OBSERVE, UNDERSTAND AND REPRESENT AN ARCHITECTURAL SHAPE: METHODOLOGICAL AND PRACTICAL APPROACHES

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Abstract

This paper deals with the learning path to teach the fundamentals of Descriptive Geometry, according to the experience I have gained in teaching over the years in different courses for first-year students of architectural studies at the Polytechnic of Turin. In teaching the same discipline in different fields of study -with very different addresses- leads to calibrate language and applications in order that they be contextual. There are different teaching models, the chosen one is an active exercise of cognitive functions. It uses practical experience leading to theoretical acquaintance with also a new way to observe and think by simple redrawing’s exercises or physical modeling that becomes visible and tangible geometry.

Keywords: observe, perceive, draw, learn by doing, tangible geometry.

1 INTRODUCTION

An Architect has to observe a shape to understand its complexity and has to chose an appropriate way to represent it with the aim of communicating to everybody. How to do it? By geometry but…can you read it hidden inside what surrounds you? It is possible to find it everywhere, the problem is “can you ‘see’ it?”

Recognizing simple shape to describe complexity is a methodological approach that provides the architect with an effective medium in conversation with cross-contextual interlocutors; therefore, teaching to break down the architecture to recompute it as a sum of simple elements becomes part of the basic didactic path. Teaching fundamentals of Descriptive Geometry in many fields of study with very different addresses -industrial design, graphic and virtual design, history and conservation of architectural heritage and environment, architecture, design parks and landscapes- leads to calibrate language and applications in order to become contextual.

Each message is mediated between sender and receiver hence teaching has to take account not only the context within which is delivered but also the cultural background of the students. To build a common language becomes here essential the choice of activities and language must become a fluid common base to be transversal to the respective subsequent characterizations.

To help students to understand an architectural shape it’s important to find a new way to observe and think by simple exercises designed to look beyond its complexity and identify the few elements needed to share its basic knowledge.

2 METHODOLOGY AND APPLICATIONS

Experiential learning is a simple and easy-to-use approach in many contexts.

Teaching the theoretical foundations of descriptive geometry through practical experiences simplifies the language and demonstrates its immediate applicability in everyday life. The discovery of transverse activities in different contexts with respect to certain specificities in order to declare their applications has led me to choose two possible seemingly far didactic dynamics, that conversely have a common element, namely the direct comparison of the source/object and its processing, graphics and not. Specifically, physical modeling -with common materials of low economic impact- and the redrew of graphic sources become the core of the didactic model.

2.1 Tangible geometry

Making tangible the geometry is an operation that educates to spatial vision, interpretation of form and its description; this way it takes the distances, in part, from the contemporary dynamics of the virtual model, recovering the ancient tradition of the physical model. The possibility of exploring a physical
model allows you to directly query some of the features of the real object even if mediated by its synthesis expression. Geometry is something that you can begin to learn from what surrounds you so you can discover geometry everywhere.

By way of example, some didactic experiences are described for the teaching of orthographic projections supported by models.

2.1.1 The wording of the hidden form

My first lesson of each course is a ‘game’, the wording of the hidden form: two students must describe to their classmates a physical real object that only they can see and the other have to represent it. They are allowed to use only geometric terms and not to talk by similarities with known forms. Specifically, the object I propose to describe is an irregular pentagonal prism section (and its description greatly depending on the cultural formation of the players). After many attempts his ‘home-type’ shape is recognized but not yet the object because they lack a lot of information.

The fact is that the concept of form goes beyond the geometry of its volume and beyond other parameters involved -the dimension, the mechanism, the material- all elements useful to the understanding of the shape in its broadest sense. At this time the object is still unknown.

The second part of the tutorial is to represent the hidden shape once unveiled: it is a special tea filter. From the observation of the elaborates it is noticed that many times the use of the view invalidate the critical selection of the data to represent: the details become too much and weigh down the representation without being able to complete it.

Finally, in addition to the theoretical lessons, students are required to model the shape using paper and try to represent it.

At the conclusion of the experience we compare the representations of the real object and the paper model to critically evaluate the specifics and look for other real forms that may be traced back to the origami model assumed as a symbolic representation of the described shape.

Figure 1. From the real form to the symbolic representation.
The proposed path is easily recaptured and replicable also from other types of shapes; the variety of didactic experiences has enabled me to verify its effectiveness even with natural forms, though much more complex.

2.1.2  **Dihedral angle and ortographic projections**

By introducing the reference system for ortographic projections $(\pi_1, \pi_2, \pi_3)$, few folds of a simple sheet of paper leads to the creation of a dynamic model useful for understanding the overlapping of plans and the introduction of the specialist language.

The introduction of some cuts -using origami and kirigami techniques together- to create a series of volumes within it allows to confront the design dynamics: displaying volumes by means of planes that
shape the "vacuum" that is created by subtraction of surfaces and leads to the problem of the uniqueness and exhaustiveness of representation.

In summary, a sheet, two folds and a straw make accessible theoretical concepts such as projection and trace; three more folds and two cuts are the ingredients to explain overturns, section planes, thickness and line types.

2.1.3  The “skewer”

Once understood the projection theory it is also important to teach not only how to represent what exists and is visible but also to plan where to place other elements in a space already defined and partly busy: the main goal is to develop the ability to visualize space.

Here, the representation of a straight line can become a complex opportunity to verify many theoretical issues. As a way of approaching this exercise, students are encouraged to design a real food skewer and try to represent it on multiple projection plans.

A similar exercise is then proposed to students, enabling the completion of multiple projection plans of a series of simple shapes. An integration is requested by inserting a straight line that meets certain requirements: on the basis of text it must intersect only two of the shapes represented and must not touch or intersect the others.

![Figure 3. The “skewer.”](image)

The exercise becomes an opportunity to practice on

- graphic language by the completion with thicknesses and types of lines of the exercise proposed only with construction lines,
- technical language for the recognition of the forms described,
- conditions of belonging to the search for the suitable location where to place the new straight line.

At the end, the solution is shown through a virtual model finding a perfect synthesis between the dynamism of the virtual model and the concreteness of practical experience.
2.1.4 Rotation surfaces

The lesson on rotation surfaces is followed by applications ranging from vaults to trees, from a particular technology to a design object. Having regard to the specific complexity, a simple exercise of physical modeling allows us to understand and to see those basic geometries (axis of rotation, section planes perpendicular to the axis, section planes to which belongs the axis) that will subsequently be identified in their own context.

An example among many is a sail vault model by cutting an orange. Cut the fruit into half by a knife, put it on a plane. Choosing the geometry of the base on which to insist the vault, cut off the perpendicular planes and “see” the arches on the skin of the orange. You must remove the pulp to see the vault: the fruit becomes tangible geometry and its peel, with its orange outer color as the extrados and its light color as the intrados, shows its technical language.

The unregulated natural shape of orange is obviously considered regular, with a symbolic value approximating the architectural form.

![Figure 4. The fruit becomes tangible geometry.](image)

2.1.5 Surface intersection

Recognizing shapes through decomposition into simple elements helps the student to understand that representation of complex shapes may be approached by parts. The problem is to understand how to oversee intersections between surfaces.

It has been said that the graphic modus operandi provides a sequence of cutting plan useful to find the points belonging to both surfaces, the modeling of a surface intersection provides a good basic theoretical knowledge that has to utilize interdisciplinary competences related to the mathematics area for the rigorous development of complex surfaces.

As an example, the study was made for the origami modeling of turned surfaces [1] that led to create teaching aids suitable for theoretical lessons. The origami has revealed a formidable didactic tool to develop spatial figurative skills, going students along in the process of simplifying form from the perceptual to the executive dimension [2].
Interacting with models *ad hoc* designed to visualize those theoretical contents has also offered students a design dimension and not just a communicative one of the origami model and has stimulated new proposals and experiments.

### 2.2 Redraw to learn to draw

Moving from the dynamics of the model described above, the experiential approach of redrawing goes from the analysis of the real object to the critical reading of a representation of the same to understand how significant elements have been identified for the graphic description of the object being analyzed.

In order to represent an object, it is necessary to know it, and to do so it is necessary to recognize its characteristics and peculiarities based on cognitive processes that pass from the perception of the already known to the critical analysis of the differences. By working just with known forms it is possible to discover new ones as results of transformation and elaboration of knowledge.

At a first visual mapping of the object, it is followed by a punctual, direct and indirect analysis. Understanding the meaning of what you observe requires the processing of information to be organized hierarchically. It follows that a critical reading of the graphic sources is a fundamental experience of the architect's training path. “...It is the drawing, and more precisely the table, to "have the word", while the text synthesizes the contents [...] It is the drawing that, by using the forms of representation, analyzes, breaks down, classifies, schematises, exemplifies and recomposes the corpus of architecture.” [3]

It is possible to decline the exercise in relation to the context: design drawing/drawing of the existing.

Specifically the re-drawing experience leads to:

- choose the appropriate graphics source for the activity and contextualize it
- identify the source language's own graphic and characterizing
- choose the appropriate graphic language and characterizing also by the medium used for its redraw
- evaluate any eventual reproduction by varying its purpose and scale of representation

Few examples to describe different application.

#### 2.2.1 Redrawing to read and understand an architectural manual

The tutorial offered to students was to redraw some constructive details from the representations in some technical architecture manuals. [4]

Working on a historical handbook means to understand the language of the profession and not to look just at the dissemination. [5]

The interpretation of the language code and its actualization according to a standardized and shared language make it an educational experience for the architect's curriculum. [6]

![Figure 5. F. Manino. Redrawing of 'Terrazzo in muratura', (Musso e Copperi, Particolari di Costruzioni Murali e finimenti di fabbricati, 1884). Tables for examination.](image)
2.2.2 Redraw to analyze an architectural treatise

A natural outcome of the methodological redrawing approach can be found in Martino Pavignano’s master thesis [7]. In this work the critical redrawing «is the result of different levels of knowledge» of the graphical source: «a formal codification of a set of theoretical and practical knowledge (gained from a well-defined author); architectural treatise; product of the publishing industry of the 16th century with its techno-graphic possibilities […]».

This kind of «crossed approach makes it possible to bypass the limits of the "language tools" (metric-geometric-formal and graphical) […] which underline a possible critic analysis of Vignola’s conceptual/creative “moment”» [8]

![Image](image.png)

Figure 6. M. Pavignano, Plate XXII/29 [7]. This image summarize the process of critical interpretation and redrawing of Vignola’s plate n. XXII.

2.2.3 Redraw an illusory architecture

Another application of the same critical approach in reading representations can be found in Federico Manino’s master thesis [9] who analyzes the geometries at the base of the illusory architecture in the 33rd Chapel Ecce Homo in Varallo (Varallo Sesia, VC, ITA).

The Chapels of Sacri Monti are episodes of a devotional narrative system that mediates architecture, sculpture and painting.

The geometric study of the scene privileges the viewer's point of view and seeks to understand the scene represented beyond the illusion. It is characterized by the presence of bi and three-dimensional elements that participate together in the creation of the scene itself.
3 CONCLUSIONS

“If you want - at the same time - to communicate effectively and marvelously, you should think of a visit that makes the museum visitor an active protagonist, not a passive viewer, and that by stimulating him/her at multi-sensorial level” [10]. Even in institutional teaching the same approach can be adopted by considering the student an active player in the lesson.

Origami is a hybrid language: it underlies a time component defined by folding sequences and makes the practice a rare opportunity for dialogue and cross-referencing skills. It is therefore a useful tool for educating the image, ranging between theory and application, creating ‘poor’ models able to evoking the reality, even though it is completely unambiguous without any ambition of realism.

Just as teaching to “copy” from a historicalized source of graphics, knowing how to grasp its value and explain the critical reading work, is crucial in a context where the focus on the existing is extremely timely.

*In fact, through the combination of different languages -in visual, auditory, tactile- can transmit more information to the visitor (and also to the student!) and get a communication, often faster and more effective than a written text.* [10]

The activities listed are the result of reiterated, redefined and proposed again direct experiences by integrating the training path by providing applications that are examples of how students can implement their training even if they are properly stimulated.

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Fig. 5 and Fig. 7 are by F. Manino; subsection 2.2.2 Redraw to analyze an architectural treatise is by M. Pavignano.
REFERENCES


