SpringerWienNewYork

Lars Hesselgren • Shrikant Sharma • Johannes Wallner
Niccolo Baldassini • Philippe Bompas • Jacques Raynaud
Editors

Advances in Architectural Geometry 2012

SpringerWienNewYork

Editors
Lars Hesselgren · PLP Architecture London, UK
Shrikant Sharma · Buro Happold, London, UK
Johannes Wallner · TU Graz, AUT
Niccolo Baldassini · RFR, Paris, FR
Philippe Bompas · RFR, Paris, FR
Jacques Raynaud · RFR, Paris, FR

SpringerWienNewYork is a part of Springer Science+Business Media
springer.at

Cover image: Philippe Bompas – Light Bunker Cor VI III.

Image p. 13: Pavillon Philips, Exposition Internationale de 1958, Bruxelles, photo Lucien Hervé, © FLC/ADAGP.

Cover Design: WMXDesign GmbH, Heidelberg, Germany
Translation Interview with Frederic Migayrou French – English: Colin Hutchison
Printing and binding: Holzhausen Druck GmbH, Vienna, Austria

Printed on acid-free and chlorine-free bleached paper

SPIN: 86094183
Library of Congress Control Number: 2012945390

With numerous colored figures

ISBN 978-3-7091-1250-2 SpringerWienNewYork

Conference Credits

Co-Chairs

Lars Hesselgren
Shrikant Sharma
Johannes Wallner

Local Organizers

Niccolo Baldassini
Philippe Bompas
Jacques Raynaud
Maurizio Brocato
Philippe Morel

Workshops Chair

Gregory Epps

Scientific Committee

Robert Aish
Niccolo Baldassini
Olivier Baverel
Philippe Block
Alexander Bobenko
Tobias Bonwetsch
Maurizio Brocato
Jane Burry
Cristiano Ceccato
Christian Derix
Michael Eigensatz
Gregory Epps
Thiemo Fildhuth
Florian Gauss
Christian Gengnagel
David Gerber
Sean Hanna
Michael Hofer
François Jouve
Axel Kilian
Martin Kilian
Branko Kolarevic
Toni Kotnik
Ian Liddell
Daniel Lordick
Achim Menges
Niloy Mitra
Philippe Morel
Tobias Nolte
Mark Pauly
Helmut Pottmann
Jacques Raynaud
Jenny Sabin
Jaime Sanchez-Alvarez
Fabian Scheurer
Alexander Schiftner
Marc Aurel Schnabel
Alla Sheffer
Paul Shepherd
Martin Tamke
Christian Troche
Maria Voyatzaki
Wenping Wang
Robert Wehdorn-Roithmayr
Yves Weinand
René Ziegler

Platinum Sponsors

Gold Sponsors

Silver Sponsors

Bronze Sponsor

Foreword

This third edition of the *Advances in Architectural Geometry* conference marks the maturity of the initial aims, the accumulated knowledge and wealth of experience gained from previous editions having enriched the symposium throughout. Initiated by Helmut Pottmann in 2008, the aim of AAG is to develop geometric knowledge within the field of architecture through debate and theoretical and conceptual contributions. The subject matter has considerably increased in popularity since then due to some recent challenging built examples.

Geometry lies at the core of the architectural design process, from the initial form-finding stages to the final construction. On the one hand, new horizons have opened up thanks to modern geometric computing which provides a variety of tools for the efficient design, analysis, and manufacturing of complex shapes. On the other hand, this architectural production poses new problems, new processes and new technologies that inform and challenge the field of geometry. It is via this discourse that the research area of architectural geometry is emerging. It is situated at the interface between computational geometry, applied geometry, engineering and architecture.

The current AAG conference aims to identify the key fields in this debate and the cooperative logic between the different actors. The conference is thus organized around four topics which have naturally found their way into the two previous events: applied geometry, architecture, engineering and technology/practice. These topics are represented by four keynote speakers who are at the forefront of the profession in their specific fields of activity. *Jan Knippers* takes with him the brilliance of realizing light free forms while appearing to defeat the law of statics. *Chuck Hoberman* brings his experience of mechanisms applied to foldable structures leading to fascinating geometries that go beyond the experimentation and are now finding their application in built projects. *Philip Ball's* studies highlight the beauty of the geometric logic behind natural phenomena as an inspiration for architects. Finally, *Pierre Alliez* brings us back to core studies in geometry.

The presence of the Ecole Nationale Supérieure d'Architecture Paris-Malaquais in the organization of the event widens the debate to include the architectural community with the goal of including each of the elements of the contemporary design process. It brings with it teaching units lead by professors who are committed to geometry, mathematics and contemporary technologies through their professional experience in the field. Their concern for exploration and implementation is essential to the French development of Architectural Geometry in that it takes the debate beyond pure logic and allows new horizons to be opened.

The Pompidou Center has put its full support behind this 2012 event by hosting the symposium in its main lecture room. More than ever, it has affirmed its role in demonstrating how industrial design and architecture address future cultural and social challenges. In this context the AAG debate owes a lot to the exhibition *Ar-*

chitectures Non-Standard in 2003–2004 and to the Art of the Engineer exhibition of 1998 organized by Frédéric Migayrou, Deputy director of the *Musée national d'art moderne, Centre de création industrielle* (Pompidou Centre). He has furthered the debate through the acquisition and exposition of some of the most iconic and visionary Architectural and Engineering models and drawings from the last century. These span from the old handmade models of Le Ricolais up to the 3D printing prototypes of Biothing/Alisa Andrasek.

Why Paris? Paris is a city which is deeply rooted in the architectural avant-garde and innovation of the 70's and 80's of which the Centre Pompidou is a prime example. As the debate has moved from Pop Art to Free Form, the influences are beginning to take shape in the form of the Café Georges in the Centre Pompidou and the Cité de la Mode et du Design by Jacob + Macfarlane and the Chanel Pavillion by Zaha Hadid. At another scale we can mention the Jean Bouin Stadium by Rudy Ricciotti, the future Tour Phare skyscraper by Morphosis in La Defense the new Philharmonie de Paris by Jean Nouvel. It is also important to note that the recently completed Department of Islamic Arts in the Louvre by Ricciotti/Bellini pioneers the application of a hybrid mesh which was first introduced at the 2010 AAG conference.

The format of the conference is similar to the previous editions. Its larger organizational base has however allowed for a wider event. As in 2008 and 2010, the talks and workshops are the core events. This base program has been enlarged to include a video panorama which presents and explains the work of over 15 architectural and engineering university research labs from around the world.

The event culminates in two public lectures by *Toyo Ito* and *Mutsuro Sasaki*. The former is an architect who has always sought out a fine balance between the fundamental parameters of the design process: architecture, aesthetics, technology and engineering. The latter is an engineer whose signature can be found within key buildings for Toyo Ito, Arata Isosaki and SANAA. While working with them he has developed a unique approach to free-form which forms the content of his book *Flux Structure*. The involvement of these two eminent Japanese professionals demonstrates that AAG and the larger geometrical debate have harnessed their digital platform to embrace a rich worldwide debate while diversifying points of view and approaches.

The conference is structured around a peer review process for the selection of papers which address advances in the field, notably with respect to processes, theory and ultimately the realization of challenging architecture. It has been managed by the co-chairs with the help of a scientific committee. These papers are published in the Conference Proceedings section which is preceded by an interview with Frédéric Migayrou where he explores the question of why free-form and geometry are important in architecture, how this relates to the aesthetic theory and history of this last two centuries and how it has influenced the social and functional aspects of the modern art of building.

Finally, we would like to thank all the people that contributed to the AAG 2012 conference; the authors of the papers whose work represents the progress in the

field; the keynote speakers who bring their established points of view and experience; and our two exceptional lecturers Toyo Ito and Matsuro Sasaki who have flown in especially to attend the event. We would also like to thank the sponsors who have made this AAG financially viable and the European Community's 7th Framework Programme (230520 – ARC) which brings financial support to the young participants.

Lars Hesselgren, Shrikant Sharma, Johannes Wallner (scientific co-chairs)

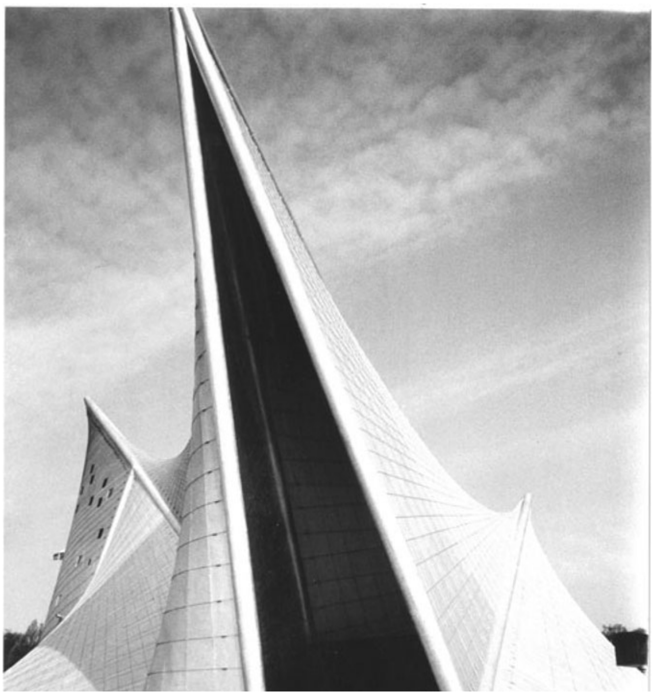
Niccolo Baldassini, Philippe Bompas, Jacques Raynaud, Philippe Morel, Maurizio Brocato (organizers)

Contents

Towards Specific and Generic Engineering

Frédéric Migayrou,

interviewed by Niccolo Baldassini, Philippe Bompas and Aurélien Lemonier



Question *- The AAG 2012, as in past events, focuses on computational and technological advances in order to open up new trends and to provide better tools - practical and intellectual - for the architect thus enhancing the art of building. It is important to put these contemporary developments into perspective, both historically and epistemologically. Could you set out the basis for a critical reading of this with respect to geometry and the intelligent use of materials?*

In brief, until the 18th century, architecture was organized around a stable set of principles, on which the modern architectural developments, initiated by the renaissance, had little impact.

Aside from the impact of an evolution in the complexity of buildings and their programs, engineering had always dealt with a stable set of materials, that is to say stone, wood, brick and metals for roof structure and sheeting. These were all age-old materials which guaranteed the continuity between the architectural language and its syntax - in brief, the Orders and the technology of building construction.

Until the middle of the 18th century, the architect had always collaborated directly with the engineer within the framework of a common language. It is not until this time that the term “engineer” as it is generally understood today, acquired the status that can be found in the “Encyclopédie”. This arose not only from a more scientific approach to architectural challenges, but above all from a radical development in the knowledge of materials. It is with the arrival of steel that the field of engineering and the role of engineers change, as they respond to the profound changes affecting the design and construction process.

Since Vitruvius, the traditional concept of architecture has been based on the specific status of mathematics and representation. The composition and the dynamic perception of constructive elements, organized within a specific Euclidean geometrical knowledge allow the project to be formalized. This status of rationalization, the idea of a mathematics framework which organizes the procedural matters of construction, continues up until the end of the 18th century.

What follows are the first great breakthroughs in mathematics, (Leibnitz, Monge, etc) which entirely change the common understanding of formal expression. At the start of the 19th century, a combined breakthrough occurs between, on the one hand, mathematical understanding and, on the other, the appearance of new materials. It is this tension which I find interesting in that it will form the substance of the future relationship between the architect and the engineer. We can consider, for example, some of the first lightweight structures by Labrouste, to take a typical view of Architectural history, and go on to consider the arrival of Eiffel where the material acquires autonomy such that it defines a new language for the engineer and by extension for the architect.

The basic formulae for the resistance of materials progressively replace the ancient theories of proportion. This movement is led by engineers such as Henri Navier, Augustin Louis Cauchy, or Jean-Claude Barré de Saint-Venant who, around 1850, published a scientific paper on the resistance and bending of solid elements. The engineer gains in autonomy, which brings with it a distance and eventually a rupture with the architectural debate. The architect in turn must take into account the new rules imposed by the knowledge base of the new materials, development and consequent thinking.

Further to the creation of the great public technical institutions of the 18th Century, the engineering profession is multiplied into a vast array of specialties which transforms the very meaning of the word engineer, i.e. specific to the one who produces and generates, to a more contemporary version of the Latin root “ingenium”, and towards an engineering which reveals a more and more complex central knowledge base. Paradoxically, this dichotomy between the aesthetics of the architect and the language of the engineer appears to be simultaneously linked to a new identity for the mathematical profession which, being itself an open experimental language, plays a profound role in modifying the study of physics, biology, economics, geography and sociology.

From the end of the 19th Century, it is the language of mathematics which becomes more and more dominant and influential. It permeates the field of calculations and rationalization which sits at the core of all the other professional fields. This fracture between the real and its rationalization, this technical mediation that has represented the age of the machine, which has created the mechanistic vision of the laws of nature for the likes of Newton or Lagrange, appears today to have reached its limit. It would seem that within all areas of engineering, whether in architecture, physics, biology or the other scientific and technical fields, the relationship between mathematics and the material has radically changed.

Today we find ourselves resolving, to be frank, the problem of the mechanistic approach to construction. It is not by chance that Eiffel has designed airfoils and aircraft too. The universal exposition of 1889 is at once the apogee of the figure of the engineer and at the same time, in terms of what it signified for the era, a foreshadowing of the decline of the industrial age. The mathematical culture of the engineer, in full flow with the rise of the automobile industry, aviation and the use of new materials such as reinforced concrete, glass and steel within the logic of the industrialization and commercialization of the process, will nevertheless be limited by the appearance of new theoretical models.

The publication of the theory of relativity, the theory of Symmetry Breaking, of a different geometrical order will entirely change the stakes. It is therefore at the very moment that the machine is triumphant, when modernism reveals itself as an affirmation of an entire era. It is at this exact point that mathematics chooses to contradict the very idea of the universality of calculation on which engineering has based itself.

From the beginning of the 19th Century, the engineer would be confronted with a new set of problems: the appearance of reinforced concrete bringing with it a new fluidity in structures, the appearance of tensile-structures and shells bringing with them questions of topology which were unimaginable within a simple mechanistic point of view. Topology models are therefore researched – one thinks immediately of Buckminster Fuller, of Pier Luigi Nervi, of Frei Otto, of double curved surfaces - a rich period in the 1930s which gave autonomy to the engineering debate while enriching it with an access to a mathematical culture offering a whole new creative and generic dimension.

How can one start to understand this period of transition, which will lead from the immediately post-war period to the experiments of Eduardo Torroja, of Gernot Minke or of Eduardo Catalano and the origins of a breakthrough initiated in theoretical physics, that of a new awareness of material, of light? We think of Poincaré and Einstein who from 1905 create new points of incidence between the scientific disciplines, porosities which lead us to biology and up to the current day where the same formalization models bridge all disciplines. For the first time, we are faced with a field where the initial specialties within the engineering profession find connections, instruments of formalization, which they share with nearly all other scientific disciplines.

What happens onwards from 1950-1960? It is the appearance of non-standard formalizations, termed non-standard analysis by Abraham Robinson, where the reference plan is radically altered. It is a rupture which is analogous to the one of the theory of relativity in that it allows one to work with infinitesimal and infinite numbers, numbers which no longer belong to the domain of the real. It is non-standard analysis research which permits the resolution of stochastic and irrational exterior geometries. This is of course after Robinson, the arrival of fractal theory by Benoît Mandelbrot, the assertion of the work of René Thom and finally the generic application of Cellular Automata.

With the generalization of the computational domain which has brought unprecedented tools for simulation and then production, the comfort of the parametric has taken hold, (Zaha Hadid), a pure formal research within the continuity of algorithmic calculations. Conversely, the advent of intelligent agents, such as the new instruments of simulation has profoundly changed the relationship between form and the material and we are led to a possible system for the distribution of material, (to be too general one could say that geometry has always been an approach towards the distribution of points). New systems of stochastic distribution are controllable and controlled by non-standard systems of modeling. Controllable in description, (this is the core of the mathematics of morphogenesis by Thom) and now controllable in a generic and genetic way - according to the new continuity which is possible between design and digital production, (File to Factory), we are now capable of moving directly to production via the distribution of material.

So, that which was a descriptive model of fluid dynamic theory with Mandelbrot, (the famous example of the English mathematician who tried to measure turbulence by throwing white painted beetroots into the Thames in order to reveal a mathematical model), the analysis of these turbulences is resolved by the arrival of the knowledge of Symmetry Breaking. It is of course non-standard analysis and can become a simulation model which integrates all the variables and parametric modifications, (density, speed) to arrive at a generic model of the distribution of material.

From here on we are already involved in the physical study of the organization of materials, materials which open completely new industrial directions. With the models which are being established today, we are capable of controlling: distributive systems in the organic; in bio-technology via the assembly of cells; in physics, with particles of course; and in a way which is not only descriptive but productive. It is for this reason that a new territory is opening for engineers; an extraordinary domain of exploration which had been anticipated and understood with great acuteness by Cecil Balmond.

When Balmond applied himself to using stochastic systems and to fully understanding geometries which integrate the random, he overturned, bottom-up, the methodology and the approach of the engineer. He saw that the distribution of forces could no longer be regarded as a unilateral, descriptive system but should be considered generically as an authentic design tool. Sasaki, in another way, followed a similar approach in working alongside architects such as Arata Isozaki, Toyo Ito or Kazuyo Sejima as an authentic design partner.

Question - *Do you believe that we are facing a turning point in the design process?*

Paradoxically, the engineer of the future will rediscover the historical shifts, that of iron, that of concrete, that of tensile and grid structures while working with materials which will certainly be entirely different. These will be materials with which we are now experimenting, (ultra high performance concrete, specialized steels, etc) but perhaps also with materials which have been preserved in their simple natural state such as timber.

The exhibition, "Multiversité créatives", or the work of Achim Menges, established firstly on the basis of systems of simulation and then through production via digital machines, does not in the end go further than exploiting the inherent dynamic properties of timber, (the calculation and programming of the dynamics of material dilation within an eco-physical environment). This is for me a very innovative engineering study. One which goes towards a naturalization in the traditional sense, reinterpreting the sense of ecology, but also one which moves towards a new productive intelligence through these same models of simulation/production.

Simulation is not only a tool for descriptive ends but can be seen as a generic tool which can in time integrate the bio-technology process more and more. The role of the engineer will transform into a study about prescribing and defining, it will touch on the generation and the constitution of artificial material and, of course, natural materials too. It will fully evolve, away from the simple studies of tolerances and of material resistances with respect to a given value, a simple *a priori* of the uses and functions of materials. The engineer will in a way, carry out the same tasks but with models of simulation which open up diachronic paths to the uses of materials, (growth, ageing, transformation, sedimentation etc…). Linked to a dynamic understanding of organic systems, (synthetic and vegetal materials…) it is the domain of an authentic eco-physics which can be envisaged.

Question - *The history of new material brings to engineering history a recognition of the architectural role of the engineer. The first to highlight the engineer/ architectural role was Siegfried Giedion. This recognition arrived late, 70 years later, after the famous break between Ecole des Beaux Arts and Ecole Polytechnique. Even now, great engineers such as Frei Otto, Le Ricolais, Hainz Hisler have not found a solid place in the history of modern and contemporary architecture. It seems that the engineering discipline has difficulty in being recognized as architectural. This is in spite of the fact that many constructions consist only of structure. Sometimes, as far as it concerns our topic, these also include a strong geometrical component…*

We can, of course, set up an archeology of innovation where the great critical breakthroughs in aesthetics are accompanied by the great scientific and technological innovations. The neo-rationalist model of structure that Perret preserves within his structural use of concrete is re-asserted 40 years later by historians such as Kenneth Frampton where, within the context of the study of contemporary architecture, it represents the work of an engineer in an entirely static way.

The Italians of the Tendenza, around Aldo Rossi, along with the neo-rationalists, while advocating a traditional vision of the project, set design and construction procedures in opposition to the change in technologies and those of the knowledge of materials. It was a return to order which aimed to challenge the excesses of a capitalist technological positivism but which in the end supported an entire restrictive economy of public building works and standardization.

We can today imagine projects which could stay within an open, variable domain, where the totality of conditions of feasibility and construction will be permanently parametrable projects which will be adaptable, where the construction will only be the ultimate choice within a larger, variable system. We would choose the most pertinent options, as these would be pre-regulated with respect to context. Earlier we talked of Cellular Automata and so of intelligent agents. These agents would react to the various parametric quantities such as, for example, the distribution of openings, those of wind resistance, climate, those of urban insertion and a whole multiplicity of complex constraints…

This flexibility, where the architectural object is nothing but the final element in the design of a project, offers adaptability. Only the most efficient state of simulation, with respect to a specific context contained in an instant T but also with respect to a principle of temporal evolution, will determine the architecture which is to be built along with the optimization of all the relevant fields of engineering. Resulting from the process of programming technical and qualitative parameters, the form will reveal itself in negative against this decision plot of options and possibilities which will form the unity of the project. The project will not be revealed until the last moment and will no longer preside as the subjective precedent of the architect's work.

This is completely the opposite of the traditional idea of architecture where one first imagines the project and then one looks for the constructive, material elements. Here, the project is born, programmatically, from a field of controlled constraints. This also signifies that the language of engineering is genetically integrated with the calculations, that the engineer is a cohesive and a simultaneous partner in the development of the project. As soon as we are confronted with the determination of the form, the material itself falls into the field of parametrics and the engineering calculations are carried out as an integral, almost organic part of the process.

But this is already the case. Engineers already produce calculations within software which integrate systems of variation in order to determine the perfect structure. The intelligence of the engineer has changed in this respect; you, the engineer already thinks differently. All innovations will go through this process of the formalization of materials. I no longer believe in the traditional logic where a project's form is 'pre-established'. It is necessary to reconsider the academic ideal of a project. It is necessary that it is the relationship with the architect which is structurally transformed. I also no longer believe, in the end, in the separation between the architect and the engineer. We have also witnessed the presence of mathematicians in architectural practices in the last 10 years who communicate in a different way with engineers within a decision making process which occurs directly via this new common language.

There is a last point which I would like to raise - it is the end of the relationship concerning typologies and morphologies, that is to say architecture merged with language, as if there had been regularities since, let's say, the time of Vitruvius in the linguistic and syntactic vision of architecture which the engineer had formalized into a more abstract language. This seems no longer possible to me. It is at least the most innovative architecture of the last 15 decades which has led to a different relationship between the system of formalization and the architect's project.

Hence this intermediary idea which is one of parametrics. Why have so many conferences on the subject of geometry appeared in the last 10 years, and around a geometry which has been altered by the tools of software? What does this reveal to us? I believe that we should turn the question around: these conferences appear in large numbers because they reveal, between the lines, a void, the depletion of geometry in construction. To describe this depletion, one must set up these conferences because it is there that one can find where the new innovations are towards new orders in mathematics and new knowledge bases.

What is rather strange however is how this levels the field. A very young set of people will be very competent in that they will be able to understand systems of fabrication and the implementation of materials in a different way. They will ask a new set of questions about traditional geometry. Most of these conferences follow this pattern. On the other hand, some leading engineers and established practices will take on board very small projects and will multiply research laboratories due to the fact that the status of geometry is in the process of changing and that a new set of problems and questions are being raised, (which does not necessarily mean that the new generation of architects and engineers are capable of resolving the questions that they are revealing).

But, in time, I think that we will move towards a growing erasure of the distance between the architect and the engineer, a distance which was born from the mechanistic world. This will represent the end of an era which was initiated in the Renaissance and which, having found its apogee in the 19th century, seems to be receding under the blows of the computational field. The sounds of machines, the engines, appear to have been substituted by the silence of network exchanges. This is not a new, better world, but a field of procedure which one has to understand and invest in. This is a world in which the mathematician and the engineer can be the guides towards the constitution of a critical point of view.

Progressively, systems of simulation will open new affinities, new domains for dialogue, a different organization for understanding projects, materials and structures where the common language will be the knowledge of materials, considered with respect to a common platform, like a shared culture.

Question *- Xenakis can be seen as a perfect example, from this point of view…*

When Xenakis was with Le Corbusier, he carried with him his training as an engineer, an architect and a music theorist. Very quickly he would develop a purely mathematical method for structural studies which would be revealed in the Philips Pavilion for the '58 exhibition. In order to describe this new found mathematical approach, he drew on his knowledge base as a musician. Music and architecture have always been intertwined. His knowledge brought with it a total dematerialization of architecture and therefore a call for a renewed idea of the material. This idea took form in his post-tensioned concrete sails. As a mathematician, he subscribed neither to the principles of traditional formwork, nor to the shuttered concrete which is the common practice of one such as Le Corbusier. He instead made use of hyperbolic paraboloids.

This project touches on a number of questions which are very much of our time even though they were revealed at a time well before the arrival of the computer. This is a flagship project in that Xenakis applies a knowledge of materials, an implementation of materials and a formal order which is entirely new. Indeed, Xenakis uses the word 'Stochastic' to describe this. It is indeed this continuity which I find fascinating, and one which leads us to ask a number of questions about the status of the engineer and that of the architect. This new mathematical knowledge which are talking about will fundamentally change the engineering and architectural professions as well as those of other, more complex trades.

Question *-Do you think that on one side we have a technological geometry and on the other side we have a sociological geometry? A building is made from a material and a form, but also by a geometry which is defined by the body and human being. In the 1930s, following the cultural advances (Theory of Relativity, Cubism, Psycho-analysis), we broke up volume. Do you think that today there is a relationship between the evolution of geometry and the evolution of ways of life?*

I believe this to be true. It is an extremely controversial subject in that if you look at the experimental projects which we know of today, they speak of abstract forms, of a formalist vision of architecture. This formalist vision will be widely criticized, as if it was separate from the real, as if it did not address social issues or the political context, as if it was not valid as part of an operational and constructive architecture.

This question is very important. For me, the sociological discourse on architecture which has come out of the 1960s is founded on the desire to be involved in the city, as if within a civil domain where architecture is defined by the collective and political will. This is the challenge of the architecture of the 1960s, in particular within Italy where architecture sets out a moral basis of which the city is the guarantor, which is an active social field undergoing constant change and which imposed a set of rules, even negative ones, on the project.

The position of Rem Koolhaas on standards of urban disorder, the negative and cynical dimension which for him favours the contextual integration of his architecture, is very explicit on these matters. The stacking of boxes, this falsely disordered functionalism which is a mirror image of the chaotic post modern city, pushes this contextualism to the extreme. Architecture (and engineering) appear to be blocked into a position which has no resolution.

To challenge this with an architecture of research which is confined to a utopian non-realism, a field of abstraction which is detached from the world in that it does not open a debate with the social, mercantile and globalised reality, appears today to be totally unrealistic. The old separations and High and Low, High-Tech and Low-Tech appear to be less and less pertinent. Hybridizations between technological input and specific cultures appear to open more complex and realistic critical points of view.

The history of the first modernist architecture itself cannot be summarized within a simple formal analysis of architectural objects. This modernism was the fruit of an unbridled technology, of an abstract functionalism which refused to consider any social and political issues. From the 1920s onwards, another reading of the person, of the subject, appears initially with the ideas of psychophysics founded in Germany. It is carried on by Gestalt theory and then is developed further in the United States. Gestalt, meaning form or shape, therefore a different idea of shape, a psychology of the shape, will have a very important impact in the United States and will serve as a basis for teaching in art as well as in architecture. We can list here the influence of Max Werthiemer, Kurt Koffa on designers such as Lazlo Moholy Nagy and then to Georgy Keppes who will go on to lead the Bauhaus courses in Chicago. The American minimalism of Donald Judd, of Carl André is the result of the lectures given by Keppes who intertwined the references of Pevsner, (of sculptures which integrated double curved surfaces) with those from cinema or experimental photography. This is a new appreciation of space-time which brings us, via reduction, towards a new knowledge of space.

Through this scientification of cognition, new systems for the formalization of mathematics and physics appear. With this appears the new comprehension of space-time, which is no longer the mechanistic one. There is a break between the habitable machine of the initial Le Corbusier works, (‘design houses as one designs cars, industrialise the dwelling for all’), with the new notion of space-time imposed by the theory of the Gestalt.

So, if one wishes to reconsider a new collective intelligence of architecture, one must reclaim those ruptures which have accompanied recent history, those of the convulsions of modernism. We cannot today live in the romanticism of typo-morphologies. One must reclaim the knowledge of these generic ruptures along with the history of the evolution of technology. From here, one can reconsider the collective production of cities and of architecture. I remind you that we are in permanent contact with systems of information which run our daily lives. Everyone knows that stock exchange systems, traffic flow controls and weather forecasting have all been invaded by mathematics. These are all complex stochastic systems which are based on the same models that will be used in time for the implementation of materials. A global knowledge base should only be, for me, to facilitate the construction of a social intelligence for the collective fields, a political intelligence and subsequently in time, a new politics of architecture.

It is no longer in the opposition between High Tech, perceived as the apogee of a capitalistic, positivist economy and a petrified view of the historic city that one can create models of interpretations of an economic, technical and social, globalised reality which is undergoing perpetual change. This dichotomy appears to no longer respond to a contemporary world. We can no longer satisfy ourselves with it. It is a contradiction which brings with it a new resolution and therefore if we want to reclaim the collective domain within architecture, within engineering and construction to rework programs which have a socio-political dimension, we must reclaim the production tools. We cannot think and act under the shadow of an ancient, inadequate tool base. The logic of markets, the economic and political logic of countries use the entirety of the computational field as a structure for production and control. Therefore, if we do not master these tools, we are left by the wayside. If we want to acquire a different level of intelligence, it is necessary to do this through these new economies in order to have a transparent access to the new systems of formalization.

There is, at the current time a sort of fascination for Gilbert Simondon and his work “Du mode d’existence des objets Techniques”. This book is rooted in an ontology and a phenomenology of the technical domain. The technical vision of Simondon is founded on the ideal of the trans-individual. Although this work is very interesting, there are however still mechanics behind the initial idea. The technical is always thought of in the shadow of the motor, of the device, of the machine. Therefore, if we do not want to assimilate the grand computerized systems as instruments of the expropriation of the collective domain, then we must change the paradigm and leave the paradigm of the reference to the machine. The technical domain should not be treated uniquely as an instrument of power and expropriation. For this to happen, one must reclaim the spaces which are formed by these new procedures. Engineers, from this point of view, are the ones best placed to master these complex procedures.

From here, when one goes through into the world of purely mathematical language, one is no longer embroiled in the old mechanistic metaphors, of the equipment, the device, a prosthetic. This system of metaphors obstructs us even if we still do use the internal combustion engine today. We are in an age of mutation, where the extension of the computational field introduces models which are more and more complex. These are models which impose an articulation and a de-articulation of the old systems of knowledge. In order to consider and accompany the contemporaneity, I believe that one must reclaim these domains. It is for this reason that engineering is, at the current time a fascinating professional field. This is because it is a generic field and no longer purely a descriptive one. One can no longer ask an engineer to simple calculate a structure, infrastructure or a territory for them to arrive at a constructive objectivity. For me, engineering can today unify the myriad of these fields of intervention, not in a quest for unity, but to gain in this complexity a critical, generic and prescriptive intelligence of the world to come.