Creative Construction Conference

Three Entities to Maximize Creative Construction Quality

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Abstract

Creativity in construction is somehow intrinsic to the nature of designers. Never, as today, was there such a demand for newness. In Portugal, the situation is no different, where there is a body of young professionals eager to unveil a reality never before attempted or, simply, unknown to them. The momentum supports their motivation to experiment, with greater or lesser awareness, though not always with the desired results, either for lack of: training; information; handling of materials and products; openness of the Project Owner; specific and cross-cutting knowledge of other sciences (present in the maturation processes / sinterization solutions); accuracy in the use of technical terminology; professional and productive environment; test systems, prior validation, construction methodology, approval, robustness assessment, assurance and documentation for registration.

At times, news about the construction sector are disconcerting, even on outstanding works that evoke architectural creativity - supported by creative construction - as a purpose. Those are often awarded in international competitions, of recognised merit, by partners, operators and future professionals.

The creative construction, by principle, is based on the reassessment dogmas! This statement, in the reality of contemporary construction, widely systematized, may translate into an overwhelming success but also into its opposite. The repetition of a defective solution can lead to the collapse of the whole, exponentially. Only a system equipped with tools that allow control over the decisions, in the different stages, can prevent failure, through the evaluation of those and consistent report on their impact, particular and overall. The involvement of fundamental entities, in the different phases, makes it possible to anticipate the robustness of the solution, a.k.a. creative construction, by the different operators, with general skills in diverse areas of knowledge, such as: assessment, monitoring and validation in the design stage or construction work; and assumption of guarantees, including corrective, if need to minimize the overall impact.

Keywords: construction; guarantee; products; roughness tests; certification and approval; labs.

1. Introduction

The need for protection against the natural elements led men to build shelters. In a slow, pondered and reflected-upon technological evolution which later asserted itself as popular architecture. Such evolved towards the maximum efficiency with no room for lack of value. Measured by trial and error, over the years, in a successful dichotomy. Knowledge - informally - transmitted from master to apprentice, reached another level with the development of manuals associated with theoretical and practical training.

The incessant search for novelty is intrinsic to designers. Through the supremacy of the solution. Be it for the simple conjunction of formulas or merely for the application of a theory: in short, the art of construction. On the one hand there is the need to innovate, overcome, demonstrate and present findings to peers, on the other the risk of possible failure by lack of knowledge, unconsidered, it is real and can ruin a construction solution. This may be mitigated by further research: access to information is now universal and, mostly, free. There are, however, other channels - so-called traditional - such as Detail Magazine (architecture detail), a monthly publication of excellence for the design / construction.

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The globalized world tends to relate to those themes indistinguishably. In Portugal, the situation is no different: almost everyone searches for novelty, at any cost, in order to surprise others, either through innovatively materials conjugation, by importing a constructive methodology or the use of "new products" (local or otherwise).

2. Context

2.1. *Situation*

Creative construction is, by conviction, the attitude of questioning dogmas, prevailing standards and preconceived truths. This requires will and courage, which we must all recognise. This determination applied to the largely systematized contemporary construction could lead to an overwhelming success. But also its opposite, as the repetition of a flawed solution, from the outset, can lead to the failure of the whole, in an exponential way.

Creative solutions are possible based on merit, technical and artistic or technical-commercial, proper or derived from stimulus (e.g., publications, exhibitions, lectures, conferences, among others). They embody an appeal to the advancement / development in construction, to which most designers capitulate before the solution geniality - believing that thus will become the author / product that we all recognize by the option that consecrated him/it. However, despite the immediate success there is a tendency that after an ill-considered decision problems arise with high maintenance costs and no practical solution, as shown by the examples included in this article. The problems even if detected tend to be ignored (e.g., designers, general contractor, project owners, et cetera), with the exception of the operator and end users. By the former, when problems interfere with proper functioning; and the latter - with no direct ability to solve them - through ongoing interaction with the resulting constraints.

In Portugal - with professionals with an average age around thirty years *[Manuel Villaverde Cabral, coordinator, and Vera Borges, "Relatório Profissão: Arquitecto/a", a study sponsored by Ordem dos Arquitectos, INSTITUTO de CIÊNCIAS SOCIAIS, UNIVERSIDADE de LISBOA, Lisbon, November 2006.]* - it is required a dynamic domestic market and that the industry (European, North and Central) is sensible to their desires. Currently, both seek to meet the needs and global values, conditioned by the hegemony of the countries with strong financial hold. This allows to accommodate and promote research centers to develop "innovative products", welcomed with great enthusiasm by professionals. The allure for newness makes them "exciting for any project", a situation that tends to divert attention from the real technical characteristics, which can trigger degenerations (both physical and chemical reactions), and the environment in which will be inserted (environment, techniques learned, construction means, et cetera), eg, when mixed with standard materials and building products.

2.2. *Reasons*

"At the City of Arts and Sciences, a huge project by Santiago Calatrava in Valencia, Spain, work is under way to fix problems that have cropped up since the project was built." by Samuel Aranda for The New York Times, about the same issue, "What you see over and over again is that rather than searching for functionality or customer satisfaction, he aims for singularity," said Jesús Cañada Merino, the president of Bilbao's architects' association. [by Suzanne Daley on 24/09/2013, under Art & Design" section, entitled "A Star Architect Leaves Some Clients Fuming - Santiago Calatrava Collects Critics as Well as Fans by Santiago Calatrava" published in "The New York Times", website.]

Excessive use of imported products - as it is the case in Portugal - can lead to extremely complex situations. With the logistics at the head of the problem: supply, rehabilitation and interventions. Issues that make it difficult to maintain the original qualities - losses enhanced by the degree of request (e.g., load) exerted on the solutions - with aesthetic and functional implications on all the systems. This condition has greater impact on public buildings, especially the ones with higher turnout, which tend to evidence an rapid wear, resulting in: widespread damage (eg, extension of areas, size of elements/parts and technical repair and specialty - infrastructure and networks); technically demanding maintenance; and difficult management of spaces / facilities. Building complexes, both contemporary and historical, are also vulnerable to the above described issues, with countless constraints (eg, transport of oversized loads - simple in the case of the current approach): not considered, by decision-makers, in the course of construction works.

Changes and adjustments during the design or construction phase are in principle reasons for the loss of quality and robustness. Those are related to the long development periods of projects, motivated by bureaucracy and / or legal approval processess: in a dynamic market, this leads to the replacement of products and the consequent appeal for novelty - a choice imposed, thus less weighted than the whole. Although these are often motivated by economic

reasons their contribution can be very positive for the overall result. But if negative, can have serious implications on the remaining elements. It becomes imperative to validate decisions.

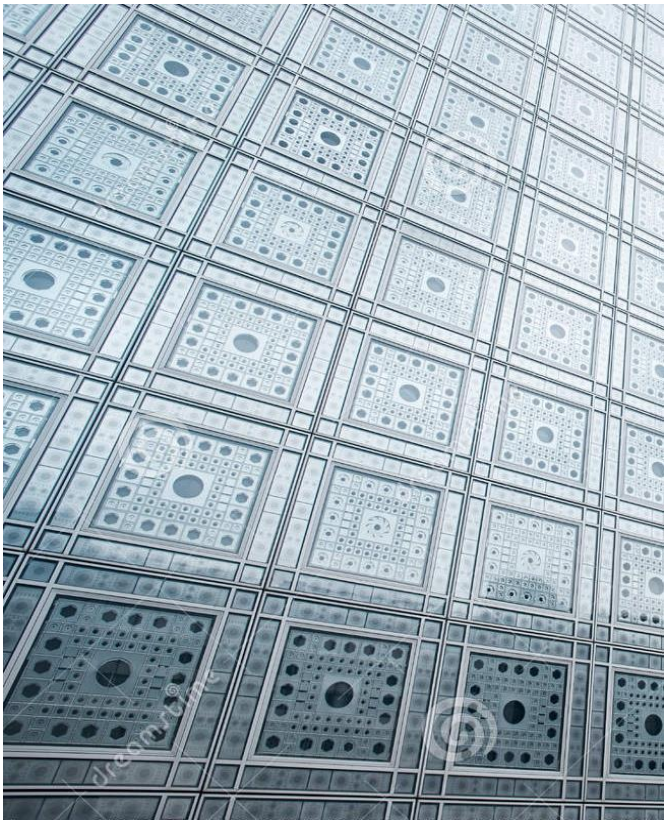
Workers in Valencia, Spain, fix leaking windows in a science museum by Santiago Calatrava, photo credit, Samuel Aranda for The New York Times.

Regarding coordination (projects - architecture and specialties), the technician in charge should be prepared to deal with the introduction of alterations:

- In general - symbiotic relationship - the system appears based on the solution and depends on it, and;
- In particular - antagonistic nature - the nature of the solution is not consistent with the general condition. The differences can cause complex problems, only understandable in the scientific field.

In the concession-construction process, due to the very short development period, should there be a need for adjustments they need to undergo a methodology based on reliable and tested data.

Specialities (infrastructures), by nature, are not predisposed to change and when subjected to them reveal dynamic problems, with transversal implications. These situations tend to reveal their full extent, during the use of the building, through constraints on the functions assigned to spaces, on the constructed elements and / or productivity of equipments, with impact to users.



"…the south facade of the building consists of high-tech photosensitive mechanical devices which control the light levels and transparency…

In 1980, 18 Arab countries concluded an agreement with France to establish the Arabic World Institute. The main purpose was to provide information about the Arab world and set in motion detailed research to cover Arabic and the Arab world's cultural and spiritual values.

The design competition was won by Jean Nouvel, who is widely known for his particular surface treatment with "smart" materials, and with this kinetic facade for the Arab World Institute, he designed a facade who responds to changing environments.

To achieve this, the south facade of the building consists of high-tech photosensitive mechanical devices which control the light levels and transparency.

It interprets traditional wooden Arab latticework screens into a glass and steel construction with 30,000 light-sensitive diaphragms on 1600 elements, which operate like a lens of a camera. The changes to the irises are revealed internally far more than what can be observed from the exterior.

The unique use of high-tech photosensitive mechanical devices made this building famous in 1987. Nowadays its still widely known and hasn't lost its futuristic impression, but the facade system no longer works." *by Van Poucke on 31/ 01/ 2011, under History, Technology, Uncategorized, entitled "Arab World Institute by Jean Nouvel" published in "Kinetic Architecture" website.*

2.3. *Products*

Trendy solutions, fostered by commercial strategies, are difficult to compare to the competition, since the advertised results represent a clear case of self-promotion. These do not strive for quality of the technical and scientific information and are not adjusted to local conditions, technologies and knowledge in the construction industry, which increases the responsibility of the technician collecting information to justify the option taken.

Technological and commercial gains justify the use of certain products, without raising questions about its efficacy (?!) - assuming the goal is to ensure the best price/quality ratio. European certification or approval of a product, with no rebuke, does not guarantee its robustness. The durability, expected or achieved, for a given country can not be guaranteed to another. Latitude, maritime proximity, industrial development, skills of the labor force and construction management are some of the constraints that undermine the certifications and approvals established by and for "Europe" - a recurrent situation in Portugal!

If we analyze the innovative products, or perceived as such, especially imported, we can conclude:

- Commercial/Business level - conditional technical data - through the use of non-current systems, shielded by non-European standards and approvals, difficult to understand - diffusion through promoters, always influential among decision makers, with an emphasis on superficial benefits (aesthetics), without any credible support to the information presented - problems only become visible / known after application (construction) and consequent exposure to the elements;
- Laboratory level - Approval / Certification - the introduction of new products requires assessment by accredited laboratories (eg, LNEC, ISQ - Instituto da Soldadura e Qualidade, among others), requested by manufacturers or their representatives - the results tend not to be disclosed or, if necessary, are adjusted by the interested parties to serve "commercial" purposes;

"In the specific case of paint, the results appear inflated by 30 percent, a clear discrepancy between the assayed and commercial information. The strength test is conducted in a controlled environment very different from actual/real conditions which are more complex, they tend to focus on the normative benchmarking, not always effective on solutions, particularly composite (combined or overlapping). The products when subjected to specific tests (e.g., chemical and biological attacks, wet and dry friction, wear from use and cleaning, sunlight exposure, mechanical erosion) with no time limit, show an offset performance, since the abuses occur simultaneously and

for long periods of time - with different intensities and fluctuating force cadences, revealing a natural degeneration adjusted to local conditions."

- Construction level - the application of a product or solution - after completion of the work, the natural degenerative process begins which may reveal some of the aforementioned issues, then it is possible to record degradation phases that reveal the amount and extend of damages, in cases where the solution is repeated across the whole (modular construction), the implications will be multiplied, creating a harmony of damages - repairable through specialized work with unweighted costs - with impact on the robustness of the buildings and therefore the industry that supports them; trial and error is ineffective for consolidating solutions, from the viewpoint of a promising technology.

3. The entities

From the authors point of view, creative construction, especially in qualitative terms, would benefit from the contribution of three entities:

- **Accredited/Institutionalized laboratories**, in Europe, already accredited to perform certifications and homologations - based on standards, conditional on payment - organised entities with capable and experienced human resources, supported by state-of-the-art equipment. Based on information available, could produce documents supported on standardised normative criteria, which are simpler to read and free to access - as it happens to documents on the energy efficiency of buildings and sections thereof, the basis for their public promotion -, online, the interested parties - manufacturers and distributors of materials or products - would assume the costs and information disclosure, to clarify and complement the commercial information, to increase the ability to communicate the actual features of the products / materials in order to inform the industry actors.
- **Universities / Colleges** are credible and independent institutions, recognised across borders on their merits in furthering scientific based knowledge. Equipped with means and resources, especially human, skilled, eager and capable of taking an active role in the analysis of the behavior and effects of the elements / constructive solutions, in a complementary way. It is recognized the commitment that modern societies do in research centers, often associated with educational institutions. However, there is a sense that those do not contribute sufficiently to solve real issues in their respective fields and to the improvement of various social systems - e.g., education, justice, security, health, economy, and more. In an effort to reciprocate the investment that societies do in them, innovative products could be assessed in an university laboratory environment. This possibility promises great scientific interest. Market players promote and share innovation. Students would take part - in a path that is starting - motivated to address these issues with minimal bias in the acquisition of knowledge, on applying rules and procedures in the test environment (robustness). Teachers would assess - through a scientific approach, of a practical nature - disseminate knowledge, the results would be debated widely with contribution to the improvement of the status quo.

Motivation is the key word. When we feel motivated we tend to ignore the passing of time, focussing on success and recognition.

[In the 90s, Bill Gates, founder of Microsoft, created an encyclopaedia - Encarta - with the participation of entities, recognised for their scientific merit regarding published content, and justly respected for their opinions. At the beginning of this new millennium a new concept appeared, founded by Jimmy Wales - "Wikipedia - an open source in which anyone could input their opinion, free and spontaneously, at the same time, the shared opinion was controlled by others of equal value and motivation for the debate. Thus was born and bred the largest human encyclopaedia. It is possible to dispute the quality of the shared knowledge, for not being validated by entities accredited for such, but it only depends on those, since they have the possibility to do so. Many already do it, others have their employees doing it. "Encarta" is just another moment in history and, by chance, in the memory of some.]

- In the system in place, the construction industry, there is a shortcoming regarding quality assurance - conclusion which results from research taken for other articles / studies. Risk analysis emerged as a new field of intervention in the system. At the moment there are no qualified technicians for this role, which could easy and quickly be taken by architecture and engineering graduates, currently in sufficient number to take on roles outside the traditional path (designers). Through a Master's level course, traditional or integrated, taught at faculties with the support of Instituto de Seguros de Portugal. Employers would be offices geared towards risk analysis or insurance companies. The risk analysts would work to ensure quality, covered by a insurance policy for the warranty period - freeing other parties to their natural responsibilities: promoter to promote, designers to design, supervision to

supervise and the contractor to build. Specifically, risk analysis should promote testing even in the design phase, to control the accuracy/rigor of the implemented construction, with the intent to assess the quality and capacity with use. Less claims, more profit - from a market economy standpoint. The involvement of key entities such as risk analysts - as strengthened in "Risk Analyst: a new player in the construction processes - Portugal"** - allows to predict the performance of the solution, especially when dealing with experimental construction, with the following phasing:

a) design/project - assessing the proposed solutions - control and validation, design and implementation of test construction, and;

b) construction - checking the rigor of the chosen solutions, imposing corrective measures to minimize the overall impact, extrapolating the behaviour for the guarantee period, assessing the risk of degeneration, specific and general, and documenting the process.

"The structural problem of the Millennium Bridge is due to "synchronous lateral excitation", where the footfalls from pedestrians create lateral movements in the bridge. These movements are enhanced when the pedestrians attempt to compensate and match their footfalls to the bridge's movements. At more than 156 pedestrians this type of movement increased visibly in the Millennium Bridge. The structural problems were studied at the Cambridge University Structure Laboratory." and "Chronology: 10 June 2000 - On the opening weekend, over 150 000 people use the bridge. On Saturday, larger than expected movements are experienced as larger crowds cross the bridge; 12 June 2000 - The bridge is temporarily closed to assess the deflection problems that occurred in the first days of opening, and; 22 February 2002 - After addition of dampeners during a £ 5 000 000 repair program, the bridge re-opens to the public." by unknown author on unknown date, entitled "Millennium Bridge" by Norman Foster published in "Structurae" website.

4. Findings / Conclusions

The proliferation of ideas that shape brilliant insights, of artistic nature, at the level of construction which, when effective, are a success story - although naturally uncommon.

The standardization of technical documentation, a proven asset for the construction operators, with gains in communication and a decrease in misunderstandings, would allow proposals to be interrelated and the compatibility of products embedded in a solution to be verified, as well as their relationship with local and respective specificities.

The introduction of educational institutions is justified by their natural predisposition to acquire knowledge without profit as motivation, a position that would allow testing the degenerations on constructive solutions in collaboration with the producers / representatives in conditions similar to reality, but in a laboratory evaluation.

This research considers that bold construction processes, especially experimental, must be subject to procedures which ensure the control of efficiency and robustness, in a system able to identify and correct errors, for operational efficiency, overall comfort and safety. A construction quality control system equipped with tools - that allow the monitoring of decisions, by stages - can prevent failures, by evaluating the options, with the subsequent learning and reporting, for future reference.

Case study for this research/paper

Shading solutions - in this case, external shutters with metallic foil profiles (movable, with non aerodynamic blades) and brise soleil (fixed) - present low durability, since the strong wind gusts and intense sun exposure contribute to the fast degradation of petroleum-based materials (recurrently used due to low cost associated with them) which cause damages and occasional disengagement/detachment of elements, with possible risk to passersby.

The devices installed on the windows of the classrooms, of the Escola Superior de Comunicação Social from Instituto Politécnico de Lisboa, of an italian brand, sold through a national representative (importer), without the capacity to make repairs, condition which requires, in case of need, technicians to come from the country of origin of the products to the school, equipped with the necessary tools and accessories, with all of the costs and logistic means that entails.

The difficulty or even the impossibility of repair/maintenance resides in the mounting system, the little space available inside makes it difficult to operate/handle and the outside requires the use of lifting means.

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References

[1] M. Taylor, H. Hosker, Quality Assurance for Building Design, United Kingdom, 1992.
[2] L. Dias and M. Alves, Organização e Gestão de Obras, Instituto Superior Técnico, Departamento de Engenharia Civil e Arquitectura, Lisbon, 2002.
[3] Moutinho and I. Vila, Gestão e Organização de Obra, Porto, Universidade Fernando Pessoa, Oporto, 2003.
[4] Sycodés - Observatoire de la Qualité de la Construction – Qualité, Progressons Ensemble, Agence Qualité Construction (AQC), France, 2006.
[5] Sycodés - Les Indicateurs d'Évolution de la Qualité de Constructions, Agence Qualité Construction (AQC), Tableau de Bord, France, 2008.
[6] V. Ribeiro and V. Cóias, Metodologia para Maximizar a Qualidade na Construção Nova e na Reabilitação, LNEC QIC, Lisbon, 2006.
[7] J. Sequeira, Redução de Erros em Obras de Construção Civil – Estudo Sobre Obras de Controlo de Qualidade Reduzido", Universidade Técnica de Lisboa, Instituto Superior Técnico, Lisbon, 2003.