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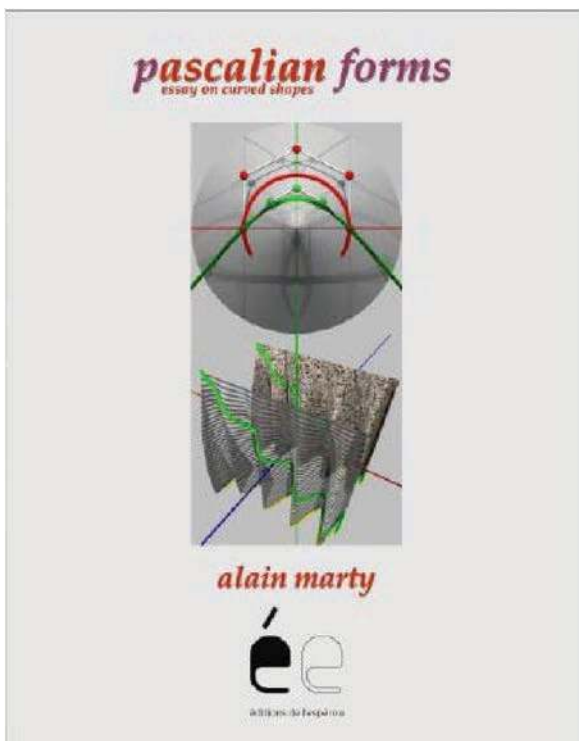
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# BOOK REVIEW

## Pascalian forms, Essay on curved shapes

### A Review of Alain Marty's Book†

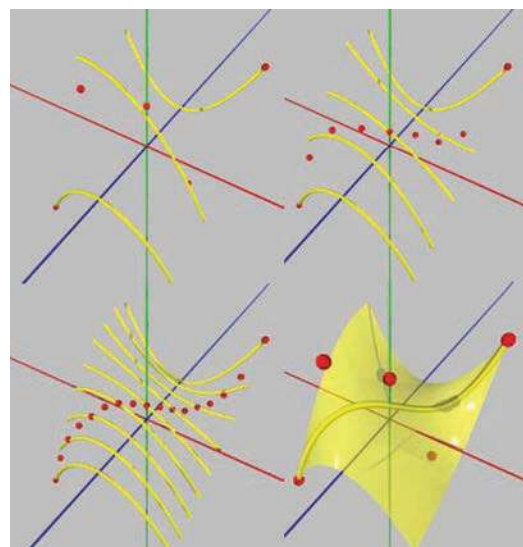
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Alain Marty is an engineer-architect who teaches computer aided architecture and who is involved in the Light Structures for Architecture Team in the National School of Architecture of Montpellier in France.

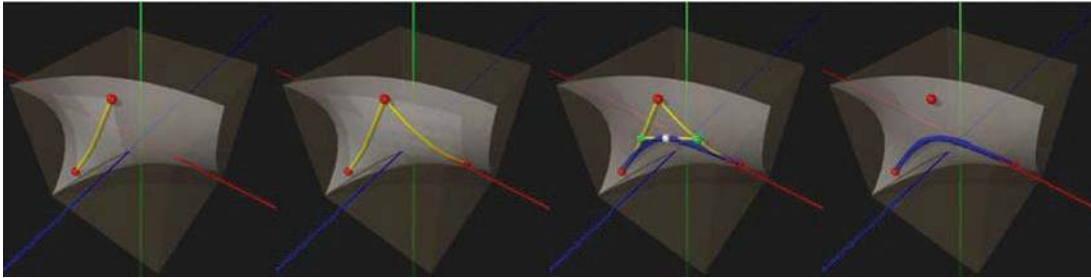
This book discusses the outcome of a research programme with an impassioned reflection about geometry of complex forms. The author argues that numerical tools provides us with easily manipulated new families of complex forms like B zier, Splines, Nurbs, Coons squares on the computer screen without

any understanding of the algorithms developed in the vast literature and often hidden “*in the depth of software black boxes*”. Proposing a unitary approach based on a systematic application of the De Casteljaou algorithm, this essay aims at contributing to add elements to a descriptive geometry of “Pascalian forms” or “pForms”. The algorithms were programmed and the images produced on Povray, an outstanding free open source environment for Ray-Tracing development and rendering (GPL Licence) developed by a community of academics and researchers whose site can be found at the following address: <http://www.povray.org>. Further information about computer implementation is also available on the author’s website: <http://www.marty.alain.free.fr>.



*A biquadric (pS33) and its diagonal (pL5), p. 46.*

† Alain Marty, *Pascalian forms, essay on curved shapes*, Editions de l’Esp rou, 2004, 192 pp.



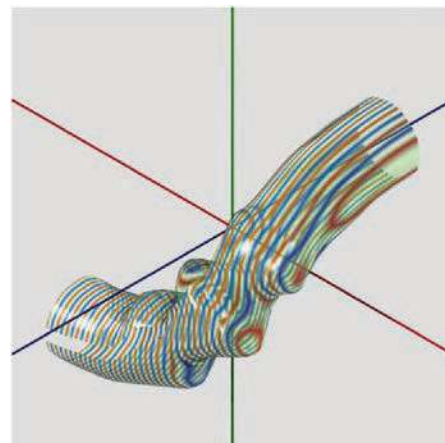
From 3 points, construction of an immersed parabola (ipL3) and its control polygon in a biquadric (pS33), p. 67.

**First Part: Definition.** This chapter presents a progressive approach to a particular case of parametrics: the Pascalian forms. The author focuses on the unitary character of forms that appear to differ greatly “like the cube and the...cubic”. From the fundamental simply returning the middle of two points, he constructs a pair of operators that first generate the family of “recursive multilinear forms” restricted to be rectilinear (straight segment, curved facet, curved cube and curved hypercube). By introducing the inverse operation, “diagonalisation”, Alain Marty extends those operators to fully curved forms. Each step, gradually growing in complexity, is explained by pleasant images and explicit sketches. At the same time, a vocabulary of pForms influenced by the Povray syntax is introduced. A new and generalised writing of the De Casteljau algorithm leads to a general definition of pForms. Their name is justified by the use of the coefficients of Pascal’s triangle in linear combinations of points, and by the particular geometric approach.

**Second Part: Properties.** In the second chapter the author reminds us clearly that pForms are nothing but Bézier forms approached from a recursive geometric point of view. Thus, they inherit all their properties. Some of them are analysed by describing the operators implemented in the Povray library. Probably keeping the coherence with his gestural approach, not much attention is paid to their explicit representation, which is usually presented to facilitate theoretical developments. The reader is simply invited to refer to the bibliography for more information...and I would encourage the neophyte to follow this recommendation in order to grasp those powerful tools. Fundamental operators like subdivision for starting a recursion to produce a finite set of points constituting the form, reparametrization of the interval of definition, elevation of degree are exposed with a constant interest in their generalisation to any type of pForms of any dimension. The process of diagonalisation is enriched to give rise to “the

*possibility of a whole geometry in curved surface*”. The emerging concept of immersions consisting of embedding pForms in other pForms extends the definition of Pascalian forms to curved spaces. However, the reasoning is inductive and does not constitute a rigorous mathematical demonstration. According to Alain Marty, the validity of the algorithms has been visually tested, demonstrating at least their interest for practical use. Although the initial aim was the handrawing, for which he gives magnificent illustrations. The library is completed by interface operators. The pForms can be manipulated by isometric and affine transformations and visualised by a functional display.

**Third Part: Applications.** This chapter deals with applications of pForms when an interest is taken in particular arrangements of control points. According to Povray, points are defined in  $R^4$  in the form referred to as projective. Thanks to this fourth coordinate, polynomial or rational forms can be generated. Consequently, the arc of circle that can in no way be represented by a parametric curve in  $R^3$  can be naturally obtained by conic projection of a defining parabola in  $R^4$ , according to the conic theory transposed from  $R^4$  to  $R^3$ . The full circle is finally expressed by changing the interval of definition. From



Tubing modelled on a cubic, p.6.

this fundamental result, the author widens possibilities for the generation of surfaces of revolution. An intellectual satisfaction could be felt when known curves like Viviani's window or the Trefoil Knot appear like simple segments immersed in pSurfaces. The intellectual investigation becomes real when Alain Marty shows a Guillaume Labelle's sculpture in Montreal. The realisation of this staircase in the form of the Trefoil Knot relies on Pascalian forms. Then, he plays with combinations of several pForms to produce pipes, Coons surfaces, parallel surfaces, useful concatenations for generating Splines and Nurbs. Other operations in pForms are proposed, like geodesic generation algorithms used to design a wood roof in the Yvelines in France.

The reader will find an original rereading of

classical themes studied by generations of mathematicians. Due to its gestural approach, this essay enables us to grasp that a complex problem in classical Euclidean space can be reduced to a simpler one in curved space. Many images and schemes will help understand the increasing complexity of curved form geometry. If the lecture requires investing some time, it's lightened by fine humour and humility always repositioning the objective and discussing the limits and the perspectives of future developments. More than 60 pages are devoted to the pForm library, resulting in a complete software tool allowing the manipulation of an important family of shapes.