Kocaturk, Veltkamp and Tuncer, 2003). As every tool whose usefulness grows with the extension of the database it manages, its availability on the net can be thought of, in order to foresee a continuous enrichment of the stored data. An association of producer should have it on its web site.

The second value is in the structure of the tool. Its capability is to manage, in a flexible way, multiple dependencies between parameters, not obliged by any pre-determined hierarchy (Chiu and Lan, 2003). It is a characteristic that makes the Assistant generally fit as retrieval tool for any product type.

## References

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