Elaboration and application of an ontology in a process of architectural project

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Abstract: It is a question of making a demonstration of the potential use of an ontology of architecture during the development of the various phases of a process of project and showing thus how an ontology can be concretely operational in this field of application. First, the relevance of such an ontology is examined. Second, some of the stages of the process of project where a consultation of the ontology allows a designer to progress are examined. These stages concern as well the classification of the elements of the project as their composition. By opening as much as by closing possibilities, the ontology can frame the process and help gradually the designer to find solutions. An ontology that will not only enables a designer to operate conceptual choices but also to carry them out.

Key words: Architecture; ontology; classification; composition; process; language; model; reference; inference; rule.

1. Introduction

It is a question of making a demonstration of the potential use of an ontology in the development of the various phases of a process of architectural project. We aim to build an ontology at the interface between processes of classification and processes of composition, which, articulated, are producers of meaning.

At this interface, the ontology is conceived as a piece of a computational system of project that will assume all the drawing functions: descriptive, prescriptive and speculative [02]. The computational systems able to help the designer in his reasoning are those which integrate algorithms [03].

Endowed with inference rules, the computer possesses a certain independency in solving problem of conception. The ontology is conceived at the same time like a referential structure, in what it is informative and descriptive, and like an inferential structure in what it affords to produce inferences between concepts modelizing

1 This article is registered following a first article published in 2006 [01]. We will not return on the questions which have been already treated there.
reasoning of authors. Offering a range of choices, it is thus a structure where preferences will be brought out².

In architecture, there are many kinds of buildings and many styles, attached to periods or authors. During his career an architect deals with clients who have very varied requirements. However, he does not have a sufficiently large memory to contain all the data useful for the exercise of his profession. He often needs to consult reference books to answer the various requests.

The ontology can become an essential tool. A tool of wide-range, in what it will classify a vast field of concepts covering decades of development of architectural and urban thought. A tool going down until a level of detail in what it will come down from general concepts at large architectural scales (for example a type of structure, "with column"), to concepts at small scales (the "capital" of the "column").

Architecture is anchored in times, styles, manners. Constructive techniques are not the same today than yesterday or than tomorrow. Architecture reflects the new methods of production, the discoveries in the technologies applied to materials, and also the lifestyles in constant evolution. But these processes are interactive. New architectural concepts have allowed and will allow the exploitation of techniques as much as they will create their development. New ways of life will upset the plans of architecture as much as new plans will upset the practices in the habitat. Our ontology aims to unroll the diversity of the concepts which have marked out the history of the city and of the building; it is an Encyclopaedia which will give an account of our knowledge.

Urban form is a fabric made up of various structures which have been gradually added the ones to the others all along the centuries. According to different dynamic, city is prone to a constant evolution and becomes of this fact unceasingly more complex. The concepts implemented in the form of the buildings as in the form of the networks contribute to explain the urban form. The increasing complexity of the urban form moreover returns into an ontology. In order to understand a given period, it is necessary to know the concepts in usage in this period. And the concepts do not evolve linearly; some ones appear, disappear or sleep and then reappear [04].

Next chapter gives some elements to understand the application of an ontology of architecture such as we have conceived it.

2. From classification to composition

In order to understand the role which can hold an ontology in the process of project, we will expose in detail the fundamental mechanisms of the architectural design in the passage from classification to composition. Classification treats of the grammatical questions of a project. Since Ch. Alexander, many researchers have used graphs to decompose the process of project [05]. Some software, such as space allocation systems start from graphs to build a geometric organization of the plan [06]. The relations networks which link the rooms together are completely different according

² Our ontology is built in Protégé, in OWL Language. Based on the principles of the predicative formal logic, Protégé allows the description of concepts and relations semantically rich. Protégé is developed at the University of Stanford and Manchester.
to architectures and contribute to a large extent to define their style. In general the designer works from a diagram of basic relations. In the passage to a complex form, this basic diagram can be developed in thousand manners.

It is a question of solving step by step questions of connexity (course), adjacency, and order (succession) between rooms. Horizontal circulations, i.e. various paths to go from a room to another one are defined. By an immediate crossing, when two rooms are at the same time related and contiguous, or through one or several rooms which separate them. It is also a question of determining, if necessary, vertical circulations. The access to another level can be more or less direct, according to the instrument (helical staircase or ramp), or its position, more or less central/peripheral in relation to the served place. Gradually an order emerges, which is defined from the relative position of the rooms; this position is then ordered. The first figure shows an order of succession of the rooms around the stay different in the top and in the bottom diagram, while the relations of connexity are unchanged.

This grammar is made up by successive approximations; during the process of project, many phases of going and return between geometrical forms, their measurements and the form of the relations are performed. The modification of the form or of the dimensions of a room can involve in return a modification of the relations, of the adjacencies and of the transition from a room to another one. The reverse is also true. While the designer refines the form of the relations, the form of the building emerges gradually with geometry and relevant measures, consistent with the choices he has set. At the beginning the range of the choices are thus largely open; there is infinity of possible solutions.

Constraints reduce the field of the choices. Constraints of site (view, orientation, topography), regulation constraints (right of way, right of view, admissible volumes), constraints related to rules of style. Let us take a very simple example. A diagram of three rooms must be integrated into a geometry (Fig. 2).

Condition n°1: the global form is a rectangle or a square.
Condition n°2: 35m² maximum available surface (regulation constraint).
Condition n°3: stay is a square (style constraint).
Condition n°4: rooms are rectangles with at least 2 m² on the small side, or squares (functional constraint).
Imagine now that the designer is dissatisfied about the size of the stay and that he wishes to increase its surface. Capturing 36m² for the stay, he modifies his diagram. In this new geometrical configuration (Fig. 3), the fourth condition is not met. Rooms do not have, at least, a width of 2m on their small side. In the passage from classification to geometry, a deformation is thus possible up to a certain point; beyond, it is necessary to reconsider the classification to find a solution. For example, a relation of direct connexity can be added between the rooms (Fig. 4). Or the designer can give up the third condition, and draw a rectangular stay (Fig. 5), or modify again the surface of the stay, bringing it back to 30m².

When he is conceiving, the architect must thus find a compromise between various constraints, which are not always compatible. As instrument which compiles knowledge, ontology can therefore help him to find solutions. The choices of the designer will be conscious, and not intuitive. Not only because he will be able to question the ontology, but because in fact, still much more, the ontology will question him. The ontology is thus an intelligent tool and of “interactive” use. It will lead the designer to take various paths; the classes of objects represent crossroads.

The system of project in which the ontology functions questions the designer and proposes him choices, examples and paths (Fig. 6). The problematic of paths can find a technical solution in the field of Artificial Intelligence [07].

In Protégé, the architect will also frame the development of his project by questioning the ontology through the function "Queries". For example, if he wants to know the list of the modern houses having more than ten rooms, or an interior patio.

Today ontologies can therefore partially describe topological relations. For example, MADS [08], developed by geographers, modelizes this kind of relations. MADS proposes a conceptual model able to modelize spatial data between physical objects.

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3 MADS, like most of ontologies, mainly aims to provide a better communication between different actors intervening in the urban form; but there is no projective ambition.
3. Form of the classification in OWL

Protégé enables us to describe classes of objects. The classes are described according to a taxonomic logic founded on relations of inclusion and exclusion (Fig. 7). But an ontology which would only offer a hierarchical classification would not have any interest. If architecture uses many classifications, it is to integrate them in sentences. In the spoken language, the act of speaking consists in forming sentences to communicate something. It is necessary to understand the act of projecting as the equivalent of a speech.

Like any language, architectural language is founded on an economy [09]. The economy is based on the principle of substitution. In the language, paradigmatic elements can take place in a syntagm in a given place and enter the composition of infinity of syntagms.

In the syntagm "the wall is made of wood", the paradigmatic element "made of wood" indicating a characteristic of the wall (an extension of the class of comprehension "wall"), in fact its substance, can be replaced by another element taken in the same paradigm (Fig. 8). But the same paradigmatic element can also enter the syntagm "the table is made of wood", i.e. to be a characteristic of another class. The principle of the language is that with few elements one can say infinity of different things. Such combinatorial allows substances, qualities and quantities to be declined.

In OWL, classes can be set in relation through properties. In the process of project, the description of the concepts organized in a tree structure is doubled by a structure of concepts in network, according to an operational logic (Fig. 9).

Protégé allows thus to articulate a finished number of paradigmatic elements in a non finished number of syntagms. In architecture, this operational logic is necessary at the scale of the components of the building.

The project of architecture articulates in a complexity dimensions that treat of materials, colours, contents, forms; all these dimensions are
in relation to the position of the components in a set.
Operational logic allows to connect rooms with furniture, elements of architecture with materials, materials with dimensions, forms with contents or to indicate the rules to carry out a concept step by step.

Our ontology is divided in three general branches [01] (Fig. 10). The first describes instances of houses. The second describes the meta-concepts (of a meta-language) with the help of which it is possible to speak about another language; in fact about the geometrical language of the plan. The third describes meta-concepts connoted in languages of authors. Some concepts, such as "plan libre", enter the composition of the language of different authors. They do not have the same meaning. This branch connects meta-concepts with authors. Properties linking classes to other classes allow the various levels of the classification to be connected. An instance of house is described through its rooms or through its characteristic architectural elements. Moreover, according to authors concepts do not always have the same meaning; the third level indicates thus to which author a concept is linked, and to which other concepts this author connects it in his language (Fig. 11). These links are in fact inferences. Inferences describe the reasoning carried out by an author, to define the elements of his language.

By appointing superclasses, Protégé opens thus the possibility for classes to belong at the same time to different superclasses.
Instances can be linked via properties (Fig. 12). The designer is informed that the socle is dislocated in various spaces. It can be used notably to move on horizontal level, to change level, to shelter, to enter, to plant. The ontology thus returns the form of a socle to contents (galleries, staircases, terraces, porches, and so on); therefore, since it indicates how to produce meaning, the ontology is actively involved in the design process.

4. Inferences and inference engine

In Protégé, properties function like constraints. While existential conditions describe what enters the composition of a class (concepts and/or characteristics), universal conditions define what enters there. In the project of architecture, the range of the choices is gradually tightened by constraints. Making it possible to lay constraints, our ontology will be adequate to assist a process of project. Universal conditions enable us to give a definition of the elements constitutive of a house of a Master, to enumerate the concepts-keys of a given architectural language. The closure axiom allows the "necessary and sufficient" components entering the composition of a house to be defined. It implicitly opens the possibility of creating variants of a model. The axiom describes a structure. This structure admits variations, but within a delimited framework. A variant of the villa Savoye with a different order of superposition of its composition principles would not be anymore a variant of the villa Savoye (Fig.13). It would be something else.

Fig. 12 Relations between instances

Fig. 13 On the left : Villa Savoye, original version [10] - On the right : modified version
But the interest of an ontology is also the opening towards new compositions. And
transgression is the basic mechanism of invention. Very often Masters explicitly
invent concepts against an established order. "OpenPlan" is a transgression of
the classic plan interpreted as "ClosePlan", and "DecomposedPlan" is a transgression of
traditional and modern plans interpreted as being "Composed". Any invention is
anchored in a norm; when the object of the transgression enters the norm, it is in its
turn transgressed.

From classes defined by a closure axiom, Racer performs automatically
classification. A new object can be classified like subclass of one or several classes.
Racer infers thus automatically hierarchies between concepts. One can also visualize
in a tree form the hierarchy of concepts drawn by the operational logic, on levels of
depth defined by the user himself.

Actually Racer carries out deductive inferences⁴. If the class of the "PuristHouses"
is defined at least by windows "EnBandeau", and the class of the "BrutalistHouses" at
least by "BetonBrutDeDécoffrage", a house which would have at the same time both
characteristics would be reclassified like subclass of the class of object of
"PuristHouses" and that of "BrutalistHouses". However, that leads to a
non-sense. Purism and brutalism are opposite trends. To avoid such a reclassification,
classes can be disjoined in Protégé. Or it could be a question of opening a new class,
by means of the "and-and" concept of Venturi⁵ [11].

One part of the conditions is
inherited. For example, any house is
defined by rooms (at least one) and by
elements of architecture (walls,
columns...). If one declines a subclass
of the class of the houses, these
conditions are inherited.

With the closure axiom, we can
define Wright’s Willets house like an
object articulating a finished number of
architectural elements (Fig. 14). Each
one of these conditions is thus
necessary to project in the "Prairie"
style.

Each room consists of architectural
elements, openings (doors, perhaps
windows), flagstones, and so on.

Therefore, if a "Bedroom" of a "PrairieHouse" has walls and windows, it inherits
the elements of the class of objects "Prairie", i.e. "ScreenWall" or "ScreenWindow".

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⁴ In our research, we wish to carry out abductive inferences. Actually the researchers of
Stanford are developing the SWRL (Semantic Web Rule Language). Different built-in apply this
language in Protégé; with these built-in we search to carry out abductive inferences from
classes of objects.

⁵ R. Venturi opposes the "and-and" complexity to the "or-or" simplicity of functionalist
architecture.
In order that such heritages can be creators of invention, we seek to establish abductive inferences, which are part of the mechanism of innovation and invention.

5. Descriptive logic and geometry

In a plan of architecture, furniture qualifies the room by assigning it a function. Small icons indicate the place of the furniture in the plan. Informing about the destination of the room, making it explicit, furniture has an indicative function.

Geometry of spatial composition and logic of descriptive classification do not function in the same way [12]. In descriptive logic, the tree draws inclusive relations; B and C are included in A if B and C are A (Fig. 15). In spatial geometry, furniture is included in rooms (Fig. 16). But it does not share common characteristics within the meaning of descriptive logic. And, according to architectures, inclusions are variable. In Wright, for example, one can change nothing; rooms are conceived with the furniture. Wright draws everything, carpet, tables, chairs [13]. In Mies Van der Rohe, there is a functional block in the centre of the room, with kitchen, bathroom and WC. The rest of the space remains undifferentiated, undivided; each one can lay out the table, the bed, the armchair according to his desire.

In Le Corbusier, cupboards are arranged in walls. According to his reasoning, the disposition of the furniture in the centre of the room represents the norm, disposition...
that clutters it up. In order to avoid clutter, Le Corbusier proposes to transgress this norm. He invents the concept of "WallCupboard". In Protégé, a class of objects "HouseFurniture" will be linked to a class of objects "HouseRooms" via a property "isIncludedIn" (Fig. 17).

The choice of a piece of furniture can involve a return on the metric or on the form of the building in project.

6. Assistance for data capture

Our graph editor (GED)\(^6\) copes with the articulation of the classification and of the composition of the elements of the project. GED gives an account of the stages of classification in form of graphs and diagrams \(^{[14]}\). Graphs and diagrams contain vertices, modeling the various rooms, and arcs modeling the spatial relations between vertices. Diagram is a familiar work tool for architects of today. This kind of representation allows the problems to be decomposed, by layers, in sub-problems.

**SYSTEM OF THE PROJECT - ONTOLOGY**

**STAGE : CHOICE OF THE ROOMS**

<table>
<thead>
<tr>
<th>REQUEST</th>
<th>CAPTURE OF BASIC DATA (CLASSES OF OBJECTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>During this stage, it is a question of selecting the rooms of your future building.</td>
<td>Select rooms in this list and indicate their number.</td>
</tr>
<tr>
<td>To connect on ontology, highlight a concept and a level of definition.</td>
<td>Stay Nb : 1</td>
</tr>
<tr>
<td>LEVELS OF DEFINITION</td>
<td>Bedrooms Nb : 2</td>
</tr>
</tbody>
</table>
| ○ Universal features | Bedroom A
| ○ Classes of objects | Bedroom B |
| ○ Metric | Bathroom Nb : 1 |
| ○ Form | WC Nb : 1 |
| ○ Substance | Kitchen Nb : 1 |
| ○ References | Total of rooms : 6 |
| ○ Rules | RoomsOfHouse
| © Library
| © Boutior
| © Laundry
| © Dressing
| © Bedroom
| © Kitchen
| © Garage
| © Office
| © Bathroom
| © Sauna
| © Stay
| © Cellar
| OK |

Fig. 18 Capture of basic data

Ontology can guide the designer in the classification stages. The first stage of a project consists in establishing and capturing a program (Fig. 18). It is a question of selecting the principal rooms of the future building. The ontology can frame the work of the architect through a list of rooms, general or which describes rooms attached to a particular style. The ontology can also inform about the contents of a specific building, like a museum or a hospital. Or the designer can directly capture a diagram.

\(^6\) Software made by the CRAAL, within the direction of D. Coray and P. Pellegrino. Later, the ontology could be connected with GED; choices made in the ontology would be deferred in form of vertices and relations in diagrams and graphs.
of a house. He will gradually modify the form of the relations to adapt it to a new context or will seek to integrate a form of grammar in figures of composition of another style.

7. Assistance for capture relations

A series of rules will frame the path of the designer when capturing relations, in particular through the graph editor. GED allows properties of a graph to be calculated. As each architectural language has got its own grammar, the graphs of a house of Mario Botta are different from those of Marcel Breuer, and do not have the same properties. These properties can be measured by rates. For example, a symmetrical graph will have a very high rate group of automorphism, since one can invert a great number of arcs without modifying the graph. Thus a graph in a classical architecture, which is by definition symmetrical, must have a very high rate of automorphism. Calculations carried out with GED, during the process of project, will be able to inform the designer about the degree of resemblance of his project with a style of reference. Values of reference will be inscribed into ontology.

Figures 19 and 20 present another example: the calculation of the valency. The valency counts the number of relations linking each room with all others rooms. It thus informs about the degree of privacy of the rooms in the house. In the ontology, the valency will be gathered together with the following rule: "for any room with a valency degree equal or higher than 3, it is advised to introduce a room with distributive characteristic".

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**SYSTEM OF THE PROJECT - GED (GRAPH EDITOR) – CALCULATION OF THE PROPERTIES OF A GRAPH**

**CALCULATION OF THE VALENCY**

In this page you can proceed to the calculation of the valency starting from your diagram, with GED.

Adjunction of rooms with distributive characteristic

For rooms with a high valency degree, we strongly advise to introduce a room with distributive characteristic.

**RULE**

For each room with a valency degree of value "3" or higher, a vertex with distributive characteristic will be added.

**CAPTURE OF THE RELATIONS OF CONNEXITY**


| Bedroom A (1) | 2 |
| Bedroom B (2) | 2 |
| Stay (3) | 5 |
| Kitchen (4) | 1 |
| Bathroom (5) | 3 |
| WC (6) | 1 |

1st vertex with the highest degree of valency : vertex "stay" (5)
2nd vertex with the highest degree of valency : vertex "bathroom" (3)

Result of the analysis of the properties of the diagram (graph), its valency

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**Fig. 19 Capture of relations of connexity and calculation of the valency**
The application of this rule adds two more rooms, which are distributive spaces, and two new relations. All the relations of the diagram are modified, in terms of degree of connexity and order. This rule has thus contributed to complex the graph. And the ontology can also help to qualify these spaces.

Seeking to be informed about different ways for gathering rooms together, the designer will be able to find, under the concept of "Filtering", an extract of the theories of Ch. Alexander. A page will describe the principal manners of assembling a room with another, in more or less long durations and distances.

The "filtering" concerns the degree of isolation, of intimacy of a room. The filtering can be measured by values reported to feelings, relative to the human five senses. In term of visual intensity (which returns to more or less transparent materials, letting more or less filter the light or the imprint of bodies and objects, or to the framing of the landscape, which is different through a large window or through a judas hole), of phonic, thermic or olfactory intensities (which return to more or less thick walls or to the use of certain materials more or less insulating), of tactile contact (serving hatch).

Values can be allotted ("Value Partitions") to classes in Protégé. According to the position of a room in a local or a global set, the needs for insulation are variable. If
one wishes a maximum degree of insulation for a restroom, if the restroom is contiguous with the stay which is also used as music room, then it is possible to build thick walls and a buffer zone between the rooms. But if the device is too heavy, perhaps it better worth to modify the position of the room in the overall configuration. A reasoning by abduction will bring an adapted solution (Fig. 21).

8. Assistance for composition

A building is not only composed of relations; it is also composed of Euclidean forms, measures and substances. In the articulation between contained form and containing form, the building takes meaning. According to the position or the place taken within a set, forms and dimensions find their meaning. It was seen that the designer proceeds by abduction to carry out these adjustments.

Consequently, one cannot draw without change from the ontology concepts which are strictly a matter of form, because during the process any room, any element and any relation expressed in a diagrammatic form is built in a measured form and "embodied" into a substance. Therefore, form, metric and substance are into narrow correlation (Fig. 22). Many parameters (freely selected and determined at the end of the path) cross thus in the design of each object of the project.

Let us take a simple wall. Does it delimit an interior space and an exterior space? If it is the case, what is the climatic context? The technology applied to a reinforced concrete wall in Stockholm is not completely the same one than in Algiers, would this be only relative with the quantity and the quality of the insulating material. Or does this wall delimit interior spaces? In this case, which kind of privacy and insulation is researched (see Fig. 15)? Is it a load-bearing wall? What is the weight of the load? What length is the wall? What is the material? Thus, once again, the ontology is a tool which can frame the project. According to situations it declines a range of choices, initially towards a particular class of object (© wall), then towards one object of this class, which, taking into account its situation in an overall configuration, will be able to adapt to the various constraints. Each element of the project must be put in congruence with the others [15].

In the ontology, the questions of form return to a series of concepts; notably to descriptors of the architectural project (which are iterative geometrical entities) and to rhetorical figures anchored in styles. TOP (Taxis Oriented Project) is a software which allows, starting from a stable element, by using geometrical operations, the figures of an architectural composition to be composed.

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7 Software made by the CRAAL, within the direction of D. Coray and P. Pellegrino.
Geometrical operations are mediated by rhetorical figures of the natural language applied to architectural language. Descriptors and figures are memorized in the ontology. The ontology will inform the designer about which descriptor to use and which stylistic figures to use for assembling them. The figure 23 [16] presents an example of complexification with a palladian descriptor and operations such as rotation, reflection, intersection, and suppression. So as the choices operated in ontology could be deferred automatically in TOP, we intend to interconnect them.

8.1 Assistance for the definition of a metric

In architecture, metric is a fundamental data of the project. The manner "of giving measures" to rooms takes part to a large extent in defining a style. Metric can be influenced by exogeneous or endogenous factors. In general, indicative measures are given to the architect at the time of the establishment of the program. The ontology must therefore give an account of rules concerning the metric which return to characteristics such as being "larger or equal", "smaller or equal", "of the same size than", "abnormally large" (metaphor). And existing architectures can be described in m² of surface. In Protégé, it is possible to deal with metric data; the value "integer" allows a class to be associated with numerical data.

In figure 24 the "Hall" is set in relation with dimensional specifications via a property "HasMetric". The designer learns that in Kahn’s architecture, the hall is as large as the stay ("Hall" = "Stay"). When integrating into a Euclidean geometry, the application of this rule of composition will probably involve a reclassification of some vertices of the diagram. The diagram is equipped with indicative surfaces. In order to visualize the effect of the metric on the diagram, surfaces are brought back to their square root.

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8 Actually, TOP treats with geometry. It will be developed so as to be able to treat of measures.
8.2. Active assistance towards Euclidean geometry

How is it possible to frame concretely the process of project when setting an Euclidean geometry? In figure 25, the global form of the future building is questioned in its relation to the context. In the ontology, each descriptor returns to a form of context. The ontology describes archetypical manners to consider the relation of the building with its site.

**Fig. 24** Report of choices on diagram

**Fig. 25** Forms of the context : archetypes
These archetypical forms return to instances. The figure 26 describes an instance representing the third archetype. Rules of inference attached to each archetype will make it possible for the designer to engage a process of development towards the form.

Let us imagine that the designer finally chooses the second archetype (Fig. 27). The field to which belongs the "smallest common descriptor" is linked to a classification via a property of content, which returns it to the range of the rooms. If the descriptor is a SCD, then it contains "ColdSpaces". If the descriptor is a BCD, then it contains "HotSpaces"; at this stage of the process, the choices are targeted at the level of depth "P1" of the tree. The designer will choose ahead in the process, in the classes of objects "HotSpaces" and "ColdSpaces", the objects appropriate to his project, at more raised levels of depth, "P2", "P3".

![Fig. 26 Visualization of a house instance](image)

![Fig. 27 Descriptor](image)
10. Outlines

These various examples have shown how an ontology can be a useful instrument for who conceives architectures. Protégé offers an adequate structure for the development of the process of project, adequate with the reasoning carried out by the human brain. Basically the act of projecting consists in inventing by setting out constraints, in order to build a single object, whereas at the beginning of the process choices are only limited by a program and a site.

Our ontology is able to inform about all the dimensions of a project, at global and local scales. By its encyclopaedic content, it is an open structure. The ontology gives rules of languages; returning a concept to another, the work of the designer is framed. The designer can enter the problematic of his project anywhere and decide to solve initially functional, dimensional, formal, or expressive dimensions. Moreover the ontology allows the designer to work at the double level of innovation and invention.

This ontology aims to become a high-performance tool of the project.

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