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Il rapporto tra Sostenibilità e Innovazione tecnologica nella progettazione dell'ambiente urbano

Il quadro delle esperienze di ricerca in corso nelle scuole di Architettura italiane

Sustainable Innovation in Architecture

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Abstract:

The Research Group "Colour and light in architecture" of IUAV University of Venice collects about 15 researchers also active in other Universities such as Milan Polytechnic, University of Udine and other specialized research centers. The researches carried out have been articulated in a series of projects in partnership that produced outputs that extend from the models of sustainable management and development of cultural heritage up to prototypes of advanced technological solutions for the realization of high performance architectural envelopes. All researches have produced several scientific publications. The paper aims to provide a comprehensive picture of such researches.

ERC Keywords

PE8-10: Process design and control
PE8-11: Product design
PE8-12: Sustainable design

Introduction (P. Zennaro)

The discrimination on performing research activities having a chance to be accepted by a certain audience, whether specialists or the "everyman" (cfr. R. Musil), consists in knowing how to productively isolate an issue, to act within it in order to discover characters that have not been adequately developed and

especially, to be able to disclose it. Where the process of knowledge finds some obstacle you can experience multiple escape routes. "If a natural interpretation stands difficult in an attractive conception, and if its elimination removes the view from the field of observation, the only acceptable method is to use other interpretations and see what happens" (Feyerabend, 1975, p. 66). If you aren't able to promote and to tell, even in an unorthodox way, the research work results and making it attractive and if you aren't able to fill some uncertainties with justifications sometimes specious, the acceptance of the discoveries will become difficult. Galileo did so to convince the greatest number of subjects of the reliability of his hypotheses.

The action to put together a research revolving around three words such as Innovation, Sustainable and Architecture, necessarily involves the allocation of a logical process that puts aside any established methodology, or alleged, opening tout court thought the use of other interpretations. Given the current explanations of the meaning of the three words above, it seems necessary to establish a logical process that is highly critical, with the aim of putting aside any ideological deviance, abundantly common in current academic rooms, particularly in areas where this paper will appear.

It is known that the academy is not exactly the privileged place for openness to new ideas and the violent ostracism that characterizes it, put it out of the lived reality, out from daily practice. It should not be forgotten that "certain research programs disappear not because the arguments that lie behind them are defeated at the level of ideas, but because their defenders are killed in the fight for survival" (Feyerabend, 1975, p. 162). Translated for the mere mortals: the researches not finding financing, although of excellent quality, are razed by squalid competition with those who encounter an easy grip on the part of lenders who aim only to easy profit (economical, political or of professional career) even causing very heavy damage to the society, easily understood by the ignorant populace, sponsored by political, religious and cultural (or pseudo) figures in a bad faith.

At the Department of Design and Planning in Complex Environments of IUAV University of Venice there is a group of researchers who carry out researches on the theme of environmental and landscape requalification that revolves around functional technologies to improve the aesthetic and performance quality of the building skins. Within this group, which was born and cut his teeth in the period of activity of the research unit Colour and Light in Architecture at IUAV University of Venice, there is a clear awareness of the commitment needed to make seriously, free of charge, efforts that will be (are) deleted from totally unscrupulous evaluators of their work, even devoid of all human dignity. But the desire and the need to fly above these mishaps and contribute to the advancement of knowledge leads them to not give up and get very positive results, as to be internationally recognized (*Nemo propheta in patria*).

I feel obliged to point out in particular that two researchers, knowing where this paper would be published, refused to present their work. Given what I mentioned above, all that remains is to give them reason. Kudos to them and to those who have exposed below what they are doing. As for myself, I necessarily had to give some pointers to institutional duty and respect for those who are genuinely committed to the improvement of the culture in a scientific field on which cultural future I have serious doubts. I think not having to give additional guidance as my researches are widely known in the circle of intellectuals that I attend, disinterested to provide guidance to those who may not understand. Each writer will choose his readers (F. Nietzsche).

From plumbing defense to the materialization of visual defense. Poliorcetic Architecture in the Mediterranean: history, restoration, valorization and sustainable management (G. Custoza)

The Upper Adriatic area is characterized by a remarkable variety, also typological, of poliorcetic architectures, built over a very broad period of time, ranging from prehistoric forts to the fortifications of the first and second world war. This presence can be explained by the increasingly important strategic role that the region has assumed, at least since Roman times, in relation to the function of the hinge, located nearby the eastern Alps, increasingly significant in the context of the development of the fortified system of road of the Italian peninsula. This rich heritage of fortifying artefacts, of social importance at European level, presents major problems for conservation, restoration, valorisation and sustainable management. It is appropriate to put in place an ongoing monitoring of these buildings, an action directly related to the state of the architectural work, in order to gather the necessary information to support the action of protection. This is a development opportunity for the territories, also in terms of employment opportunities. The fortified architecture can and must be functional to the economy, to the labour market, to social inclusion, to sustainable development, training, and innovation. The management of this, must be based on a fundamental act of knowledge, restoration and valorisation. New needs and opportunities for the socio-economic area emerge. Several are the plans for the conservation of the works of ossidional art of the area

that the research activities we carried out examined, aimed to knowledge, protection, preservation, restoration of historic Sanmichelian fortified architectural heritage. The sustainable management and the virtuous use of the historical Sanmichelian architectural heritage are based on virtuous public-private partnerships. The model of re-use and sustainable management of historic fortified foresees the establishment of productive activities and sustainable business within different sites. This model is based on a set of fundamental assumptions. There are three lines of development we identified:

1. The identification of innovative models of knowledge, restoration, valorisation and management, specifically directed to the sustainable management of the historical architectural fortified heritage;
2. Identification of the main factors involved in creating a multiplier profit growth, the attractiveness of the environment in which insists the historical architectural fortified heritage;
3. The development of specific virtuous restoration practices aimed to combine the initiatives of revaluation, sustainable management and conservation of the fortress, with actions of social nature.

Smart Shading: adaptive sunscreen systems (A. Premier)

In the last years, personal researches have focused on the sustainable innovation in architecture, in particular for what concerns materials, technologies and products. These researches were published in the book "Innovazione sostenibile per l'architettura: materiali, tecnologie e prodotti", Maggioli, 2014. The research called "Smart Shading" is a deepening of these wider researches. It aimed to show how an intervention on the last finishing layer of the exterior walls can lead to a significant increase in the value of the whole building in terms of environmental quality and improvement of the thermal insulation performance. The project has been developed by Iuav University of Venice, "Colour and Light in Architecture" Research Unit, Veneto Region, Materis Paints Italia SpA and CERT Treviso Tecnologia (now T2i).

The research started with the goal of identifying new technological solutions for the protection of the external walls of the buildings from the summer sunshine, possibly through the application of innovative materials and smart technologies. The objective of the research was to develop, in collaboration with the partners, a thin (3mm) finishing system suitable to be applied on insulating materials (but also on other surfaces), providing adequate protection from the sunshine on the walls of the buildings. Even in a cost-benefit perspective the first phase of the research has shown that, to achieve the desired results (reduction of the surface temperature of the finish), it was necessary to work in two directions:

- Increase the surface reflectance of the coating system;
- Identify a three-dimensional configuration of the finish, able to decrease the surface irradiated by the sun (smart shading effect).

The research, which concentrated on these two aspects, has considered various possible solutions, identifying the use of pearlescent pigments the most suitable solution for increasing the reflectance of the surface finish. The work on the three-dimensional configuration of the finish aimed to ensure that a portion of the incident light radiation could be easily reflected and part of the wall could be shaded, reducing its total surface temperature. To achieve this effect we tried different solutions, identifying at least an "hacksaw" design for the stucco with an average slope of the "teeth" adapted to different latitudes. To achieve this special configuration we tried different tools. At the end of this process we identified the right trowel for the application.

After the of the new stucco was ready, to validate the research, we asked the "network partner" Treviso Tecnologia (now T2i) to carry out comparison tests on samples of panels treated with the new finish and panels with standard Materis Paints finishes. The panels with the new Smart Shading finish, in all the performed tests, showed a difference of surface temperature greater than the standard panels. In fact, with the same wall surface, the new finish increases the surface/volume ratio that enhances heat dissipation providing better performances of the walls in the summer period.

Smart glass art façade. Art glass intelligent components for building envelopes (V. Brustolon)

The research project entitled "Smart glass art façade. Art glass intelligent components for building envelopes" investigates and analyzes the concept of chromaticity, dynamism and interactivity of the architectural envelope through an in-depth investigation stage followed by a design phase characterized by the realization of chromatic and adaptive façade modules. The operative partner is the Simone Cenedese – Murano glass company. During the first half of the year the project has been focused on the analysis of the actual state: a careful and precise cataloguing was carried out of artistic glassware, smart and nano-structured materials, vertical glazed closures and media surfaces with the identification of projects already made (case studies) within the framework of external façade systems. The second period of six months is focused on the design of the prototype of the facade with non-traditional chromatic and bright characteristics.

The project idea draws inspiration from a famous chair designed by Joe Colombo in 1969 called the 'Tube Chair', characterized by 4 leather hollow cylinders linked together with hooks. In the same way the façade modules resumed the scheme of the four hollow cylinders made in Murano glass with a maximum diameter of 300 mm and a thickness of 4 mm, in order to ensure a certain type of safety and strength in view of their location in external facade.

These glass cylinders were hung from the building façade through a system of steel cables and fixed to a certain height through stainless steel clamps with self-locking system. In addition, within each cylinder, were positioned glass discs with suitable silicones, which thanks to ancient techniques of glass blowing propose an 'optical' drawing, i.e. a texture showing a spiral (with iridescent shades from red to green) that is capable of simulating a vibrating and animated optical effect. To allow maximum visibility of the facade even during the night, particularly innovative LED light bulbs were placed within some of the glass cylinders, at regular distances, hooked directly to the steel cables that support the glass modules. In the concave part of each cylinder, to allow a certain self-sufficiency in the supply of the Leds was applied an innovative photovoltaic paint called "Photon Inside". This transparent paint is capable of capturing in an efficient manner the rays of the sun and turn them into energy to satisfy the energy needs of the building. It can be spread on all types of large surface and can be reapplied as it degrades (although it is very weather-resistant) with lower architectural and environmental impact to practically zero and without any risk of theft. It also has a high efficiency: with 50 m² of wall it's possible to obtained 3kW of energy at half the cost, if compared with the common silicon photovoltaic panels.

Alternatively, it's possible to use as a light source a particular phosphorescent paint called 'Litroenergy'. This betavoltaic technology is neither toxic nor radioactive and the light is emitted in every condition, without having to be plugged into any power source. Since the first application, the average duration is 12 years.

I-mesh for facades. Architectural integration of textile sun shading systems for environmental sustainability (C. Gregoris)

The research "I-mesh for facades. Architectural integration of solar shading systems for the textile environmental sustainability" is part of a wider path, done in recent years, which has, as its theme, the building envelope and facade coating with high performance.

The research program "I-mesh for facades" is developed in collaboration with the University IUAV of Venice and the company Sailmaker International Spa, which produces high performance wings dedicated to boating. The company has also developed a number of technologies, born for the nautical industry, to create innovative materials dedicated to architecture and interior design. This material is an experiment of a series of "textiles" created by the intertwining of high performance fibres such as carbon, basalt, Kevlar, etc. The characteristics of durability and strength of materials used are interesting possibilities for external applications of a building.

The main objective of the research is the study and identification of technological solutions for the architectural integration of systems for dynamic and/or adaptive solar shading. I-mesh is created with innovative textile materials, in order to improve the environmental quality and thermo hygrometric performances of buildings. In fact, the field of textile materials' testing is very wide: in recent years the introduction of intelligent fabrics on the market, created a growing interest in these products and in the realization of facade systems.

Thanks to the deepening on the used textile materials and shading systems, a prototype will be test and product, which will have the lightweight and high-performance "fabric" with innovative and

patentable technology solutions. It must be a product that is competitive on the market, but as well innovative in architectural point of view: the result of the research on the use of colour, design of textures, plot and the choice of support for eventual manoeuvre systems.

The project, therefore, aims to produce an improvement of environmental quality (and as well micro-climatic) of new and existing architectural heritage, through the implementation of a specific system of solar shading for the building's facades, using innovative and smart materials as elements of protection, supported by fixed or mobile systems, that will be equally innovative.

Eco-Tile (A. Martini)

"Eco-Tile. Rivestimenti di facciata adattivi a base di materiali naturali, di provenienza sia estrattiva che di riciclo" is a research that can be considered a development of my last five years of studies on cladding, energy efficiency and innovative materials. Such research program, in collaboration with two international leader companies of the composite materials industry (Quarella spa and Poliver spa), points at the production of sustainable and raw materials based façade components that can be either recyclable or mining compounds derivatives.

The project aims at experimenting and developing a modular and combinable prototype, made of recycled materials which has to be applicable as an external cladding system: a component that can be sustainable from an environmental and energy efficiency point of view but that can also meet specific appearance trade requirements (adaptability, colour, aspect, surface finish). It deals with a transfer of technology applied to one of the best-known compounds of the composite material field: the artificial stone (also known as engineered stone). The artificial stone is a composite made of a mix of quartz, marble, or granite based filler joined to unsaturated polyester resins: a technology that derives from the ancient traditions of *cocciopesto*, *palladiana* or *marmettoni*, which were applied for both internal or external surfaces covering and that used to be on-site casting. Nowadays artificial stones use thermosetting polymers instead of cement matrices.

In order to make such innovative material more competitive, mostly in the façade cladding market, the research's aim is that of studying a cladding technology having mechanical-chemical and physical resistances and surfaces qualities (finish, colour, UV resistance) superior than the other materials' ones.

Being a technology that utilizes a vibro-compression of a grainy filler mixed to a thermosetting resin, such product solidifies in an irreversible way after a heat-treatment forming a webbed molecular structure. This is why we discarded the option of using thermoplastic polymers like the ones used for Solid Surfaces like Corian or HI-MACS (compounds having such qualifications).

The research target is obtaining, thanks to an addition of acids, polymers and reinforcements to the "traditional recipe", a composite material having the same characteristics of the artificial stone now in trade but with a superior grade quality of pliability.



Fig. 1. Marble design. Marmomacc 2014, Verona. Photo © Anna Martini

d'A.n.c.a.p., digital Architectural new cover and protection (R. De Monte)

Throughout the history of architecture, the facade has always been a fundamental element, the main factor of communication and sociality.

The building envelope delimits and defines the perimeter of the construction, its main function is to mediate and connect the inside and the outside and, at the same time, it divides, and separates, becoming an environmental factor, which circumscribes and identifies the outdoor areas of the landscape.

The experiments of the last decade, however, seem to want to give at the envelope a new feature: it has become, in fact, a media filter, a blank canvas where are projected and transmitted images, text, information. Following this new trend has been developed the architectural project of the d'Ancap, an international manufacturer of porcelain. The client required the creation of a new layer, a new external structure that could redevelop the existing building and also become an element of communication and advertising.

The analysis of the surrounding context, mainly hilly, allowed to trace the profile of the new wrapper, a 'veil' white ceramic which, in addition to providing a new visual impact to the company, has also equipped the building of a new insulation filter of which was completely devoid seen that the first part of the company was made in 1964.

The project for the middle of the new coating, the point at which were present the glass parts, has been designed as a light filter, the area where the most innovative and communicative intervention could come to the surface. Thus was created a band of conical ceramic elements, joined together so as to form a mesh, in this way the natural light filter inside the building, while, in the night hours, the strip of LEDs inserted in each cone allows the transmission of messages to the surrounding context.

The lighting system is electronically programmable through dedicated software, so the management of the images and text can be changed according to the needs of the company.

The roof system has been reworked through the placement of metal mesh scales that support the panels of cadmium telluride, a photovoltaic material that has excellent performance even when the sky is overcast or there is diffused light: a way to completely undo the future consumption lighting system of the new casing and lower the overall consumption of the company.

Conclusions (P. Zennaro)

The facade is the part of the architectural envelope that represents the building, it is its *facies*, look, appearance, able to communicate to the outside all the inner movements. It provides direction and meaning to the artifacts. Without the facade we would not be able to understand the motives of a complex set of works. This is what all the common people believe is the architectural envelope. Trivial! Tautological! Foolish! How can a person with average reasoning, even mediocre, think and even write such trivialities. Yet how many books of building technology we had to read unwillingly where full professors of building technology and their legions of flies which absorb their stench, wrote such meaningless ruminations. Architectural skin is art, a caricature of thought, at best, or a foolish and clumsy simulation of what you aren't able to express in words. "Ce qui est vrai seulement (...) c'est que seule de toutes les opérations expressives, la parole est capable de se sédimer et de constituer un acquis intersubjectif" (Merleau-Ponty, 1945, p. 231). The realization destroys every project proposal transforming the artifact in an object that does not communicate, cumbersome, which wastes space. Only the Architecture with a capital A, as a work of art, can try to approach to have some message, to take some sense. The rest only serves to the poor in spirit. The researches we presented served to deepen this way of thinking, trying to clean up from dirt and stench of unhealthy interpretations.

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