

The strategic appropriation of performative geometries and local craftsmanship

Case study of a competition design entry

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Abstract. This paper analyses the design and development of a novel museum proposal over several competition stages by the Laboratory for Explorative Architecture & Design Ltd. (LEAD). The work was conducted in the context of a multi-stage open competition in which the proposal was the third place award winner. Using jury's evaluation reports the paper assesses the reasons for it being shortlisted for phase 2 and discusses the design changes that were implemented in response to the received score in phase 1. In parallel the international design community's response to the competition itself is scrutinized. This study presents the challenges and opportunities presented by the project's thesis, which states that generic design can be avoided and replaced with distinctive, innovative, and locally grounded outcomes when universally applicable digital design tools, geometries and structural principles are merged with local singularities. The paper concludes with possible ways forward for implementation of the design thesis in future competitions.

Keywords. design competition; light-weight roof structures; performative geometry; biomorphic; craftsmanship.

Introduction

This paper uses the third place winning open museum competition design entry by the Laboratory for Explorative Architecture & Design Ltd. (LEAD) to analyse the validity of its concept and the potential for future application in architectural design and competition.

The competition entry argues that generic design outcomes can be avoided and replaced with highly distinctive, innovative, and locally grounded solutions when universally applicable digital design tools, geometries and structural principles are merged with local singularities. It pronounces that innovative spatial solutions emerge when non-Euclidean, highly structurally performing geometries are coupled with locally available craftsmanship, construction materials, and building techniques; outcomes that celebrate regional specificity and generate identity without compromising on building performance and sustainability.

The paper studies the design development of the project throughout both phases of the design competition, and evaluates the project specific and general jury reports. It draws conclusions on the competition in general and ends with possible ways forward for more successful implementation of the design thesis in future competitions.

The Liget Budapest Project

In spring 2014 the Government of Hungary committed itself to erect new buildings for the six important cultural institutions in Budapest. As part of the "Liget Budapest Project" five fully anonymous open two-round international design competitions were

launched for six museum buildings: fine art, ethnography, music, and architecture combined with photography. A high profile international competition jury of ten members was assembled, including Marta Thorne, executive director of the Pritzker Architecture Prize. Half of the jury members were Hungarian, as were all four alternate jury members.

LEAD chose to enter the competition for the Hungarian Museum of Architecture and the Photo Museum, Budapest. For this competition 2635 persons downloaded the design competition documentation; 112 applications were submitted in the first round; and five teams were invited to enter into the second phase of the competition.

The objective of the design competition (Final report, Liget Budapest, 2014) was to find architects whose design submissions:

- can functionally meet the expectations of a 21st century museum [...];
- can offer a lasting aesthetic experience at the supreme level of contemporary architecture to the visitors and contribute to enriching the built heritage of Budapest;
- respect the historical park and environment of the City Park;
- create a unique, well-marked and identifiable complex of buildings conveying efficacious architectural ideas, capable of expanding the international recognition of Budapest and Hungarian culture;
- create open, transparent, alluring community spaces [...];
- comprise exemplary buildings of sustainable architecture that are innovative in meeting the most recent expectations;
- offer a long-term economical solution for the museum-type institutions housed therein.

Except for the competition for the Museum of Fine Art, four of the five competitions concluded in December 2014. For the Hungarian Museum of Architecture and the Photo Museum, Budapest the first prize was given to the Hungarian firm Középülettervező Zrt. with a design that comprised of two highly functional cubic volumes, one black and one white, placed quasi-symmetrically along the cultural axis entering the City Park. Second prize was awarded to the Italian firm GSMM Architetti who developed two minimally designed buildings with a strong reference to Ludwig Mies van der Rohe's Neue Nationalgalerie (Berlin, 1968). Third prize was awarded to LEAD and is discussed in this paper. Honourable mentions were given to the undulating surface design of UOA Co. Ltd. and to the rational grid-based project by De Ferrari y Grass Compañía Limitada (Plan Común).

Competition Phase 1

Phase 1 - Design

The design competition demanded for two buildings, similar in size and programme, positioned on the border between park and city. The buildings are located next to a public promenade on which they form a gateway to the park by being positioned on both sides of a new cultural axis. This axis will connect the city centre with the park. Both buildings have museum programmes as their primary function and in addition to public exhibition space also house an archive and research centre, a library and learning centre, and staff offices.

LEAD developed their phase 1 design with as main drivers a spatially engaging and structurally performative geometry combined with a strong integrated environmental design approach.



Figure 1
Night view.

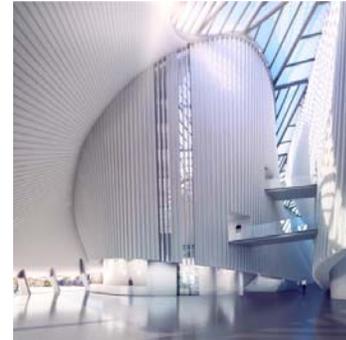


Figure 2
Interior view lobby

The competition brief stipulated no direct daylight in the exhibition spaces. Hence, the museum buildings are defined as two large roofs which house the exhibition underneath (see figure 1). The ground floor is kept open to allow easy accessibility and connection to the surrounding landscape. A canyon space is used to split the roof into two wings and bring daylight deep into the building core (see figure 2). Libraries and learning centres are positioned above one of the exhibition wings, where the roof opens up to provide views of the surrounding park and city. Large roof overhangs and minimal glazed areas reduce excessive solar heat gain (see figure 3). Most delicate and climatologically demanding core spaces are arranged so that they are buffered by spaces such as entrance lobbies or staircases.

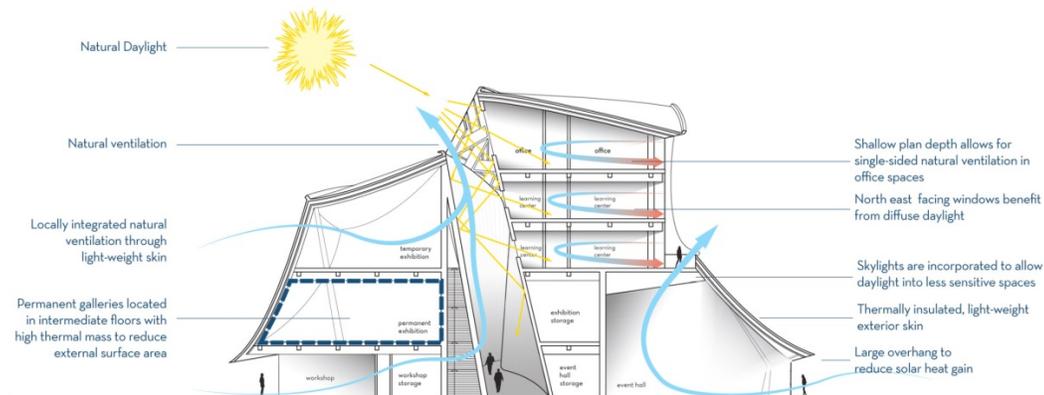


Figure 3
Building section showing energy strategy

The structural concept for the roof is the most significant space-defining element. Inspired by Frei Otto's Institute for Lightweight Structures (Stuttgart, 1967), a warm-roof concept is proposed that applies a tensioned cable net as its structure (see figure 4). Steel net is suspended between the canyon walls and floor edges. Curved steel profiles are used to prop up the net and create useable space underneath. Thin wooden

rafters running parallel to the supporting steel net cables form the basis for wooden roof planking. This deck is covered with mineral wool insulation, roofing and finally cladding.

Whereas Otto relied on elaborate physical models, or analogue material computers, to physically calculate his structurally performing geometries (Nerdinger, 2005), today digital simulation tools based on similar physical principles allow for a more streamlined and automated form finding process. Here, elaborate spatial and programmatic requirements were built into a parametrically controllable design model that permitted the real-time deduction of roof membrane geometries most suitable for the building programme. Not dissimilar from traditional attic spaced, the spaces below the roof adopt its geometry as a ceiling.

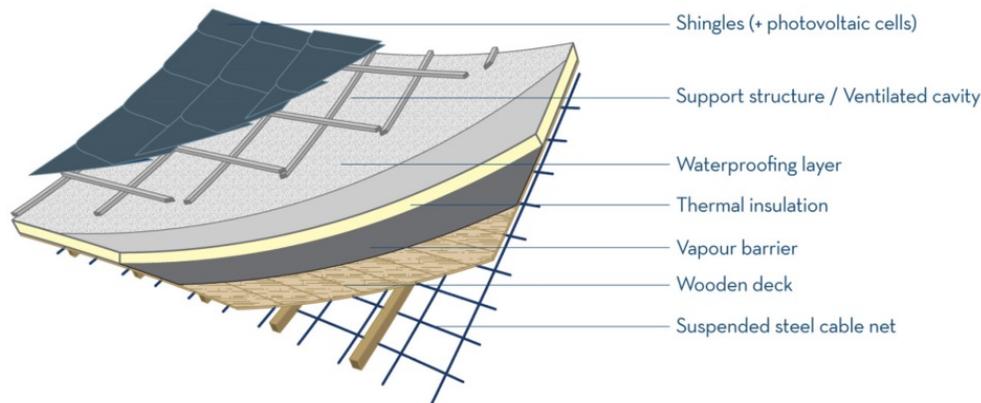


Figure 4
Roof build-up concept

Phase 1 - Evaluation

The final jury report (Final report, Liget Budapest, 2014) revealed that from the 112 applications submitted in the first round seventeen were excluded for infringing confidentiality and four failed to meet the content requirements. The report included a detailed assessment of the remaining entries and provided each entry's individual scores for all of the applied evaluation criteria. Figure 5 gives a graphical overview the author composed of these individual scores, including the normal distribution and the scores of the five teams that were invited to enter in competition phase 2.

Analysis of this data not only reveals information on the average quality of all entries: it also reveals the jury's unexpected response to LEAD's competition submission. Both the final winning and second placed team already took the lead in phase 1 with an overall score of 65% and 61% respectively. However, with only 44% as a total score, LEAD scored the lowest of all teams invited to competition phase 2, valuing the design below average (46%).

Generally speaking competitors paid most attention to “Sustainability” (60%), and “Technology and function” (52%). “Cost” was assessed rather high as well (50%), followed by “Dialogue with the environment” (42%). Lowest scores were largely given for “Architecture and mass formation” (27%), with the average grade for “General architectural impression of the building, mass, properties” being the lowest at 24% and “Unique, innovative external and internal appearance, character of the building” receiving the second lowest average score of 27%. The third lowest average score went to “architectural quality of spaces” (29%).

Hungarian Museum of Architecture & Photo Museum, Budapest

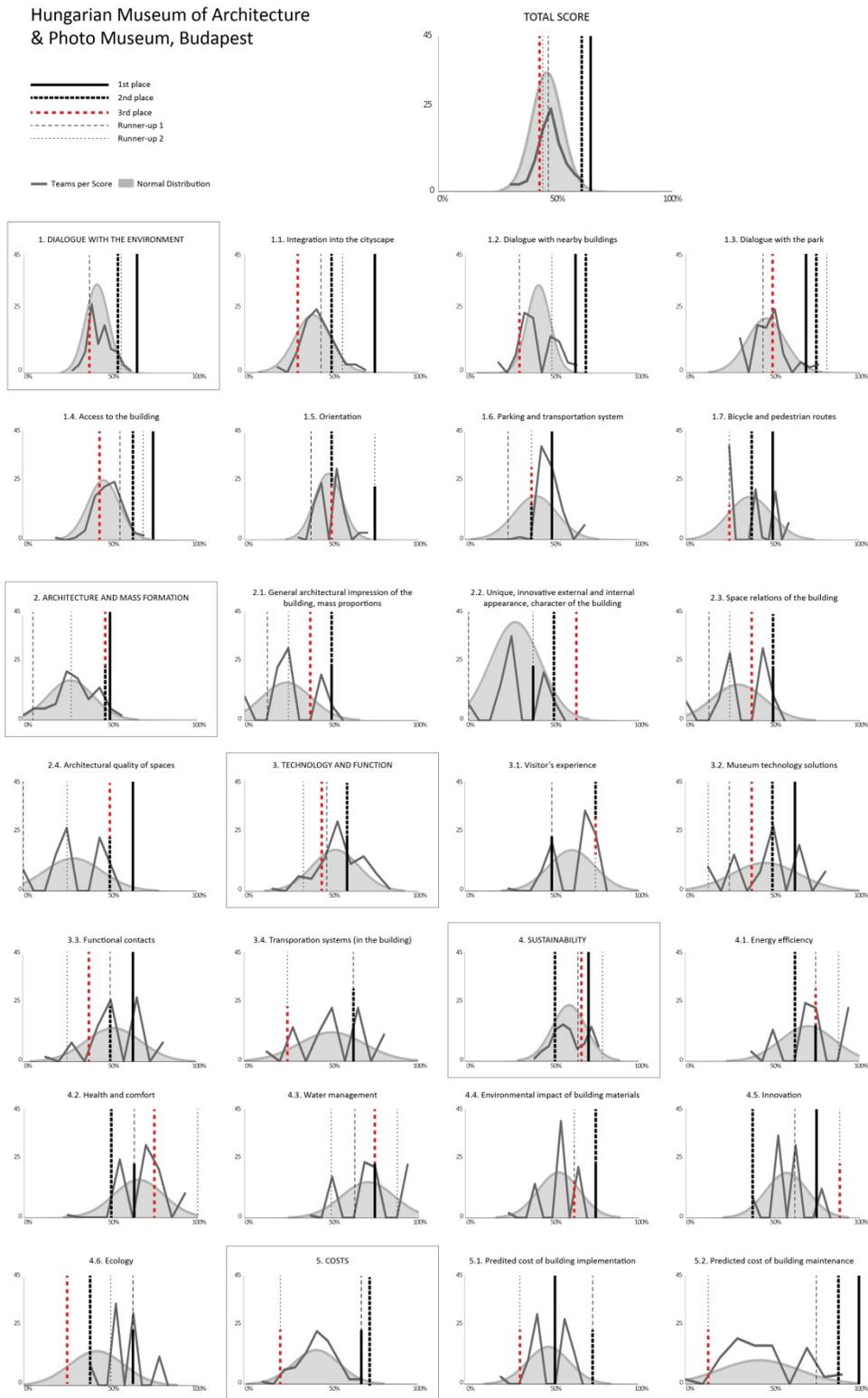


Figure 5
Overview of evaluation scores of Phase 1 competition entries.

Analyzing LEAD's score in more detail reveals that the jury assessed the "Dialogue with environment" to be below average (38%). They found poor "Integration into the cityscape" and "Dialogue with nearby buildings" (both 31%) and an insufficient development of "Bicycle and pedestrian routes" (25%). "Costs", which for most other designs receives high grades, gets the second lowest score from all entries (25%), with "Predicted cost of building maintenance" receiving a mere 13%.

For "Architecture and mass formation", however, the team is at the top with 47%, scoring even the highest from all phase 1 entries for "Unique, Innovative external and internal appearance, character of the building" (63%). "Technology and function" scores are average (44%), but "Sustainability" scores are again on the high side (67%). For "Innovation" again the highest score is given from all entries (88%).

Phase 1 - Conclusion

Without being able to generalise from this data beyond the scope of this single competition, some interesting conclusions can be drawn.

Firstly we can conclude from the average scores that the jury was far from impressed with the international design community's general architectural design quality. We see a tendency from the international design community when entering an anonymous design competition like this to focus on pragmatics and performance, rather than architectural design and innovation.

Secondly, the jury seems to have had a rather straightforward decision in picking the first two teams invited to the second phase. The highest two scoring teams were allowed to proceed automatically. The choice for the others invitees seemed to have been more challenging as only three teams were picked to proceed when the jury was permitted to select four (Liget Budapest Second stage competition program, Liget Budapest, 2014).

Data reveals that the jury opted to supplement the two leading projects with three "wild cards" – teams that excelled in certain aspects, rather than going for the highest total scores. This could potentially generate more diversified design options in the second phase. Where LEAD scored high in "Innovation" but low on "Cost" and "Dialogue with the environment", the eventual first runner-up scored extremely high on "Cost" (81%) in phase 1, but very low on "Architecture and mass formation" (6%). Similarly the eventual second runner-up scored extremely high on "Sustainability" (79%), with even 100% for "Health and Comfort", but rather low on "Architecture and mass formation" (28%), and "Cost" (25%). The two "safe" entries seem to have been supplemented with three projects with exceptional scores in the varied categories of Cost, Sustainability, and Innovation.

LEAD's push for architectural innovation seems to have struck a chord with the jury who decided to invest in one and only one ground-breaking project to see the idea developed further.

In hindsight this was a rather risky strategy for the design team to take.

Competition Phase 2

Phase 2 - Design Development

Together with the invitation to participate in the second competition phase, participants were only given their individual score sheets with no information on the valuation of other entries. LEAD developed their design further focussing specifically on answering the early shortcomings (see figure 6 and 7). Plans were thoroughly

reworked and optimised, a comprehensive landscaping strategy was developed for the surroundings, and responses were formulated to answer for construction and operational cost, dialogue with the environment, and internal building functionality. The most substantial change, however, came in the fundamental modification of the structural system.



Figure 6
Phase 2 design - View of café and promenade



Figure 7
Phase 2 design - Winter Perspective Dozsa György Street

Further studies by structural engineering consultants revealed fundamental issues with the originally proposed tensioned steel net. Impractically high degrees of anticlastic curvature in the roof surface were needed in order to reduce the necessary tension on the steel netting and with that the supporting structure underneath. In addition the cost of the irregularly curved steel perimeter beams needed to tension the net would be prohibitive. Since no tension cables outside of the building perimeter could be used to tighten the membrane the suspended net system was abandoned.

In our search for light-weight structural alternatives "suspended roof structures" proved to offer a series of suitable advantages. A catenary curve is an unequivocally ideal shape in which there is only tension and no compression or bending. Unlike compression based load-bearing structures suspended systems are not in danger of buckling and use all material equally as there is no neutral plane inside the elements. Thus this system is suitable for very large spans with minimal cross-sections. For this system to become applicable as a complete roof structure the beams need to be additionally stiffened with a roof deck. This allows it to withstand alternating loads such as wind and snow and avoids excessive deformation.

The Ingalls Rink in Yale University, New Haven, built by Eero Saarinen in 1958, is one of the most notable first examples of a suspended roof structure (Merkel, 2005). From a parabolic concrete mega arch down to the concrete building perimeter numerous steel beams with a catenary shape are suspended. Six years later, in 1964, Kenzo Tange's Yoyogi National Gymnasium opened for the Tokyo Olympics. Here the concept was pushed further in two buildings, where metal beams were suspended from large tension cables for the Olympic Pool, or from a concrete pillar for the Sports Centre (Tange, 1984). The curvaceous geometries were maximised to create the dramatic interior spaces for the celebration of sports. Nearly a quarter of a century later, in 1987, Frei Otto expanded the suspended roof system even further by converting the steel system into a wooden alternative. Four experimental manufacturing pavilions were constructed for Wilkhahn in Bad Muender, Germany (see Figure 8), using a wooden hanging truss system that is a purely tension structure (Nerdinger, 2005). Starting from two three-jointed purlin frames of laminated wooden beams, curved rafters were suspended. On these rafters a double-curved wooden shuttering made from standard tongue-and-groove planks was nailed in order to

provide additional strength. The double curvature of the surface allowed the roof to withstand variable loads using a minimum amount of material.

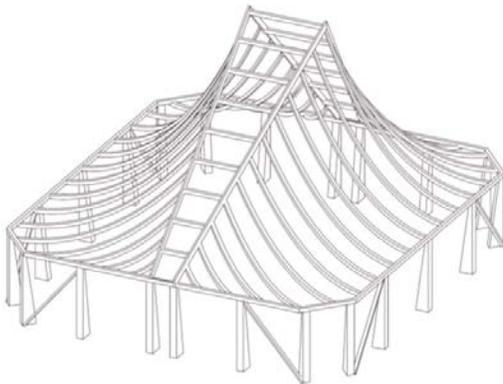


Figure 8
Structural concept of the Wilkhahn Manufacturing Pavilions, Bad Muender, Germany, Frei Otto, 1987-8

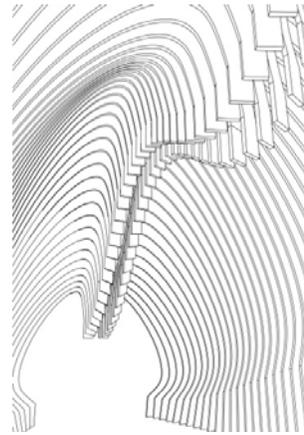


Figure 9
Interior view of wooden ceiling structure for the Farkasrét Mortuary Chapel, Budapest, Hungary, by Imre Makovecz, 1975

Following a more in-depth study of 20th century Hungarian architecture and locally available craftsmanship, LEAD opted to expand and adopt this wooden catenary roof concept further. The reason for this is that Hungary has a very strong tradition of experimenting with wooden roof structures. 20th century Organic Architecture, represented by preeminent figures such as Imre Makovecz in Hungary and Rudolf Steiner in Austria, produced some of the most unique roof structures known today (Heathcote, 1997). Buildings such as Makovecz' Farkasrét Mortuary Chapel (Budapest, 1975) (see Figure 9), Roman Catholic church (Paks, 1987-91), or the Hungarian Pavilion for the Universal Exposition of Seville (1992) portray the seemingly limitless possibilities Hungarian wood craftsmanship permits.

A highly innovative and unique roof typology was devised, tailored for Hungary's existing craftsmanship, by combining the fluid geometries of Organic Architecture with the performance driven geometries of Frei Otto's suspended roof systems and 21st century computational design tools (see figure 10). With this both museum buildings are given a locally grounded, contemporary, and sustainable building solution that produces highly engaging interiors (see figure 11).

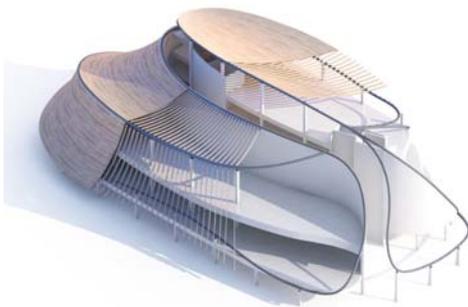


Figure 10
Structural Concept



Figure 11
Event Hall Interior -- Hungarian Museum of Architecture

A comparative analysis between the final phase 2 design system and a system based on traditional bending beam framework justifies the selection of the catenary beam option as it uses 19% less timber.

In addition to the structural system also the roof finish was used to ground the project locally. Numerous examples of buildings that use highly ornate and colourful roof tiles were found throughout Budapest primarily stemming from the Art Nouveau era when the city was at its cultural peak. The Zoo's Elephant House by Kornél Neuschloss-Knüsli (1912), only 500m away from the site, applies blue coloured tiles on its revolution-shaped roof geometry. Also the Matthias Church received a colourful renovation of its roof and both Ödön Lechner's Museum of Applied Arts (1893-6) and Geological Museum (1896) boast coloured roof tiles.

The phase 2 design solution was developed with globally available digital tools and structural principles for structurally performing geometries. Specificity and identity, however, is found through the integration of local craftsmanship and references. The combination of material and cost saving with the investment in the local construction economy gives the project further financial and social justification.

Phase 2 - Evaluation

In the end LEAD's design entry was awarded third place – the winner of the “wild cards”. Unfortunately no grade sheets were released in phase 2 that would allow the more objective assessment of the design development and comparison with others. The final jury report however does give a textual evaluation of the projects by various jury members. These reveal a divide in the assessment of LEAD's phase 2 design.

Although the project received very strong support from those focussing on performance and technicalities, and was even labelled the strongest in terms of energy concept, occupant health, material efficiency and its use of passive and hybrid solutions, the overall biomorphic form seemed to by some have been found too categorical and dominant in appearance, not suitable for the environment in which it is placed, and even a compromise to the detriment of functionality. In terms of cost the project was ranked fourth out of five (Final report, Liget Budapest, 2014).

Moving on

The challenges of successfully integrating non-standard geometries into architecture are widely known and it is difficult to assess the validity of a specific design approach using one single architectural design competition. Design concepts are far from fully developed in competition stage and it would be premature to assess their validity.

Objective competition data and jury reports are rarely made public, making it problematic to draw general conclusions. Although jury evaluations and score sheets of the other Liget Budapest museum competitions have been made public, the phase 1 submission designs have not. This makes it impossible to track certain design changes and responses to the evaluation throughout the competition phases. Nonetheless, a comparative analysis between the scores from all five Liget competitions would allow for a slightly more general conclusion on tendencies and trends in museum competitions today.

The practice will need to enter further design competitions to get a clearer grasp on the suitability of the design strategy presented. A more rigorous and successful combination with more conventional and mundane assessment criteria is needed to avoid the risk of being the jury's “wild card”. Invited competitions, rather than resource draining public competitions, would be a more suitable platform for this.

Conclusion

This paper starts from the premise that today innovation can take place by replacing non-standardised architecture's abstruse argumentation for form with reasoning grounded in building performance and locally available resources.

By following a competition design entry throughout several design phases, and by analysing and comparing jury reports and evaluations, the challenges and risks in dealing with innovative proposals in a competitive market are laid bare. Conversely, the process also makes visible the opportunities that out-of-the-box thinking can bring as the jury here sought to spice up an otherwise safe group of phase 2 participants with three "wild cards". From these "wild cards" the design seeking architectural innovation, rather than cost-saving or sustainability achieved at the expense of design quality, took the lead.

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