Miradas a la investigación arquitectónica: construcción, gestión, tecnología

Architectural research findings: building construction, management, technology

DEPARTAMENTO DE CONSTRUCCIÓN Y
TECNOLOGÍA ARQUITECTÓNICAS ETSAM-UPM

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ARQUITECTURA, CRISIS, HOMO FABER

A lo largo de la época contemporánea la arquitectura se ha ido relacionando cada vez más estrechamente con los desarrollos industriales y tecnológicos. Y sin embargo, en la figura del arquitecto siempre ha sido manifiesta una cierta escisión entre los conocimientos politécnicos y los propiamente artísticos. En la segunda mitad del siglo XIX el arquitecto español se empezó a formar en las Escuelas Técnicas Superiores, mientras que en otros países de Europa continuaban estudiando en las Academias de Bellas Artes, prueba de ello es que en el seno del Movimiento Moderno, coexistían en las mismas filas artistas con pocos conocimientos de construcción (como Rietveld o Le Corbusier) y técnicos al mismo tiempo científicamente severos y sutiles al proyectar (como Jan Duiker o Nervi).

La dualidad dista mucho de estar resuelta en un mundo en el que conviven con gran éxito caracteres opuestos como Norman Foster (experto en cuestiones de construcción y tecnología, y requerido precisamente para encargos high-tech) y Frank Gehry (un artista informalista y libre que confía en la informática y en sus colaboradores para poner en pie sus diseños sin pensar de antemano en su materialización). Y, sin embargo, la gran ventaja y notoriedad del arquitecto formado en España a menudo puede cifrarse en su fuerte carga politécnica, que coexiste con la formación proyectual. La celebración del I Congreso Internacional sobre Investigación en Construcción y Tecnología Arquitectónicas, que tendrá lugar en la Escuela Técnica Superior de Arquitectura de Madrid durante los días 11, 12 y 13 de junio de 2014, supone una ocasión inmejorable para debatir y reforzar la orientación de la formación que se da a los arquitectos actualmente.

En el presente, cuestiones como la sostenibilidad, el ahorro energético, los sistemas ecológicos de construcción, la producción limpia y la eliminación de residuos arquitectónicos hacen que la cuestión tecnológica sea más importante que nunca, y ello en un sentido que nunca antes se hubiera imaginado. Pero a estos problemas sociales y medioambientales de la actualidad se une la necesidad de que el arquitecto perfeccione sus conocimientos tecnológicos y saque partido de esta diferencia con respecto al arquitecto "proyectista" tan habitual en Europa y en el mundo. Se trata de un momento clave en la transformación de la profesión del arquitecto y en la reasignación de roles que los egresados de las escuelas de arquitectura podrán adoptar en el futuro. Una reflexión sobre los aspectos constructivos de la profesión, así como de su directa e inevitable relación con las cuestiones proyectuales y formales, resulta del todo imprescindible. Sea por tanto muy bienvenida la iniciativa de este I Congreso Internacional sobre Investigación en Construcción y Tecnología Arquitectónicas que se celebrará precisamente en la ETSA de la Universidad Politécnica de Madrid, el lugar más indicado y simbólico posible para un encuentro de estas características.

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Parametric design for technological and "smart" system. Adaptive and optimized skin.

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ABSTRACT

The goal of the research program is to study technological and "smart" complex systems through the development of emerging technologies and a multi-disciplinary approach. The awareness that innovation in architecture field , but in general in science, it's essential to provide concrete answers to issues of general interest, such as energy resources consumption and construction systems obsolescence used so far, makes research fundamental and priority. It's necessary that the architecture is adjustable to the environment as the living organisms are, through a new multi-disciplinary approach: not only studying the morphology but investigating the generative process starting from the physical characteristics of materials and components, from the analysis of bio-inspired systems, for an architecture that is increasingly taking the form of a living organism [1]. Achieving this requires efficient technology and mutual collaboration systems that can only be reached through research in the field of emerging technologies. Specifically in this full paper, this approach will provide basis for the prototyping of "light" dynamic and adaptive facade system able to synthesize the different contributions that these new technologies are able to ensure. In the second step of the research the aim will therefore be, in addition to the development of high performance skin system, to define a new methodology, a new design process, involving major innovations in the design and prototyping fields of technology systems to be transferred, in the clearest possible way, to the industrial sector, so as to ensure the product innovation necessary to compete at European level. The knowledge of the "state of the art" and critical, directs research towards a prototype system of flexible facade based on pre molded components and achievements obtained by the nonstandard and avant-garde processes, even experimental, which contains sub-systems able to collect input from outside and rework them to provide an adaptive and optimized response.

Keywords: Parametric modeling; computational design; adaptive; optimized; high performance skin system.

1 INTRODUCTION

Given the importance it plays worldwide, nowadays, the innovation and the research for new strategies and new technological systems in the industry construction is a necessity . Construction industry is one of the most impressive in the world, in terms of employment and earnings, and influences, in EU countries, the 30-40% of energy resources use. This sector "consumes" during the construction process the 50% of global resources[2]. Similarly we can say that the construction industry, and then the technologies and components used in manufacturing processes, are still linked to the use of standard materials that dominate the market, such as reinforced concrete, steel and glass, and obsolete constructive and productive systems. The industrial revolution of the 19th-20th century, based on the serial process, produced very efficient but very expensive systems in terms of energy and use of materials: today we need to rethink this process using the experiments carried out on new materials and new production and realization technologies in the construction field as robotic system , additive process, morphing and especially 3D printing surfaces). One of the elements that affects more buildings, in terms of energy expenditure, acoustic comfort and cost of construction, is the "skin" understood as a complex element capable of modify inputs from the outside world.

Figure 1. Robotic fabrication printing «ICD/ITECH research pavilion 2012»

Technology evolution, particularly in expansion in recent years, has transformed "skin" from passive to active, and finally, in hybrid, in which building and plant technologies becomes complementary to each other and the skin becomes part of an integrated building-plants, rich in apparatuses of regulation and control that placed it at the center of experimental processes in prototype models of futuristic living field [3].

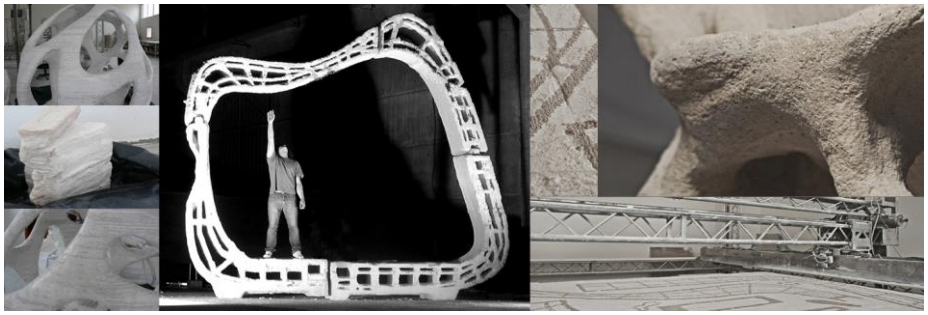

Figure 2. Material deposition 3d printing «D-shape 3d printing»

If research on the topic of "skin" has reached a level of development on the energy and environmental side, on the other side today we need to enter in this process new variables affecting the generative process in architecture. The adaptive aspect of architecture related to the variable conditions of the outside world such as social needs, climatic conditions and human iterations, forms the basis for future testing: analyzing how everything that is variable and dynamic can affect architecture and its technological components. Aside from the three, now consolidated, macro-categories which characterize passive, active and hybrid façades we have to introduce a fourth category that is intelligent and dynamic façade.

2 METHODS

This new approach to the intelligent technological systems, in particular regarding facades, needs a different methodological approach and the introduction of new systems of experimentation able to reduce the current gap between the practical and the research fields. In this initial part of my research the interest will focus on intelligent facade for innovative building prototypes, high rise buildings, from almost zero energy consumption characterized by high value of adaptation and high energy efficiency in the Mediterranean area. This new bottom up approach allows to optimize the processes of analysis and allows us to obtain optimized results. The interaction between architecture and environment theme, leads us to analyze natural systems. The inquiry of the system in relation to the external inputs is the basis of the process that has the creation of the genotype, generative algorithm, and the analysis of the phenotype, physical model. Both exercises were carried out in Ascoli Piceno area(AP) lat.42 ° 51' - long . 13 ° 35 ' , and Meteonorm and Ecotect software reconstructed the city climate file. The first exercise is aimed to optimize the tower skin " energy " in order to identify, through the definition of a range of values , the energetically active parts and to determine their annual gain in terms of energy production. Specifically,

the analysis provides a bottom-up approach: after defining the weather file and the object of study geometry we passed to the environmental analysis through the use of software designed to optimize the skin behavior. Thanks to parametric design tools in Rhinoceros, in particular the link between Grasshopper and its plug-in Geco and Ecotect, it was possible to evaluate the effects of any changes made in the project area in real time. In addition, studied and defined the process, this study can be repeated for different climatic zones and for different architectural configurations by replacing the weather file in input stage.

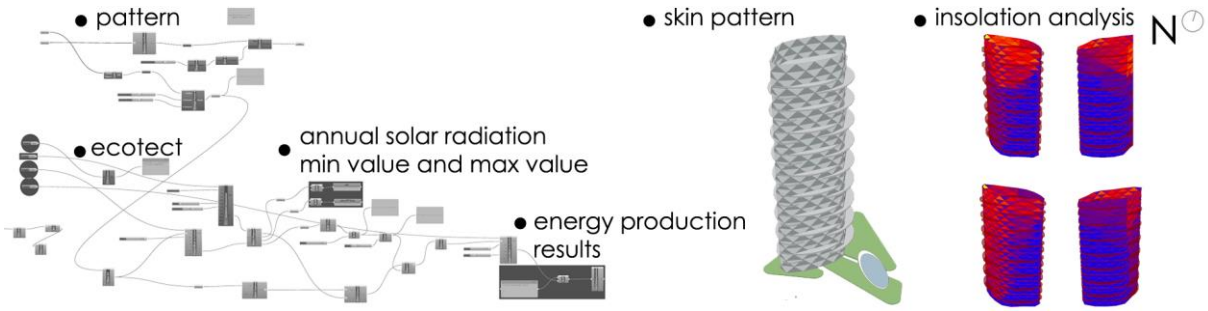

Figure 3. Bottom-up process for skin optimization: the image shows the process for the evaluation of incident annual solar radiation through the link between Grasshopper and Ecotect.

The second exercise aims to define an intelligent and adaptive technological system to apply to high-rise buildings, able to ensure an optimized response to inputs coming from the external environment. Specifically, after identifying the adaptive system we proceeded to "panneling" the analyzed surface through Grasshopper software, in Rhinoceros, and then we evaluated the result through Ecotect and Geco software. Once defined the input process, climate file and geometry, we analyzed in output stage the surface behavior among the inclination of the sun's rays in order to study its dynamic and adaptive behavior.

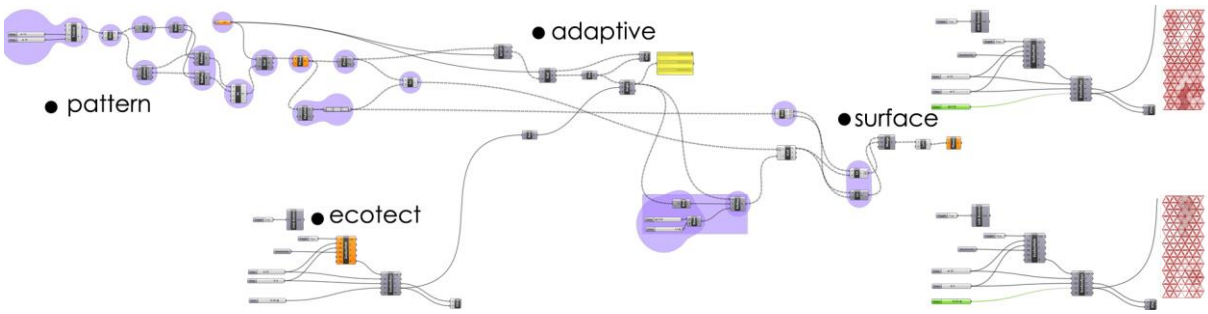

Figure 4. Bottom-up process for skin optimization: adaptation of daylight system in Mediterranean area. In particular the image shows the adaptation of the skin surface in relation to the inclination of the suns' s rays.

3 RESULTS

Both exercises aim to study surfaces behavior in relation with specific environmental and climate input changes; in the first case the incident solar radiation on the entire surface, measured in kwh/year, is used to define the surface energetically active parts and assess the need of technological devices able to shield and avoid their overheating. In the preliminary project phase, better don't underestimate the possibility to assess the energy gain derived from the surfaces energetically active parts. In the second exercise the adaptive capacity of the building external surface is tested in relation to the solar path, angle and incidence on the surface. The process aims particularly to define a dynamic surface able to open and close in an adaptive way according to the external conditions inputs, of natural lighting. The optimization as a guide in complex processes. Main difficulties, until a few years ago, resided in the technological know-how that would allow to consider architecture as a living and adaptive organism.

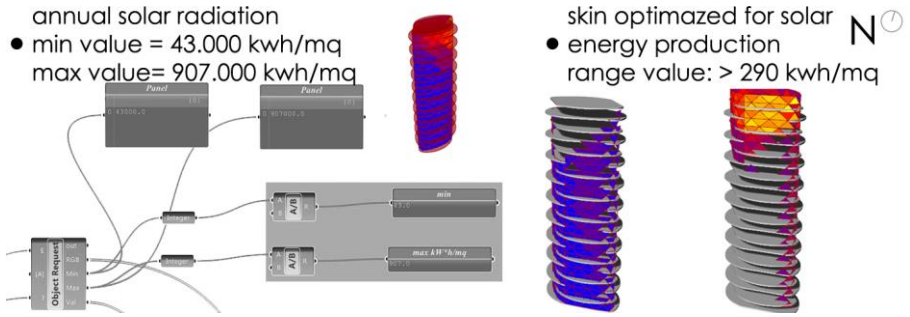

Figure 5. The image shows the surface energetically active parts and assess the need of technological devices able to shield and avoid their overheating through the definition of a range of values.

Each architecture would have its genetic composition and a specific combination of genes. The genotype will represent the intrinsic characters while the phenotype would be the character set that the architecture shows clearly. In biology it's well known: the phenotype depends on the genotype but also by iterations between genes and environment.

4 CONCLUSION AND OUTLOOK

The presented research proposed a new bottom-up process for developing a new type of building's dynamic façade. Skin becomes, in these examples, a technological intelligent system that interfaces with the external environment and its inputs. In this way the technological system is equipped with artificial intelligence able to collect and process data from the environment in order to return an optimized and adaptive response. Today, thanks to digital technology developed, you can safely talk about "form follows energy flows". The use of parametric modeling software combined with assessment tools and simulation of environmental performance, allows the development of technology components which record and respond to climate change creating a further project phase. In the next step of research the main objective is a territory research of companies able to invest and ensure technical and financial support for the realization of the prototype and reduce the gap between the research subject and the industrial production world.

Figure 6. Model prototype of dynamic skin for physical analysis with Arduino board.

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