Scripted Vernacular Architecture – Invisible Computation

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Within a given short period of time, how to achieve the equal quality of collective customization as vernacular architecture does through a long time? How to systematize vernacular styles without losing its semiotic meaning to the local community in the context of computational design?

Computational design has been mostly used to explore new forms for pushing the boundary of architectural discipline. More and more surprising "architecture" is generated by scripting to make people so dizzy that it seems anything can dress up as "architecture", no matter what the "body" may be. It reminds me the Avant-garde architects in 1920s who naively believed new technology can bring human being a beautiful world, whereas the world evolves into many depressions and even the two world wars. Architects tend to be heroistic with the belief that they can save the world. Consequently, architecture has to bear obligations to resolve all the problems which would never follow the same way as the architects wish. It is true that this digital wave has changed architectural design for the first time in many aspects, such as influencing design thinking, changing design processes and, equipping architects with tools as advanced as those for creating artificial intelligent life. All the values of architecture have become so intangible that young architects often follow the visual madness rather than the thoughtful calmness.

Rather than keeping pushing the boundary of architecture, we are more interested in how to immerse the digital means into the synthesis of architectural design including social and economic values. This is why we look into new possibilities for vernacular architecture which has been formulated and is ready for a new creative presence.

Undeveloped regions in China

Economic development has become the irresistible force sweeping all over China where internationalism clashes into Regionalism. The tension between cities and villages intensifies at suburbs. How to sustain the culture merits which are deeply rooted in the local majority, meanwhile favoring the political and commercial interests of the minorities, is one of our main agendas for applying computational approaches. For new real estate developments in those areas, the lack of sustainability compared to the vernacular living environment is essentially because of the rapid speed of development for both political and economic reasons. Consequently, in order to meet the deadline, it has to erase architectural diversities and adaptability, which can be only achieved through the evolution for a long time. Can we design out one-off developments with the same qualities as vernacular architecture has? Intelligent computation together with empirical design sensation makes it possible.

Find architectural platforms

This essay is based on a project near Gui Yang, the capital of Guizhou Province[ii]. The gross land surface area is 95 ha. It comprises a high end resort, commercial streets, a museum, leisure & sport facilities and, residential buildings. The site location is between the old city center and the new city district triggered by the national high speed railway.
（fig 1）

Fig 1

Our first challenge is the rugged site topography. For mountain architecture, how to make the best of lands in terms of controlling costs, improving land using efficiencies and, stimulating coherent sceneries in site contexts, are among the issues haunting around many architects. Recently the central government has been stringent about the codes for mountain architecture after several fetal landslides and mud-rock flow occurred in southern China, e.g. to forbid any structure on slops with a gradient of more than 30 degree. In correspondence to this, we started this planning project directly in 3D by reading point coordinates (fig 2) on a survey map and translated them into a 3D mesh surface, so that many design decisions can be based on this relatively accurate 3d surface model with color-coded slope gradients (fig 3). Another obvious advantage was that we liberated from the survey map which always surveys contour lines based on 5m height difference. Now could we find the contour line wherever we introduce cutting levels. As for the road design, we had two approaches. One was cutting horizontally at particular level in relation to the adjacent roads. Secondly, for roads connecting different levels, we developed another script to find the shortest splines between two given points at different levels on a given surface.

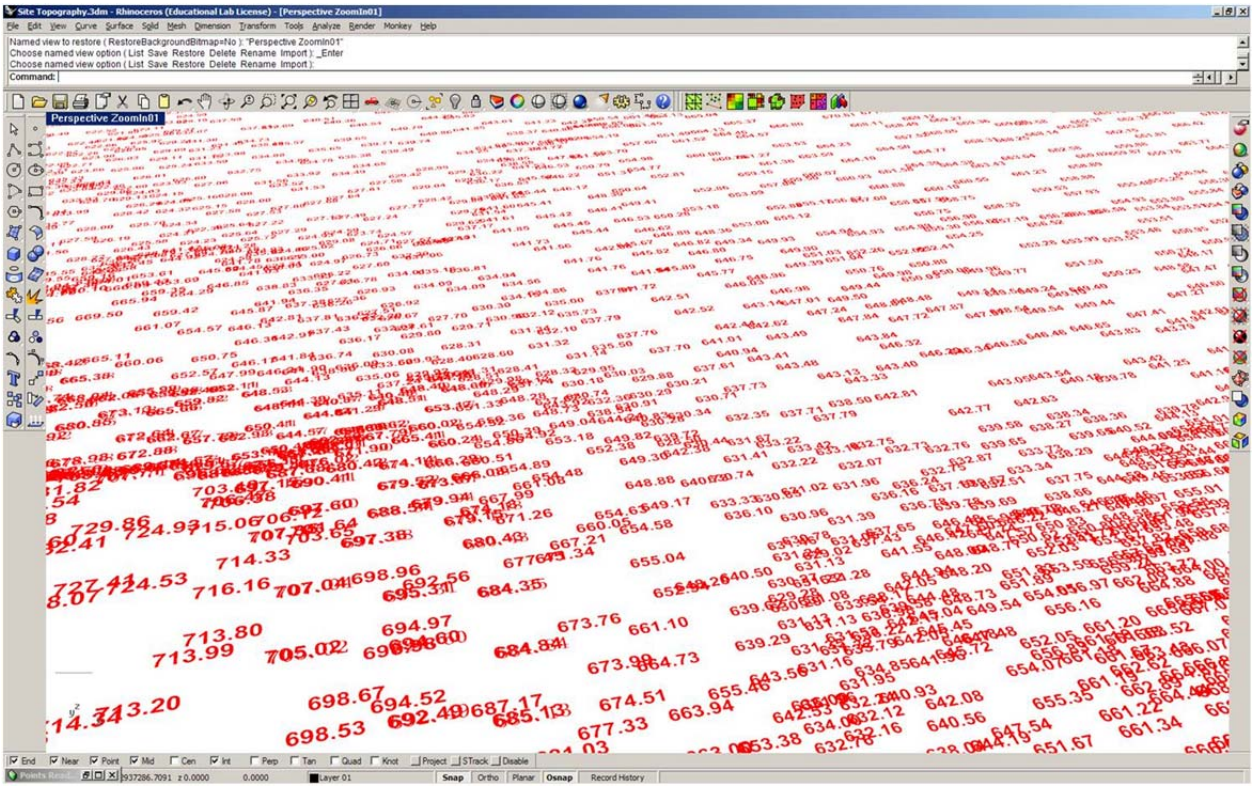
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Fig 2

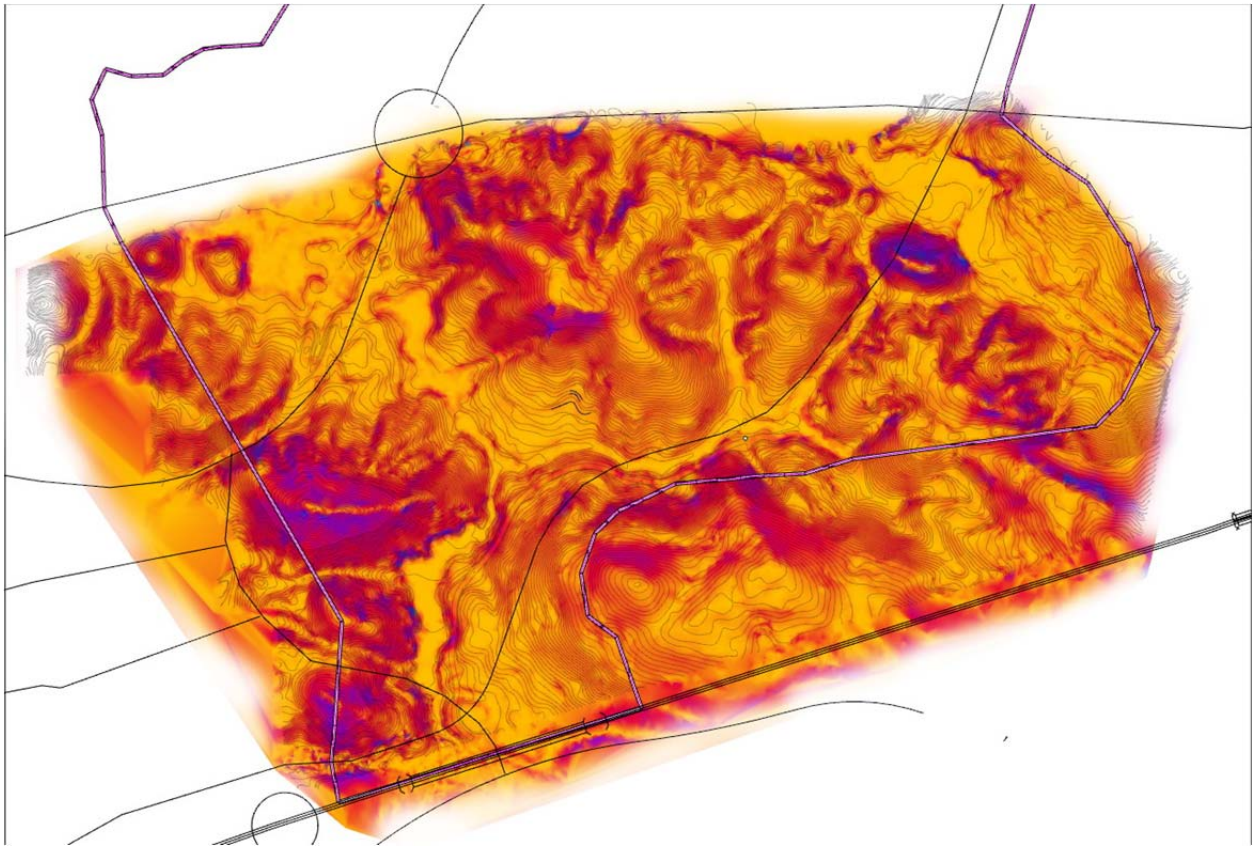

Fig 3

Thanks to this set of scripting tools, we can freely find all the appropriate building platforms at any level and controlled them parametrically (fig 4). For instance, if the height difference between two contour lines is 3m and the gradient is constrained to 30 degree, then the depth of that building platform has to be minimal 5.1m, which further varies according to the functions of that building. The adjustment of different combination of parameters also indicates the control of architectural density in relation to the landscape and public realms. The determination of the height difference between contour lines is the result of balancing land excavation and refill, as well as the visual and daylight impact to buildings at different levels. Even though the design may probably change later for many foreseeable and unforeseeable reasons, this design approach allows us to easily adapt the design content to new conditions without losing the overall quality.

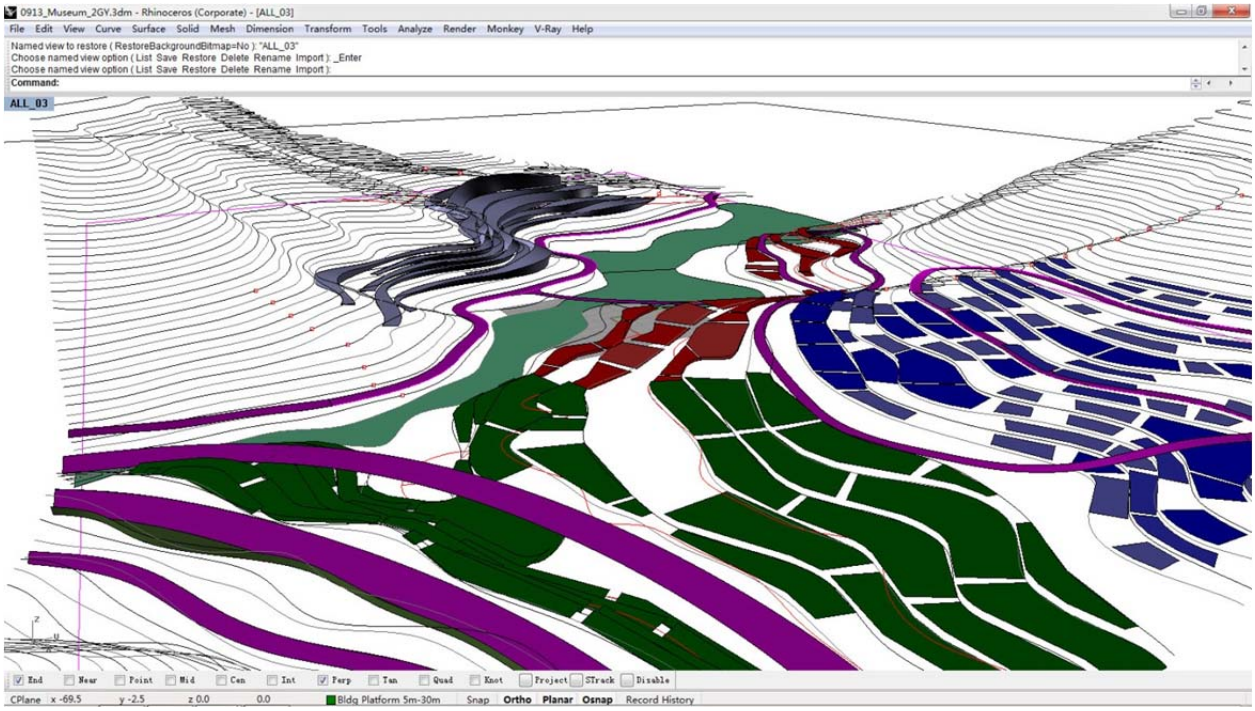

Fig 4

Grow architectural forms

The site is within a minority tribe region called Miao (fig 5). The local government is stringent about any new buildings against the architectural tradition of the minority culture. Design outcomes have to be valid creation based upon existing vernacular styles in addition to coherence to the complex topography.

Based on the exercises for finding appropriate architectural platforms with various evaluation criteria, we studied the syntactic rules of the vernacular architecture of Miao, which is essentially a timber frame structure with double pitched roof and living volumes suspended off grounds. Rather than the singular building style, it is the collective effect by thousands of houses on their best locations and with appropriate orientations that gives a recognizable vernacular style. Understanding this we need to advance the generation process to grow architectural forms out of the architectural platforms.

First of all, we designed a set of parameters sufficient for generating overall building frames which are essentially governed by pitched roofs. Based upon the outlines of the architectural platforms, we can compute the projection of roof ridge lines and lift them according to the building heights as per FAR. Then several rotating plans are introduced along roof ridges to define the plans where pitched roofs are to be located. The final shape of each pitched roof is the intersection between the inclined roof plans and extrusions of building footprints. Further down the line, the building façade frame can be developed according to the rafter spacing of the roofs (fig 6). All the faces have to be planner shape for not only referring to the traditional styles but also concerning of costs. It appears that the soul of the local vernacular architecture can be inherited as long as the collective roof effect against topography is achieved (fig 7).

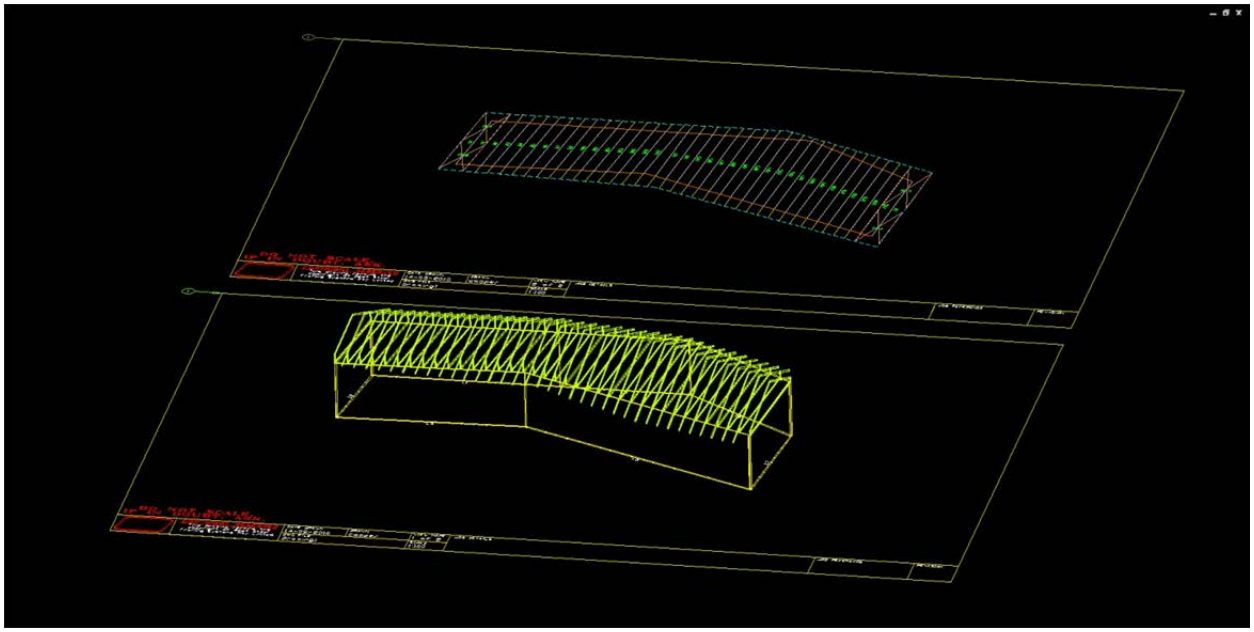

Fig 6

Fig 7

Fig 8

In order to differentiate various clusters, e.g. hotels, retail shops, villas and so on, automatically and parametrically, we constructed the syntax of aggregation as per the topography beyond the shape of individual buildings with the parameters including building depth, roof pitching angles, degrees of folding ridge configurations in 3d and so on (fig 8).

With regards to the museum on the northern slope of the mountains, due to its functions and location, we used different generative strategies inspired by the terrace farmland of Miao. A series of contour lines were smoothened as the spines for the main museum volumes. The gaps between terrace roofs automatically formed high level windows facing north as if fins. The main entrance is under the cantilevered strands stretching out over the west plaza. In contrast, the other end of the building series was buried into the land gradually. With strategic combination of green roofs and metallic cladding systems, the museum was unfolded well into the landscape. (fig 9)

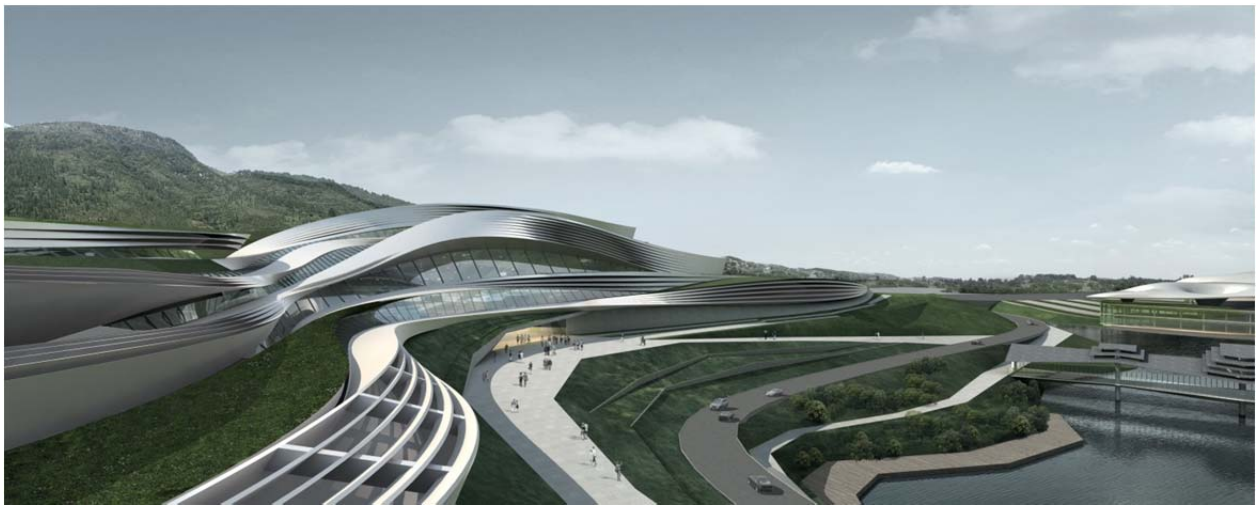

Fig 9

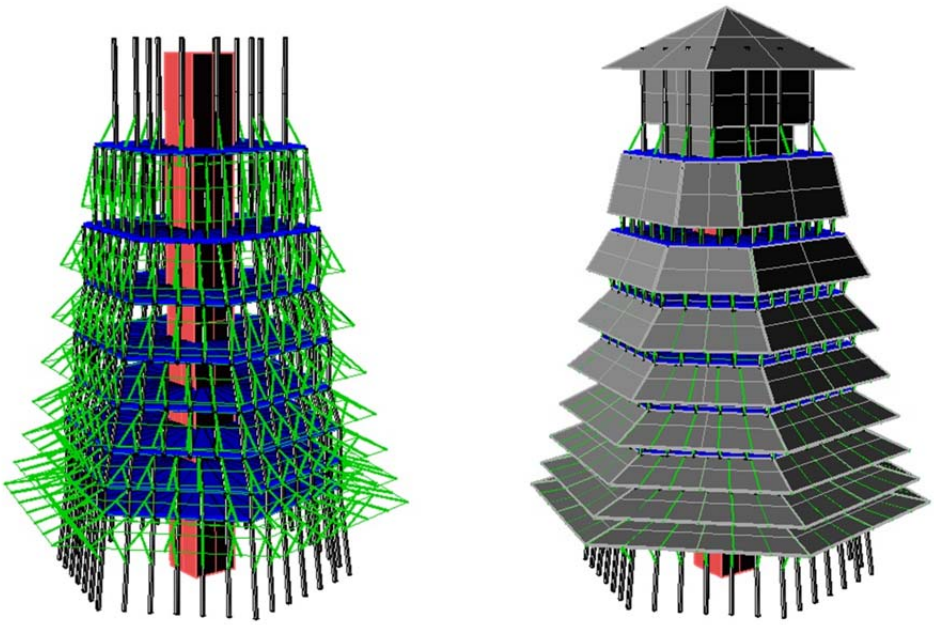

Fig 10

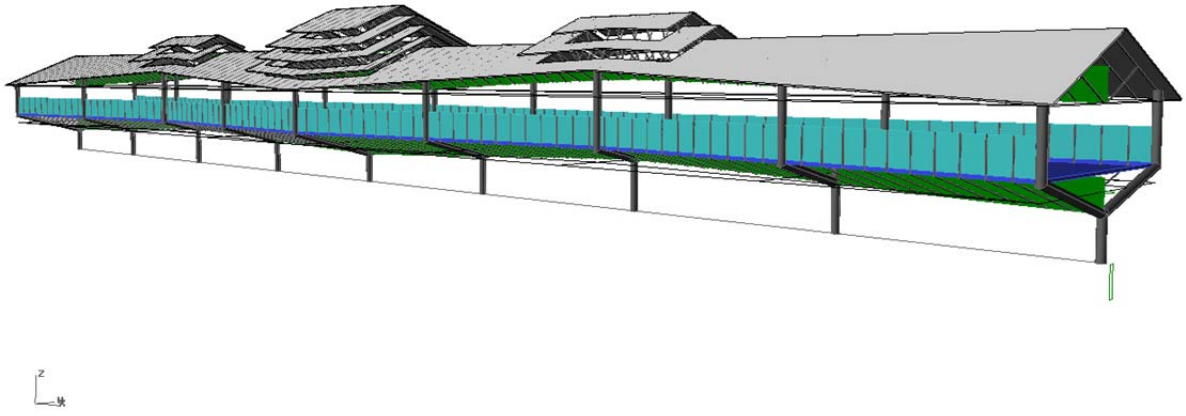

Fig 11

Other meaningful elements on site are Wind & Rain Bridge, an inhabitable bridge with vernacular styles, and Iterative Eave Pagoda, a high structure used for communal gathering and orientations in old days. We examined the traditional syntactic and semantic implications and removed the irrational components on the basis of contemporary materials and building technologies, then extracted the intrinsic merits of these two elements and developed them into parametric systems through scripting and parametric tools like Grasshopper, recreating new outlooks without losing the spirit of those vernacular signs.

Summarize architectural value

Instead of taking for granted the conventional ways of doing master plan, this project transcends the inertia of 2D planning with a new way of 3d planning, i.e. computing gradients of the site topography for the most appropriate architectural platforms which then generate individual building forms referring to the vernacular styles. We explored a set of techniques for intelligent massing in real time. As a result, no single house is identical and all match the topography perfectly. A series of evolutionary design strategies were also made to further teeth out both buildings in different shapes and in-between public spaces in various scales. The automated and valid customization processes for collective architecture deliver similar quality of being genuine and diversified as the local vernacular architecture, sustainable in both cultural and economic dimensions.

End

No exceptionally, this project exhibits our design philosophy to immerse computational techniques (no objection to any tools and not being constrained by any tools) into design processes comprehensively and thoroughly so that concepts, ideas, intentions are celebrated and achieved extensively instead of showing off how advanced we can use those tools. Our goal is neither to focus on the computation itself, but address deeper issues associated with design values in reality for architectural design, urban planning, landscape design and, interior design. The results don't have to be visually complex, but it must respect the complex context. Computational design, or more popularly known as parametric design in China, is neither the whole asset of design, nor the add-on to design. It should intermingle with team collaboration, creative ideas, thinking processes and, effective presentations. It should be promoted from the technic level to the mental level and become invisible eventually. After all, no clients will interest on how you do it more than what you can deliver.

Technology cannot simply bring us a beautiful world on its own. We embrace new digital means but not obsessed with them. We are more interested in extending values of design in the increasingly complex realities when everything is connected with everything else. Our aim is to not talking about computational design as it is part of our instinct. In the end, it is the people who drive design decisions instead of ubiquitous computational tools that make a design project different from others. Whatever digital means you choose to use, e.g. scripting, macro or parametric software, they are only one of many ways to do it, but not the purposes of design activities. The significance of implementing digital means, e.g. scripting, is to enhance designers' abilities of extending design ideas, generating more design possibilities, improving design executions and, the last but not the least, ensuring design qualities. We have passed the decade of testing the limits of these tools. We get used to hearing claiming of pushing design boundaries. We stay calm however the forms scream. What we are envisaging, as these advanced digital means enable us, is the synthesis of innovative ideas, development processes, material & building technologies, project deliveries, intellectual properties, evaluation criteria, sustainable performances, information communication and many others. All in all, we want to make better design decisions.

The power of computation shouldn't and cannot over run the power of human brain. Human society is far more complex than the digital empire itself. Yes, architecture sometimes needs revolution to leap forward. But, it will eventually become a drop of the evolutional stream. Hence, our future cannot be simply scripted out of computer, but rather benefit from the synergy of processors and human brains.

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Bibliography

1. Tao Zhu, *Experiment Needs Context*, New Perspective, vol. 9, Urban Flux, May 2009
2. Qiang Chang, Ning Duo, *Evolutional Planning: Computational Planning and Architectural Design in Mountainous Area*, Architecture Technique, 01-02 2011
3. Patrik Schumacher, The Autopoiesis of Architecture, A New Framework of Architecture, Vol. 1, 2011
4. Yan Gao, Ning Duo, *Synthetic Computational Design*, Ubiquitous Computing, Tongji University Press, ISBN 978-7-5608-4394-0, Aug 2010
5. Robert Venturi, *Complexity and Contradiction in Architecture*, The Museum of Modern Art, 1977;
6. Nadin Mihai, *Computational Design: Design in the Age of a Knowledge Society*, Formdiskurs 1997;
7. Albert Laszlo Barabasi, *Linked - The New Sciences of Networks*, Perseus, Cambridge Ma., 2002