# Infoarchitecture

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## Abstract

Different geometries lie behind different architectural styles.

There is now an improving alternative to the Euclidean/Cartesian geometrical environment in which the design process has developed up to now. Computational geometry has developed enough to be seriously considered as a source for new shapes for architectural objects: parametric functions and control point curves are entering the architectural design world. NURBS modelling allows the design of architecture with surfaces and volumes that could not even be thought of before the application of a computing device to their geometry.

This fact means a deep change in the epistemological charter of the whole design process itself: the geometrical immanence of a project becomes unreadable by human capabilities because the reference shapes no longer have abstract and easy-to-deal-with images (i.e. a parabola, a sphere, an ellipsoid, a cube), instead they are cryptically hidden into very complex volume aggregations that can be designed only if computational geometry is assumed into the shape definition process. Therefore, the architectural design procedure has a new step that I call "computational filtering", that allows the making of an option between the two geometrical environments. Obviously they can be mixed too, but at the moment I think this can be thought of in the same way as a standard and well-known shape-balancing procedure
*Keywords: computational geometry, design methods.*

## 1 Introduction

The opinion that studying what a digital-numerical representation of an architectural project is, is an unavoidable demand within a theoretical story about contemporary design that can be discussed, nevertheless it is outstanding that it's nature of "real topic", somehow or other, can't be denied. A topic, I think, that needs to be approached with all the instrumental means from critics and of

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abstract thought concerning all the consolidated elements. Actually, this has been made quite often and quite well, but I still see a certain lack of organic unity within this matter due to the variety and to the objective disciplinarian heterogeneity of intellectual contributes.

The didactic environment of architects and building engineers is an experiment area that should be managed with real care: it's necessary we keep in mind that the introduction of the information technology instruments for the representation normally occurs at the same time of the first impact with architectural culture itself. This is the reason for me to think that the need for the Academies to learn to properly handle this knowledge structure can be defined as urgent.

Sometimes this urgency becomes an emergency when the spontaneous overlapping between epochal mutations (the information technology era) and didactical transformations, depending upon the computer use, which too often is as diffused as dogmatic – simply happens without even a minimal thought in design universities too.

Tomàs Maldonado in 1985 (Maldonado [1]) writes that a computer can be considered as an "intellectual prosthesis" and offers compensation to human function that lack in repetition and precision and accuracy and calculation speed abilities.

Seen from an up-to-date point of view, Maldonado's computer, in my opinion, is a better "extension" than a prosthesis because it can't substitute any human function but incorporates and implements new additional ones into a man skill set.

Therefore, I think that the new "digital functions" in the set do not enhance any human character but just add different chances to a generally firm environment of human capabilities. So, in the peculiar case study of the architectural project I assume that the innovative techniques should add to the traditional methods, better than being offered as alternatives.

Architects and building engineers are at the moment on very unsteady soil towards the enrichment of formal resources that the computer use can give to their design capabilities. One can produce very complete and graphically rich outputs in a surprisingly fast way, physical and economical properties of materials can be easily handled and introduced into the design procedure from the very first concept idea and the final project can be transformed quickly into the sum of its parts.

Any operation of planivolumetric re-arrangement, element substitution, re-positioning on new alignments as well as recycling of complete blocks from other external or inner sources are very accessible even from the first level of a student doing vocational training. It would be anachronistic and luddist to oppose this with a radical spirit and force students to adopt a totally manual drawing method, nonetheless I think that the best results in the use of computer graphics as an extension can be obtained if a complete and well structured knowledge of theoretical and practical geometry is given together with an adequate improvement in traditional drawing methods. Staying in the track Maldonado has shown, any technological extension (or prosthesis, it makes no difference) can work undoubtedly better if it is joined with a biologically efficient base structure.

This very important aspect tells us, with no surprise, that at present it is completely impossible to deem that the machine can substitute the hand and that the virtual cybernetic space take the place of the real cognitive thought. I think that this awareness should brightly indicate the straight and narrow path for didactics into architecture universities.

## 2 Representation, geometry and design

It is a well-known fact that in the territory of architecture, drawing a representation are in biunique relation with geometrical knowledge and that they cannot be considered as the more application oriented side of the *Académie-des-Beaux-Arts*-style picturing. How come then, somebody thinks that if one of the two key elements of the relationship changes the other stands still without transformations? I think we can give an account of this by simply analysing the state of things. We can legitimately think that a kind of new architectonic era has begun and that a century of new architecture is starting by means of hybrid paths through plastic arts and painting and design. Its outstanding examples are in the work of people like Koolhas, Liebeskind, Hadid, and Gehry. Concerning this last, another architect like Jean Nouvel in 2003 says "[…] his fantasy - in another era – would be curbed by almost insoluble building problems, but today's computer can make drawings and calculations and his incredible buildings can stand on. So, fantasy and inspiration can run to new brain waves […]" (Nouvel [2]).

We still have to understand if this is just the "Infoarchitecture project era" as I use to call with an explicit word, but it's a really problematic matter to stay in the course of a discussion upon the topic of the "project" without considering the mutation of the epistemological core of the topic itself.

We can't individuate it in its complete shape from our contemporary point of view but we can track down its material traces over the cultural framework that a previous archaeology has outlined (Foucault [3])

An architecture project – no matter what architecture – is given birth within the spatial thought domain with the appearance of a projective representation set, and grows to a material consistence by the action of the visual thought (Arnheim [4]). Otherwise, it goes backwards: from the idea of a projection in the field of vision the ratios among the spaces of the project are derived.

Regardless of the way a project comes out, there is an inevitable element to deal with: the language for thinking of space and vision is geometry.

We well know that no thought can exist without a language (Augé [5]) and because of this I believe that geometry is the language of the project and it's only and lonely unbreakable methodological grounding. Representation through geometry, therefore, is not an *a-posteriori* but coincides with the *ποιεσισ* (poiesis – primary creation) of the project itself, playing the role of the fundamental *λογοζ* (logos – own peculiar expression) of the whole process.

 
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Aristotle sees the technical thinking action as guided by the *ειδοσ* (eidos – theoretical reference) and Augé has widely shown that no thinking action can take place without a language to be built with. Therefore, the abstract model of Architecture can be expressed and even thought just within a geometrical language, while the *τεκνε* (tekné – operational skill) intervenes for the material completion of the *ειδοσ* (eidos) in the project, so that it can overcome the unavoidable defiance with the construction.

It's almost impossible to talk of project methods from a cultural point of view without dealing with transformations in the field of representation. We can't voluntarily neglect a knowledge framework that – it's a fact – is becoming the "key" for architecture lands. Michel Foucault observes how *époques* are identified by an episteme that is to be thought as an implicit and unconscious and generally anonymous rule system with – eventually – some cultural reflections concerning the rules themselves (Foucault [3]). It is just this kind of structure that defines the domain of possibility where the typical knowledge of a given era is established and works.

The passage from an episteme to another is not continuous and is not ruled by an insider logic for a progressive development and evolution, it happens by jumps, so it's not easily explainable (Foucault [3]; Thom [6]). So we cannot think of acting from inside and somehow forecast the schemes of *this* era, because "[…] the destiny of any intellectual passage is to happen without a will, without a known destination and just having control on the very close waves nearby the boat […]" (Bobbio [7]). Bringing an era's own episteme to light is a duty for what Foucault calls "archaeology" (Foucault [3]).

Then, "the speech on the already said" in architecture is a sempiternal problem: asking ourselves "how we can compare and measure architecture?" is asking the same question as "how to understand it?" and how impossible it is projecting architecture without understanding it.

Vitruvio's *De architectura libri decem* is the first try, which has arrived as far as today, to talk about architecture measuring its quantities and describing its qualities; some of those were relatives, internal to a given style, others were absolute, as parts of the cultural framework and "[…] paying the right attention, one can see that the same concepts as Vitruvio's triad (*firmitas, utilitas, venustas*) and as all the many others which followed, constitute an equal number of "measuring units", that an architect makes explicit in his designing and that critics use for pronouncing their judgements […]" (Ugo [8])

Therefore, whether the chance for a voluntary interaction with the epistemological cores of architectonic eras is not given, the chance for displaying its immanent phenomenology is in an architect's hands. In other words: architects and civil engineers can and must design. And each project is inevitably given birth inside its own cultural frame. Guarino Guarini in the first page of its treatise Architettura Civile claims that "[…] architecture has the right to correct the rules of the ancient times and to give new ones […]" (Guarini [9]) and saying that he incorporates architecture itself into an architect and – at the same time – puts himself in a position that with a game of mind we could define as foucaultian *ante litteram*, by giving the personification of the mutation will to a single man. Moreover, he resumed the vitruvian model and expressed architecture as *initium τοποσ* (topos – recurring thought) of human beings, as it's evident that no era is peopled by architects only! Men build houses that are the material phenomenology of their culture and of their historical sense.

A construction before being solid matter is a concept, because "[…] poetically men live on this earth […]" (Hölderlin [10]). "Making poetry", in the prevailing cultural frame of modernity means accomplishing tasks that imply the formulation of hypothesis, intentions, wills, projects (Heidegger [11]) and such tasks certainly and chiefly include the act of commeasuring, in other words of thinking men in a relationship with something that is absolutely "other". That brings directly to discover a hidden meaning (God) through what is uncovered (men). So, metonymically we have reached the most general and absolute among all the *initia τοποι* (initia, plural of initium, lat.; topoi, plural of topos, gr.)

Finally, even if we can't directly perceive the epistemological core of the architectural era we produce our projects and our theories on them in (neither can we have any kind of sureness that it is just what I call "infoarchitecture age") we can surely act like architects do, designing what the "spirit of times" (Hölderlin [10]) brings us to design, as even if –maybe- Architecture doesn't exist, surely Architects do (Kahn [12]) and the works of architecture are prerequisite for men.

## 3 Some notes about geometry

We have seen in the previous paragraph how geometry is the fundamental environment for reasoning about space and its transformations, and how no concept can exist without a formal expression, how no over-instinctual thought can be assembled without a language. (Augé [5])

So, the project for a work of architecture is a linguistic expression of an optative mood and the intention to modify the *shape* and the *matter* of a portion of *space* cannot develop in absence of the notions of shape and matter and space and of a method for organising the creative reasoning.

Shape and matter (substance) are concepts with a deep philosophical background and this makes their manipulation for other purposes quite complicated. In Descartes, extension is the only really essential property of material substance and the access to the notion of shape is strictly tied to the geometry that Descartes himself constructs (Descartes [13]).

If we accept of echoing the biunique structure of the epistemological model in a more practical instance about the structure of the geometric description systems of objects, we can remember how Kantian critique to the analytic nature of this kind of *a-priori* judgement (Kant [14]) brings us to think that the declarative proposition on ontological consistence of matter actually is a datum of a purely analytic nature, that is inherent to the exercise of direct experience. If we assume that "there is no matter without extension and no extension without matter" (Descartes [13]) we are allowed to bring the concept of extension into the fundaments of the logic domain of geometry. This, on its turn, implies the transfer into an *a-priori* judgement set for the metric topic in survey and project, elevating it to a gnosiological necessity rank even for the works of architecture, which are brought to existence within the representation ambit by means of the internal commiseration relationships among architecture elements (Ugo [15]).

If a measure – on which scale it's to be seen – is a fundamental element of a project on a theoretical level too and it is not just a repercussion of the application of a specific *τεκνε* (tekné) to its genesis, I think that taking special care to all the procedures that transform an element into its representation should be an architect's specific duty.

The notions of metric scale rate and the projective transformation functions within geometric constructions do not simply have a pragmatic role but they are real elements of the *ποιεσισ* (poiesis). They have two possible courses into an intellectual elaboration of the *πραξισ* (praxis – standard procedure): First is a logic road of the representative kind, second is mathematical, with – talking of contemporary times – a special accent upon computational aspects.

Descartes, when describing the philological line of a scientific method says: "[…] those long chains of reasons, so easy and simple, that geometers use to show their more complex demonstrations, had given me the opportunity for imagining that every thing that can fall into human knowledge are chained in the same way and that – at the only condition we refrain from taking any false thing for true and we always observe the right order for deriving the ones from the others – there is neither anything too far for being reached, nor so hidden that one cannot find it out. And I did not think too much about the starting points: as a matter of fact I already knew I had to move from the easiest and simplest to know and considering that, among all have inquired into truth in sciences, the mathematicians only have been able to find demonstrations, in other words they found evident and sure reasons, I was sure I had to start from those same truths they had found out […]" (Descartes [16]).

Descartes does not submit the archaeological knowledge problem – and it could not be otherwise – rather he desires to find the form of scientific progress and consolidate in a method-shaped structure Galileo's experimental praxis (Galileo [17]).

In Cartesian geometry, Euclidean geometry is implicitly included and the logic-deductive method based upon the axiomatic structure is still valid, enriching itself of a mathematical course which is expressed by numerical set and equations that define and analyse geometrical constructions (Reinhardt [18]).

Euclidean geometry, such as its partial Cartesian new methodological elaboration, is the set of rules that a generic material substance must and is able to follow for being a part of the existing world. Within this concept the notion of model is implicit and it's just the abstract set of the system-included objects. Therefore, the model is the reference scene for the reasoning about *res extensa*. Then well, the model is seen as the only place for a "spatial intention" which involves matter to be conceived: in other words it's the only place for the *ποιεσισ* (poiesis) of a project.

The topic of architectural composition, starting from classical times to modernism is in a close relationship with the form of geometry of its coherent knowledge frameworks. They have all been solved by means of axiomatic structures, even if, after Cartesius work and for non project-oriented applications, they can be solved through non-strictly-graphic solving procedures.

The problem of geometrical logic to apply for, or better, by means of a project can be made, had never been submitted for the reason I have just shown: there was not a system of alternative choices.

The “constructions with a ruler and a pair of compasses” that are the main topic for Euclidean geometry are the roots of any classical geometrical thinking upon architectonic proportions. The two main approaches of Greek geometry are the solving of problems of construction and of problems concerning quadrature (squaring), and both of them brought to an easy-to-see material phenomenology of geometric reasoning within classical architecture.

In the *De Architectura Libri Decem*, (Vitruvio [19]) one can find the implicit correlation between formal geometry and building geometry, as Vitruvio introduces inside the topic of project method the problem of *scenographia* (Panofsky, [20]), in other words, the problem of the projective construction of images that an eye could get looking at the architectural object if it was really built. Vitruvio gives other names to the typically Euclidean representation, such as *ichnographia* for the plan views, *othographia* for the elevation and explicitly “[…] scenographia est frontis et laterum abscendentium adumbratio ad circinique centrum omnium linearum responsus […]” (Vitruvio [19])
(Transl. by author: “[…] scenographia is the representation of a main front with also a “graphic hint” at side views, that is build by drawing together all the lines and making them converge into a small circular area” […]) .

## 4 Some notes on the *corpus mathematicus* of architecture

Whether the main sediment of the scientific knowledge where architecture stands is made up with geometric culture, the grains of its matter are the elements of mathematics.

Infoarchitecture is the most mathematical among all and its large amount of embedded inner numbers and equations is cryptically hidden behind the curtain of operative knowledge that allows the design of volumes and surfaces by computing machines. We know that geometry cannot subsist without a mathematical rule set, because any axiomatic system needs the dialectic form of its *ποιεσισ* (poiesis), otherwise it downsizes to simple intuition.

This *porta et clavis omnium scentiarum* (Bacon [21]) is in my opinion a straight way to architecture too, even if its straightness is actually based on the acceptance of a split path where the twin courses often cross and tie each other, as they are: from a geometrical shape to an architectural one by means of the intellectual use of the latencies and from the indistinct shape to a proper shape through the formalisation of separate space ruling laws one can obtain through computing (Papi [22]).

In the first case, geometry is the same of latency itself and of the relationship between a project and a view it can offer: so we are in need of putting some problems of the descriptive and projective kind. In the second case, the main

 
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geometrical instance stays in the computing of the material shapes and the whole problem turns into computational scope.

In both cases the speech is double, because a computational product too can be shown and seen only by projections and a latent geometry too has an algebraic side. Can we try to say that the kind of geometry is also a part of the *τεκνε*, (tekné) as far as we can trace it into the shape? Probably, this is the moment to state that there is not a single *τεκνε* (tekné) for all the architectures. Is *τεκνε* (tekné) just the way to make a work of architecture stand and stay physically joint, or from an opposite point of view, is it enriched by the methodological fringes of the project and we had better say that different *τεκναι* (teknai, plural of tekné, gr.) follow different *ειδε* (eide, plural of eidos) and that they are different by nature and result in different *ποιεσεοσ* (poiesein, plural of poiesis, gr.)

Does speaking of the "objects of the Architecture" make sense enough or it seems more likely that the "architectures of the objects" are the real topic? I think that from a different geometry which derives from a different epistemological scope and a different generative process it can't come out anything but a different architecture. An architecture that must deal with its own geometrical *vacuum* as "[…] it exists a space, which lets us presume a real space that is independent from who is experiencing it and that is already determined in its frame. Thus, more than one space is possible, there is one for each possible definition and point of view […]" (Garroni [23]).

## 5 The geometry of Infoarchitecture

Non-Uniform Rational B-Splines are a very flexible mathematical instrument for the construction of complex shapes in a computational scope (Rogers [24]).
They are a particular form of B-SPLINES with can we written with non necessarily rational coefficients and are in close relationship with all the Control Point Curves, starting from Béziers curves.

Their mathematical flexibility is particularly useful for all the design applications (Piegl [25]; Rogers [24]) because their shape can result by direct manipulations on the knot vector that can be conducted by means of visual interfaces with the projective space of a monitor.

Through user-friendly visual interface and easy-to-use practical parameters a designer can develop his reasoning on the shapes within the spatial thinking language and is allowed to access precision and accuracy levels which normally are reserved to the final measure check phase. The algorithms for NURBS evaluation, moreover, are reasonably fast, numerically stable and exact and if we keep in mind that NURBS are invariant functions respect affine and perspective transformations we have to consider the cultural and epistemological easiness with which the computation instrument can be integrated within the traditional geometrical knowledge framework.

In normal circumstances a project method works from general to particular, in a different way from an abstract speech or from a linguistic metonymy that are its specular reflections as in fact progress by propagation. Nevertheless geometry lives in the abstract thinking domain being at the same time a rule set and an evolution mechanism for the same rules: the relapses of this on the material immanence concern the reference system and because of this they cannot follow the method “from general to particular” that normally define the generative process of an architectonic design. In other words, geometry is not epistemologically compatible with his consequences on the try of modifying the space shape with a project. Geometry is inductive and deductive and formal and inferential logic and in all of these processes are concepts spreading towards rules: before a rule is given no point is internal to any geometry. Because of this I think that the relation between project and architecture happens at a rule level. Rules for Infoarchitecture include topologic approach to space. The information technology instruments we often claim as innovative come to us straight from very ancient instruments and the only really new item in the geometrical scope is the recognising of the invariant properties of any point for any condition of any plane or space. Talking of invariable properties and any deformation of a given rule we can now see how an epistemological adjustment between the abstract model of geometry and the material model of the architectonic project. Therefore, an experience in Infoarchitecure could not happen but though topologically relevant instruments with special regard to ruled planes and spaces.

## 6 A first test project

In my first experimental test a NURBS modeling software only has been used to define a project for a building, namely, it is a theatre with the aggregation of many other public functions, and no other traditional project method or instruments was allowed. The first logical step for an Infoarchitecture project is building a relationship between the problem and its design solution and we obtained this by means of the analysis of the expected functions of the final object and give each a “weight” that will condition the volume and the surface that will be assigned to it. We have also topologically defined a functional maximum overlap index which varies depending upon the general criteria we impose to the shape generation process.

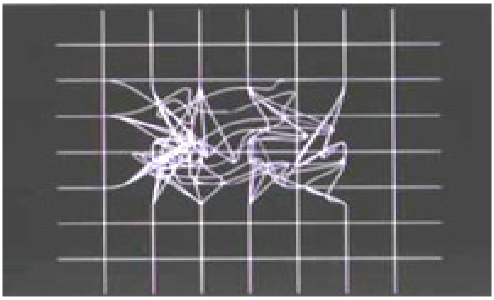

Figure 1: Plane projection of the topolgic analysis results.

As a second step we have considered the esthetical complete set of all human senses and each weight has been specifically tuned for complaining with aesthetic expectancy. This data has been geometrically transformed and projected into the model space on planes lying on the direction indicated by the analysis of human physical limits, chiefly horizontally and vertically, but without forgetting the connections, and with a "weight quote" assigned to sloped paths.

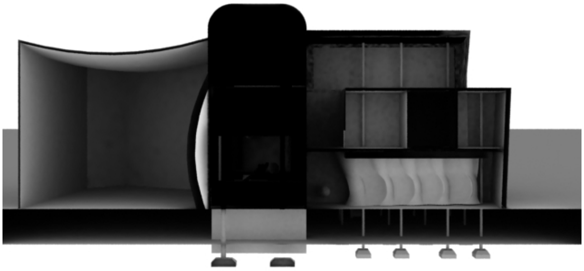

Figure 2: Volumes and surfaces interaction.

Finally, the shape projected on a reference plane had then transformed spatially towards a volumetric consistence with the total respect of topological rule concerning each element. The volumes have been physically verified and developed with regards to matter and texture.

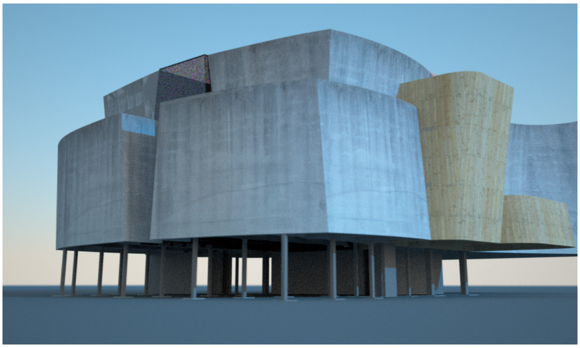

Figure 3: The final architecture of the "Inforchitectural Public Theatre".

## References


[1] Maldonado T., *Il futuro della modernità, Nuovo Politecnico,* Milano, 1985

[2] Nouvel J., *Lecture at the Triennale di Milano,* unpublished transcription, 2003.

[3] Foucault M., *Les Mots et les Choses,* Paris, Gallimard, 1966
[4] Arnheim R., *Toward a psychology of art,* Berkeley U.P., Berkeley, 1969
[5] Augé M., *Symbole, fonction, histoire. Les interrogations de l'anthropologie,* Paris, Hachette, 1979
[6] Thom R., *Stabilité structurelle et morphogénèse*, Interédition, Paris, 1977
[7] Bobbio N., *Lecture at the Università Statale di Milano,* unpublished transcription 1986
[8] Ugo V., *I luoghi di Dedalo,* ed. Dedalo, Bari, 1991
[9] Guarini G., *Architettura Civile,* Torino, 1737
[10] Hölderlin J.C., *Musenalmanach fürs Jahr*, Stuttgard, 1792
[11] Heidegger M., *Bauen Wohnen Nachdenken,* Lecture in Darmstadt, 1951
[12] Kahn L., *Lecture at the unveiling of Philip Exeter Academy Library*, Exeter, 1965
[13] Descartes, R., *Méditations métaphysiques*; *Objections et réponses, suivies de quatre lettres, chronologie, présentation et bibliographie de Jean-Marie et Michelle Beyssade*, Garnier-Flammarion, Paris, 1979
[14] Kant I., 1783, *Prolegomena zu einer jeden kŸnftigen Metaphysik die als Wissenschaft wird auftreten kšnnen.* pp.253-383, Heidelberg, 1783
[15] Ugo V. *Mimesis. Sulla critica della rappresentazione dell'architettura*, CLUP, Milano, 2004
[16] Descartes R., *Discours de la méthode, avec introductions d'Alain et de Paul Valéry, éd. établie, présentée et annotée par Samuel Silvestre de Sacy,* Le Livre de Poche, Paris, 1970
[17] Galilei G., *Lettere copernicane,* I, IV, 1613, 1615
[18] Reinhardt N. Computational Geometry, MIT Press, Boston, 1993.
[19] Vitruvio, *De architectura libri decem,* I sec BC
[20] Panofsky E., *Die Perspektive als `symbolische Form,* Vorträge der Bibliothek, Warburg; Leipzig, Berlin, 1927
[21] Bacon R. *Scientia Experimentalis*, IV, 12, 1256
[22] Papi D., *Architettura pensata,* DPI, Milano, 1997
[23] Garroni E., Kant e il principio di determinazione del giudizio estetico, in "Paradigmi", 7, 7-19, 1989
[24] Rogers D.F., Earnshaw R.A.(editors), *State of the Art in Computer Graphics - Visualization and Modeling*, Springer-Verlag, New York, pp. 225 – 269, 1991
[25] Piegl L., On NURBS: A Survey, Jan 01, IEEE Computer Graphics and Applications, Vol. 11, No. 1, pp. 55 – 71, 1991