Slovak University of Technology in Bratislava
Faculty of Mechanical Engineering
13th Conference on Applied Mathematics **APLIMAT 2014**
Proceedings

# LOCAL/GLOBAL IN PICASSO'S PAINTINGS, A RIEMANNIAN VIEW

**CARLINI Alessandra (I), TEDESCHINI LALLI Laura (I)**

**Abstract.** Simultaneity of points of view, or polycentric views, characterizes much of the twentieth century visual culture, both in geometry and in the arts, allowing the description of complex spatial relationships. We will review the analysis of two drawing of Picasso, their local charts, and re-assemble the charts in atlases, to reconstruct the position in three dimensions of the represented object, much following the methodology established in Riemannian geometry to glue local information, when possible, into a global one. The second painting had never been analyzed before, to our knowledge. This talk is dedicated to Mauro Francaviglia, who encouraged us with stimulating questions about curvature.

**Key words.** Riemannian Geometry, Polycentric view, Visual analysis, Local Charts, Global Atlases

*Mathematics Subject Classification*: 00A66, 58-02, 53A99

## 1 Introduction

"*This study has been an experiment in communication between a mathematician and some architects, starting from the premise that architects are used to paths of abstraction in their work of representation, and these paths imply choosing a model to represent a 3-dimensional object on a 2-dimensional one, and then planning instructions for reassembling all this information in physical space. When considering a painting, the problem is not what mathematical model was chosen to represent the object, but rather what mathematical model* we *choose to decode it, and to synthesize an image in our mind*" (cf. [14]). The study, narrated in several papers and exhibit, has now proceeded onward to other paintings, maintaining the dialectics between mathematician and architect about representation. In the case at hand, as interpretative model, we propose Riemannian geometry, and its methodological tools: local charts and global atlases.

We review here the local/global methods of Riemannian geometry that we adapted to analyze two portraits Picasso drew of two of his children, Maya and Claude, when toddlers: "Maya with a doll", painted in 1938, and "First steps" painted in 1948. The study of the latter is published here for the first time, and yields to a larger view confirming the method.

We choose the methods of Riemannian geometry because it was well established and in wide use in all Mathematical Departments at the time the paintings were done. So, even if Picasso had not directly heard of the methods, we can speak about "the spirit of the time". Moreover, after our first study, a more historical research was published [11] pinning down the actual reading of Poincaré, by the Picasso strict group of friends.

The crucial hypothesis we were able to put forward in the process is that not only there are simultaneous points of view often represented in one painting, but that the narration of these points of view is crucial to the painting, as in each point of view there seem to be an actual spectator, that one can retrace, at times in earlier paintings of other painters.

Fig. 1. Pablo Picasso "Maya with a Doll" 1938

## 2 A method of analysis.

We will assume an object exists, external to the painter, and is represented in the painting. The model of representation changes from a detail to the other, because the point of view changes. We call each point of view a "local chart", because it is internally coherent to the same representation: each chart is coherent to one local geometrical model, in general a projection such as used classically in drawing, when referring to a "point of view". The several local charts (referring to different points of view) need then to be assembled together, with rules of "gluing". In Riemannian geometry this set of rules is called "the atlas", with clear influence from the actual representations of the geosphere. It is worth noticing that this method was also exploited in a way completely independent of mathematics, in much of the subsequent artistic research, as witnesses the extensive work of David Hockney [9]. This global reconstruction is in general much more difficult than the previous step; in mathematics, the global reconstruction is not always possible, and when it is possible, it is not necessarily unique.

The first step to be taken in our analysis is rather intuitive and clearly not arbitrary: in order to single out details belonging to the same local chart, it is necessary to be able to draw, i.e. to be

educated in the graphic representation of objects immersed in a space endowed with a coordinate system. "Drawing" is here intended as a tool research, and unveils the structure of a spatial relationship. Following, we will need meditating about spatial relationships among different parts, and therefore trigger new questions about rules of gluing of the local charts. As rule for gluing, we will take vicinity of details in the sense of possibility to pass with a continuous path (or pencil) from one to the other, much as in the road maps gluing. This possibility is quite strikingly clear in Picasso's paintings.

In both paintings we describe here only three local charts, while there might well be some more. Three are sufficient to reconstruct the composition in physical space.

### 3.1 "Maya with a doll": three local charts, three onlookers

Picasso painted his daughter Maya in several paintings in 1938, at the same time he was painting Guernica. Our analysis of "Maya with a doll", Fig. 1 was published in [12, 13, 14], in successive layers of understanding. We summarize here some results.

First striking our view are the two eyes of the child, her nose and her mouth. Re-drawing these details, we became aware that they are seen from two very slightly different points of views, and from someone positioned lower than the child, and very very close to her. We therefore suppose somebody is looking at Maya, and plays by opening and closing his/her two eyes, much as children do when they are up close to an object, or to their mother's face [10]. In Fig. 2a) details are seen from these neighbor points of view, and make up for the slightly different views of the mouth and the nose. We also recognize that the two painted eyes are in fact the same eye as seen from close up and slightly different positions: the bluish shadow below one of them gives the clue. This is our first chart, summarized in Fig. 2a.


Fig. 2. a) details seen by two eyes slightly below Maya
b) details seen by an eye positioned slightly higher than the doll, bluish;
c) details only an external observer can see, in green

Secondly, look at the doll and her hat's rim. The detail tells us somebody is looking at the doll from very close up, and from above: the front rim, expected straight, is curved, and the lateral are slanted, as in the aberration of a central perspective drawn from very close up. So, we suppose somebody is looking at the doll, from close-up and above, Fig. 2b). Now look at the black shoe: only the proprietor of the foot is able to see a shoed foot from its internal side; moreover, this point of view is compatible with the sight of the doll's hat, so they belong in the same chart, or projection: the proprietor of the shoed foot also looks at the doll.

Thirdly: look at the shoe with its visible sole: only a spectator removed from both Maya and her doll would be able to see it this way. In redrawing other details we became aware that other parts can be seen as represented from the same point of view, as in Fig. 2c).

We therefore keep in mind the provisional hypothesis that there are at least three onlookers: one slightly below Maya's face, one slightly above the doll's face, and one external to both and looking at both. Another detail now can tell us something about interpretation: the doll's mouth has a human quality, and looks exactly like a newborn's mouth. A mother certainly recognizes it.

### 3.2 "Maya with a doll": the global composition

As in atlases of road maps, the rule to go to the neighboring map is that roads that are continuous in reality, become continuous if charts are glued following instruction. In our case, we presume that what is glued together, is glued together also in three dimensions. See Fig. 3.

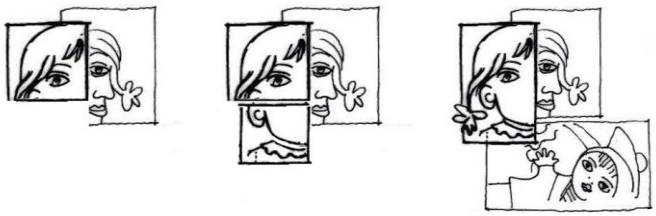

Fig. 3. The Atlas: glue the local charts according to actual neighborhoods observed.

To reconstruct in our mind a composition of details, respecting the gluing found in the painting, we notice that if the doll is in Maya's arms, in passing from Maya's eyes to the doll's eyes, an observer needs to reverse his orientation in physical space.

Fig. 4. Composition in 3-d and planes of projection

We think there is a (abstract) plane of "exchange of glances" over which Maya and her doll are respectively projected, from either side. The painter, external to both, is narrating this exchange of glances, much as he sees it is done, from close-up Fig. 4. In passing, we underline that exchange of glances between mother and child has been much in the actual subject of maternity paintings of all times. When the child is not looking at his mother, such as in some iconic tradition, this is a crucial message *per se*. On the use of color: we also notice that all details seen from the external view (the painter), are shaded in green. The needed orientation reversal of the observer is narrated by reversing all green details in the painting. The bluish shades point to yet another interpretation, compatible with Florenski's theory of colors [7], and accepted by Kandinski.

### 4.1 "First Steps": three local charts, three onlookers, where are they?

Now let us look at another portrait of one of Picasso's children, drawn much later, "First Steps", representing his son Claude, in 1948, when Claude was one-year-old and learning to walk.

Fig. 5. Pablo Picasso "First steps" 1948

First task is to ascertain some of the local charts, or points of view. The first detail that struck us was the feet of the child. We do not think the two feet are seen exactly from the same standing. Someone is obviously in front of the child and looking at him from the same level. The entire painting seems to be drawn with a frontal point of view, and certainly many more details are from this point, such as the child's nostrils and chin, and the mother's black shoe. So let us assume somebody is in front of Claude, at his same level. This is a first point of view, or onlooker.

The pocket in the toddler's overall is quite flat as seen from the side. A similar point of view can explain the mother's sleeve, and her breast. Also one of the child's cheeks is drawn as seen by somebody at their side. This is a second point of view, a second onlooker.

The left hand of the toddler is obviously seen from above, resting open in his mother's hand, not clutching. Also from above is the detail of the collar just below the chin, the contiguous part of the

toddler's overall, and the left arm. These details of the overall are in blue. So, we think there is a third onlooker, above Claude. Fig. 5

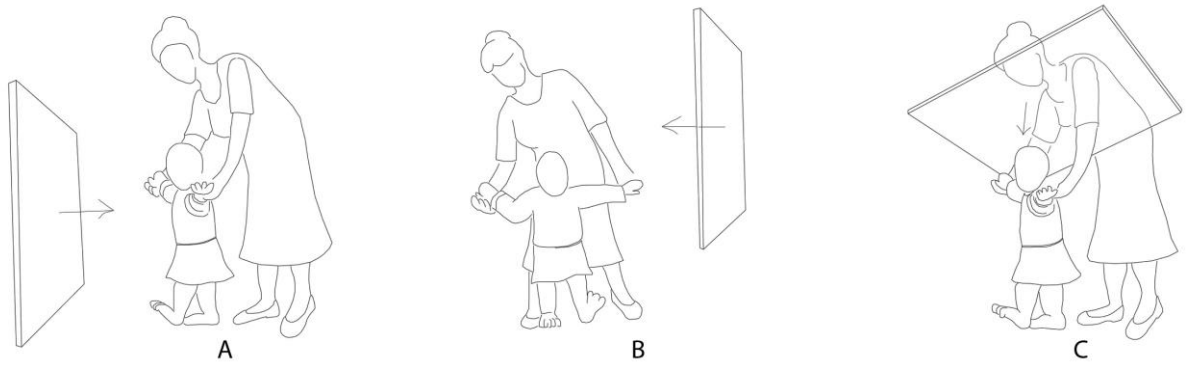


Fig. 6. three onlookers: a) front, level of Claude; b) side, mother's level; c) above Claude

### 4.2 "First Steps": its predecessors, the onlookers unveiled

Two paintings have the same name as this one. "First steps" by Millet, 1848, and "First steps" by Van Gogh, 1890. The two painting are explicitly related, in that Van Gogh studies and re-draws Millet's painting, as often painters do to study each other.
The differences among the two are: obviously the colors, Millet's being drawn in pencil; the mother's bonnet disappears, yielding to the sight of hair; some white sheets appear, hanging on the fence to dry in the sun, and giving the entire composition a different light; finally, the lines on the soil compose a perspective pointing to an external observer, this is important.

We think Picasso might well have joined the chain of these successive studies of a painter on another. In this case, he has summarized all people looking at Claude in the older paintings, into one simultaneous painting. In all paintings the scene takes the instant in which the child is about to make a step; one foot well on the ground, the other lifted, and he looks at his father. But there are differences: the mother, in Picasso's painting seems to accompany the child rather than holding him tightly, Claude wears no bonnet, and his raised foot could be either left or right. We think it is right.

Fig. 7. "First Steps", left: Millet 1848, right: Van Gogh 1890

## 5 Conclusions, with some open problems

Again, we discover the painting as the representation of "what the painter sees", as Picasso used to say. The painter is a human, not blocked into a stiff position with a still eye [7].

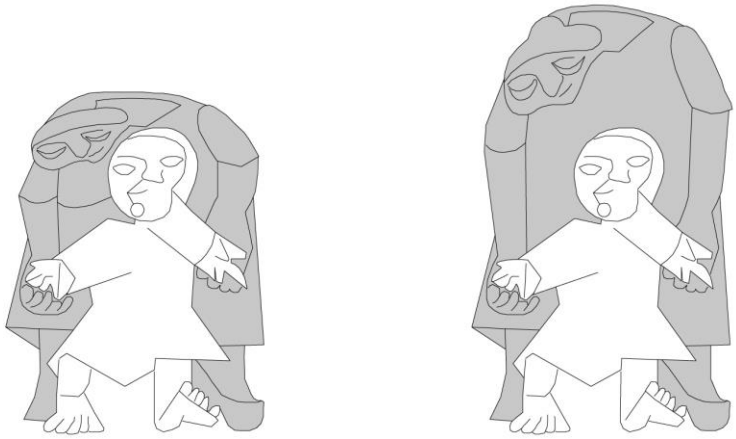

Fig. 8. Some metric discrepancies, pointing to a treatment of curvature on surfaces

Moreover, the painter is intrigued with the onlookers, or with glances exchanges between different subjects. We report that both Claude and the doll are immersed in bluish shades. In the symbolism of colors of the iconic tradition, reported by Florenski [7] , blue is the color of "the creator looking at his creature", or "the soul looking at herself". This symbolism, in use in icons, and quite different from other theories, is taken over by the Vchutemas of Moscow, and in particular by Kandinski in a conference at Vchutemas. In the same symbolism, green is the color of the external spectator, neutral. We think this is striking.

Another open question regards the sight of the mother, as represented in Fig. 8. We are not quite sure from which stand point the mother is taken, while it is clear that her shoulders are taken from neighboring points of views, narrating their curvature, and hence the embrace.

## 6 Acknowledgments

Maya was the first of a long series of analysis performed by the students of the School of Architecture at Università Roma Tre (12), and inaugurated the collaborations in mathematics and art, as well as in mathematics and architecture, that led to founding www.formulas.it, the Laboratory of Mathematics at Roma Tre. Our deep thanks to dean Francesco Cellini who encouraged this experiment in the math courses from the beginning. Università Roma Tre now funds the Laboratorio. The research is performed with funds from the Laboratorio, and funds from the project "Diffusione della cultura matematica", of the Dipartimento di Architettura. After a first talk on this subject in the GNFM conference 2002 in Montecatini, Mauro Francaviglia asked some questions on the curvature represented in the paintings. This has been such a good question that we are still working on it. Ciao, Mauro! Thanks for your interest and encouragement, and thanks for having brought us together, and in Aplimat where mathematical modeling is accepted as deep tool to discuss art.

## References

[1] Abate M., F. Tovena, *Curve e superfici*, Springer 2006.
[2] Abate M., F. Tovena, *Geometria differenziale*, Springer 2011.

[3] Brunetti F., Francaviglia M., Lorenzi M., "Mathematical Aspects of Futurist Art-Digital Photography and the Dynamism of Visual Perception", *Aplimat-Journal of Applied Mathematics,* 2011, Vol.4, p.39-60.
[4] Capi Corrales Rodrigáñez, "Dallo Spazio come contenitore allo spazio come rete", in *Matematica e Cultura 2000* a cura di M.Emmer, pag.123-138.
[5] Corrales Rodrigáñez, C. "Local/global in mathematics and painting", in *Visual Mind II*, M. Emmer ed., MIT press, Boston: 295-307 (2005).
[6] Do Carmo M. P., *Riemannian Geometry*, Birkhauser 1992.
[7] P.Florenskij, "La prospettiva rovesciata", in M.Misler (ed.), Pavel Florenskij. *La prospettiva rovesciata*, Gangemi Roma 1990, p.73-135.
[8] Francaviglia M., Lorenzi M., "The Role of Mathematics in Contemporary art of the Turn of Millennium", *Aplimat-Jaurnal of Applied Mathematics* 2011, p.215-238.
Henderson L.D., *The Fourth Dimention and Non-Euclidean Geometry in Modern Art*, Princeton University Press, Princeton 1993
[9] Hockney D., *Picasso*, Hanuman Books 1991.
[10] H.Kay, *Picasso's world of children*, Doubleday & Co., New York 1965.
[11] A. J. Miller, "*Einstein, Picasso: Space, Time And The Beauty That Causes Havoc"*, Basic Books 2002.
[12] Tedeschini Lalli L., "Conoscenza astratta: uno sguardo", in *Disegnare* n.15 (1997), pp.49-58.
[13] Tedeschini Lalli, L., "Locale/globale: guardare Picasso con "sguardo riemanniano"", in *Matematica e Cultura 2001* Emmer, M. ed.: Springer (2001).
[14] Tedeschini Lalli L., "Appendix: a graphic analysis of *Maya with a Doll*", in [5].

**Public exhibits**

Carlini, A. Marinelli, A. Sabbatini V. "Locale/globale" in *Spazi matematici e spazio pittorico,* Facoltà di architettura dell' Università Roma Tre,1997. Arch.Michele Furnari, curatore.
Carlini, A. Marinelli, A. Sabbatini V. "Locale/globale" *Biennale Internazionale dei Giovani Architetti* exhibit on the occasion of the International Architecture Prize Sarajevo 2000, Roma 1999
"Immaginare, animare, visualizzare, capire". *Festival della Scienza*, Genova, Palazzo Ducale, 2006
"Immaginatevi…", *Festival della Matematica*, Roma, Auditorium Parco della Musica, 2007
Carlini A., Marinelli A., Sabatini V, "Punti di vista", *Festival della Scienza*, Genova, Magazzini del Cotone, 2008
*La matematica scoperta*. Facoltà di Lettere, Università degli studi Roma Tre, Roma, 2009
"Bella e possibile. La matematica", *Festival della Scienza*, Genova, Galata Museo del Mare, 2013

**Current address**

**Alessandra Carlini, architect, Ph.D.**
Via Santo Stefano 50 I-03023 Ceccano (FR) Italy
e-mail: alessandracarlini@yahoo.com

**Laura Tedeschini Lalli, Professor**
Dipartimento di Architettura,
Via Madonna dei Monti 40 I-00146 Rome Italy
e-mail: tedeschi@mat.uniroma3.it