PERFORMATIVE ARCHITECTURE: NEW SEMANTIC FOR NEW SHAPES?

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Abstract. Two innovations have more deeply changed the building process: the operational continuity of the design and construction phases and the software allowing not only the representation but also the autonomous creation of complex shapes never before thought, just because they could not be represented. This last innovation introduce to a "Performative Architecture" that addresses to emerge a new kind of architecture. Building performances (structural, environmental, energetic) are guiding design principles, adopting new building performance-based priorities for the design of cities, buildings and landscape. This emerging architecture places broadly defined performance above form making; It utilises digital technologies of quantitative and qualitative performance-based simulation to offer a comprehensive approach to the design of the build environment. Some aspects of "Performative Architecture" theories are critically examined and we report two experiments made using these procedures. The results try to give a contribution to detect some misunderstandings in relation to recent building projects shown.

Keywords. Performative Architecture, simulation, performance..

1. Environmental performances

Environmental influence is shown by the action of force fields which can be either tangible, such as the force of gravity and weather conditions (i.e. wind, solar radiation) or intangible, such as the forces emerging from those environments linked to significant cultural and natural heritage. Hence, the shape given to the building becomes the expression of the peculiar forces animating the environmental context. Such forces may be used in shaping the building with the aim of attaining specific objectives, such as "energy efficiency" and "eco-sustainability", or rather of simply expressing purely shape-related environmental influence, as it is the case with "Free-Form" surfaces (Kolarevic B., et alii, 2005).
For "New London City Hall", solar radiation was used as the environmental reference parameter in developing shell geometry and solutions. The interaction between this model and sunlight was studied and its features were modified by modifying surface control points effectively until obtaining the optimal shape for energy performance (Fig. 1).

Figure 1. Foster and Partners. City Hall, London (2002). Nine phases of model

For “Swiss Re Tower” (Fig. 2), direction and speed of prevailing winds played a fundamental role in identifying the best relation between morphology and energy performance of the building shell. The digital model underwent specific tests through a CFD system, called “FLUENT” to simulate air currents flowing around the building.

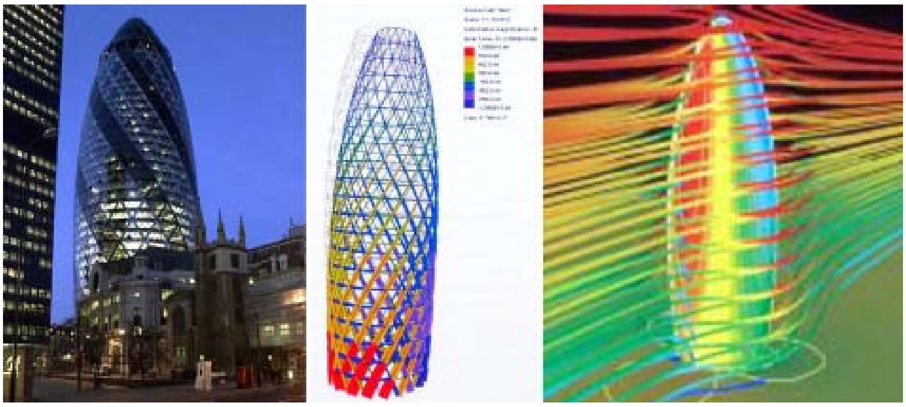

Figure 2. Foster and Partners. Left: Swiss Re Tower (2004), London. Center: the FEA analysis of stresses. Right: the CFD analysis (FLUENT)

For the “BMW Exhibition Pavilion”, the “Blob” system was used to develop the “Bubble” pavilion in order to devise a dynamic shape expressing the action exerted by physical forces when two drops are merging (Fig. 3).

Figure 3. B. Franken, ABB Architekten. BMW’s Exibihtion Pavillion, Frankfurt, (1999).

Visitor flows were assumed as reference trajectory for modelling software. A quadratic trajectory was obtained by projecting the perspective of a single walking spectator. The digital model was examined by using different methods, such as the FEM, Gaussian analysis, CNC machines (Fig. 4).

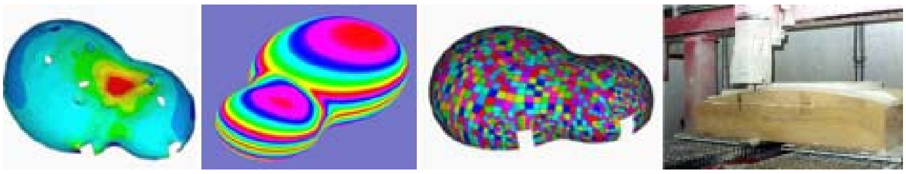

Figure 4. B. Franken, ABB Architekten. BMW's Exibihtion Pavillion.

The "Dynaform Pavilion" is the space representing complex dynamics through the simulation of a car accelerating within a matrix of parallel lines. The external context was then included into this force field through the action of some disturbing forces simulating the effect of surrounding buildings. The "master geometry" (Fig. 5) was developed by deforming the matrix lines as a consequence of the force field produced by acceleration.

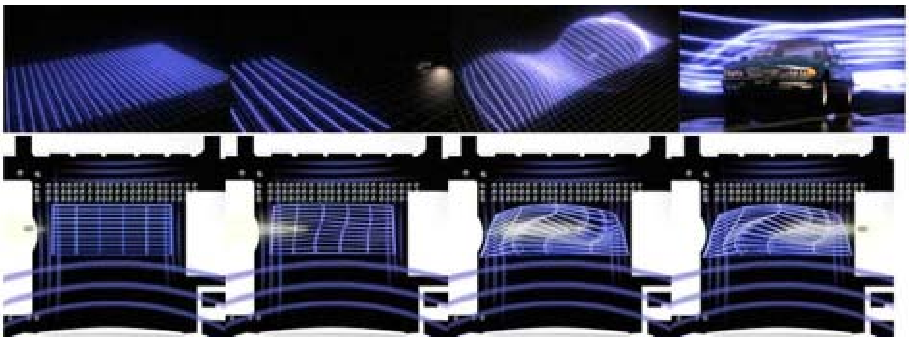

Figure 5. B. Franken, ABB Architekten. Dynaform Pavilion, Frankfurt (2001). Form follows force: the line matrix being deformed by the moving car.

2. Two experiments

The theory of the influence that contest forces exert on the formal choices of architects sensitive to them seems in the same time convincing and dubious. Convincing because of its reference to environmental aspect of which an objective presence is asserted. Dubious just because this objectivity is subjectively asserted; which seems a patent contradiction. It seems reasonable to think that much depends on the "strength" of the context, on the presence of highly characterized natural configurations or dynamic phenomena. We decided to perform a simple experiment: the simulation of the deforming activity of "landscape forces" on a project previously designed (Colajanni et alii, 2006). The environment is a place at the foot of the mountain chain closing the Palermo plain. The mountain behind the lot is the dominant element of the close environment. The hypothesis is that the mountain exert an attractive force tending to distort "autonomous" volumes, geometrically defined according to only self-referenced configurations. The attraction should fold the volumes towards the mountain. The project chosen fits well to the experiment as its shape is geometrically clear, self-centered and independent from context influences. The project comprises a small airport station with an annexed congress centre and an hotel. The meeting halls of the congress center acquired the characters of auditoriums.
The volume most sensible to the attraction of the dominant mountain is the hotel because of its height and slimness. The most important point of view is the access street. The searched effect has to be well visible from it. The attraction of the mountain was interpreted as a set of

forces directed towards it and applied as a thrust to the side of the hotel body opposite to the mountain (Fig. 6). The sensitivity of the hotel body to the contest forces had to be evaluated and simulated.

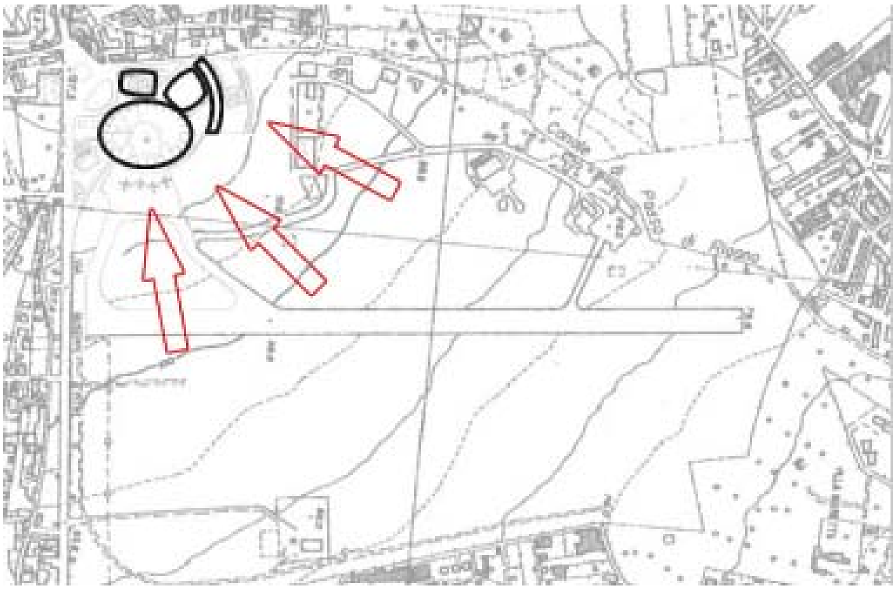

Figure 6. Plan showing the context forces.

A possible way was to compute the deformations of the hotel body by means of finite element method software, recycling and modifying intensity of forces and/or elasticity of the structure until a visible deformation could be obtained. This way besides being long had an intrinsic contradiction. Elastic deformations are always small enough as not to change the geometric conditions of the static equilibrium; just the contrary of what is needed. 3D Studio Max supplies another way: the volume is considered as made of a soft material, whose behavior is conditioned by some parameters as mass, friction, relative, density, stiffness damping, air resistance. The acting force is wind. This mechanism of simulation allows much more intense deformations, more deep and irregularly than a FE software could make. In the simulation, some elements are restrained to the soil, representing a certain will of resistance to the context force, besides the necessary stability.

The following figure 7 show the results on both sides of the hotel body.

The results of the experiment are not immediately readable. The deformations are wide and somewhat irregular. The relationship with the mountain laying behind can be understood only after a careful consideration of some data of the procedure. The shape of the inward flexion of the lee side is a consequence of the restraining effect of the two towers and of the upper chain. On the mountain side an extroflexion can be read as the effect of an attraction, again restrained by the fixed elements of the building.

Of course the experiment is very simple and does not pretend to give enough elements to dissipate all the perplexities that such innovative approaches arise. The deformation tools is powerful. It allows the reshaping of previous forms as you want. Less easy is mastering the results once the object parameters, the restraints and the force fields are given. We think that the subjectivity of the interpretation of the force fields is substantially confirmed. We don’t think that the looseness of correspondence between the hypothesized nature of the context forces and the voluntary model in which they are translated denies reliability to the procedure.

It only brings the same looseness in the meaning that the deformed shapes are able to express. However this is nothing new: subjectivity, i.e. personal individual characterization has always been the very essence of art and then of architecture. What is wrong is denying this subjectivity.

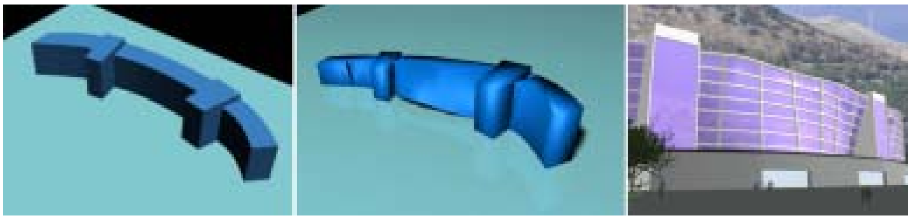

Figure 7. Hotel volume before the Performative Architecture design process (left). South fa ade after process (center). North fa ade after process (right).

The second experiment carries out an application of the “Generative Design” methodology to design of a specific technological system (Bazzanella et alii, 2007). The envelope of an existing building needs to redefine his shape in order to improve the aspect and its energetic and lightning performances. The experiment does not define a design methodology but tests a process referred to a specific case not easy capable of generalization: an industrial building in Torino constructed whit regular and prefabricated elements in which the actual envelope will changed by a double skin ventilated fa ade. The external wall will consist in stone panels fixed to structural support by inclined mullions of variable length in order to generate a new shape with a not plan ruled surface (Fig. 8). The process of generating the envelope components is directly and dynamically controlled-verified following some design criteria like solar lighting or air flow and heat exchange. In fact, changing variable values of the functions that describe these phenomena, during the design of the envelope shape, is possible to evaluate system performances and make some changes interacting on the morphology of the elements defining the fa ade.
The software used is “Generative Components”, a parametric and associative system based on the CAD Bentley’s platform (Microstation e Triforma). Generative Components has two fundamental characteristics: creating objects which geometry is controlled by parameter defined whit functions and macrofunctions; the immediate propagation of any variation of one parameters to all others connected whit formalized relationships. Like for the “New London City Hall”, the process of performances control/project modification can be managed and implemented by this software. The digital model of the envelope has been implemented with Generative Components, through the definition of a ruled surface whose directrix, corresponding to floors of the building, are constituted by b-spline curves. The surface thus achieved is divided into triangles. Each triangle is the base for a computation of the solar lighting with external software: “Sun angle calculator”. This tool provides a method of determining solar geometry variables for architectural design, such as locating the position of the sun relative to a particular latitude and time. It was developed by “Libbey Owens-Ford Company”.

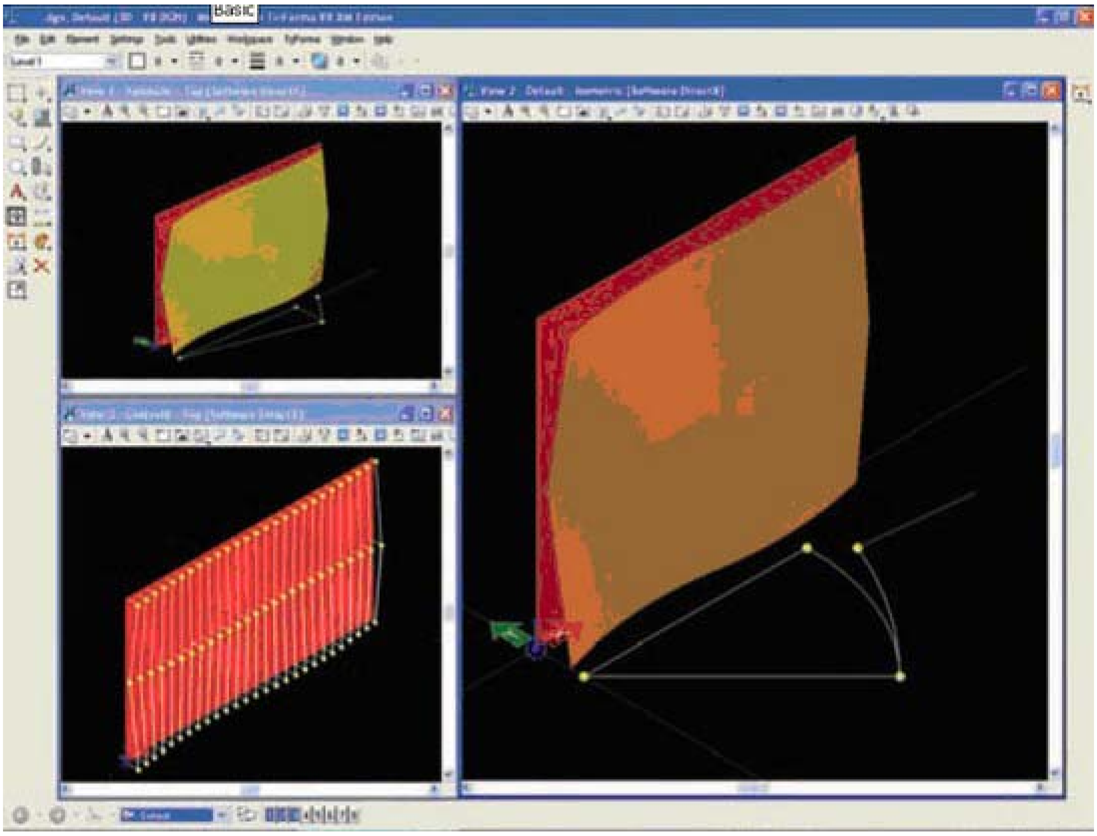

Figure 8. The experimental system, display Generative Components.

The distribution of the solar lightning on the fa ade of the building is visualised with a colorimetric representation (Fig. 9). Therefore variations of solar lightning values, in order to improve the system performances, interactively produce modification of distances of the panel junction points, corresponding to mesh of the fa ade network, and different their orientations, modifying in a controlled way the envelope configuration.

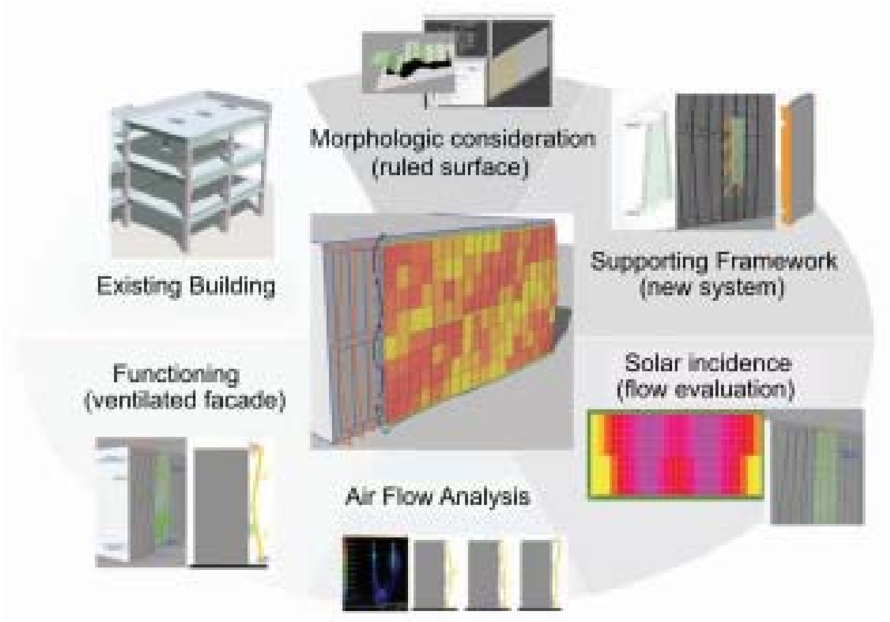

Figure 9. Representation of the interaction-process.

3. Performances as design criterion

One of way to generating new shapes commits the deformation of a starting known shapes to a system of forces directly act of this. The simulation is carried on a model endowed with virtual, global mechanical properties. Virtual mechanical forces (also possible metaphors of non physical influences) are expected to produce virtual mechanical deformations. The aim is ambitious, the simulation of the effect that the context exerts on the shape. Some perplexities raise naturally. Let us refer to Franken's words: "Admittedly, we cannot grasp forces directly with our senses, but can only infer them through their effects. Our experience, however made is very sensitive to deformations that correspond to a natural play of forces. Our perception is thus conditioned toward forces, and uses them to interpret shapes. Deformed forms carry information about the forces at their origin" [Kolarevic B. et alii, 2000]. Substantially, Franken affirms the "a priori" impossibility of grasping the system of context forces before their action on the objects. From their effects they can only be inferred, not known. Moreover, information about the origin of the forces can be drawn only interpreting the deformation with our sensibility. So, if the hearth of the design procedure is the deformation effect of such a force system it is difficult to avoid the rise of some perplexities. How to foresee the system of forces to which the designed shape has to be submitted, if also its origin can be inferred only from occurred deformation? And, overall, how to translate, not physical forces into mechanical (physical) models of action and reaction? Isn't the determination of the force systems, supposedly representing the influence of the context, somewhat hydiosincratic, largely subjective, and, eventually, arbitrary inasmuch as it is not susceptible of validation? And how to decide the degree of virtual deformability of the shape? Also an interactive procedure generating a series of refined solution cannot escape the arbitrariness of guessing the system of context forces. Notwithstanding all those uncertainties Franken has no doubts: "The forms we generate are never arbitrary, they can be explained and are subject to rationalisation" [Kolarevic B. et alii, 2003]. We maintain our perplexities on the real correspondence of the obtained results to the asserted procedure independently of their architectural value, which is, in the end, the only thing that has importance.

4. Toward a new semantic?

The paradigm of "Performative Architecture" introduces two different approaches to design. Both approaches go beyond the prevailing formalism which characterises the most recent expressions of contemporary architecture, giving new shapes to requirements which have always been connected with architectural design. The first approach entails considering the architectural work as being particularly sensitive to its surroundings, the latter perceived as a group of forces able to directly determine the building shape. The surroundings are indeed interpreted in a broad sense, i.e. not only in terms of their physical features but also in terms of the dynamics pertaining to end users. Adopting such an approach is quite difficult and may be dangerous due to the discretionary interpretation of these forces. Once again, it may result in the attempt to justify new kinds of formalism. However, it responds to real requirements. The second approach, the most traditional one after all, is heavily influenced by performance assessment exactly from the first stages of the project, also by means of automatic equipment for direct retroaction. We could define it as neofunctionalism. This is a trend towards developing really interactive software applications which are susceptible of promising future achievements, being able to establish real-time interaction with specialised software applications for performance calculation. The use of "Generative Components" is an example of this interaction between building shape and designer.

"Performative Architecture", along with the help of IT tools, enables architects to check dynamically the whole evolution of the work. Moreover, it offers new opportunities for designers both paving the way for up-to-date morphological experimentation and establishing new relations between working methodologies and implementation of the architectural design. Nonetheless, although the contribution to operational continuity made by these tools is clear and valuable, the influence they exert over the possibility of actually creating new shapes is less evident. In some cases, using such innovative tools becomes an occasion to state that they belong to a completely unknown form of architecture: the "new architecture". Formal innovation may be the means to show the designer/creator's skill in using IT tools and to officially acknowledge their state through a special language. Still, it is not the goal, i.e. creating a form of architecture which is innovative as to all its meanings. However, it is evident that using innovative tools does not necessarily produce innovative architectural results. We only have to observe the past to realise that original architectural and building expressions have existed which have been based on shapes designed and represented by means of analogous tools, well before the widespread use of computers in design.

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