REGIONAL BARRIERS

A Study on the Applicability of SHoP’s Project Delivery Strategies to China’s Architectural Environment

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Abstract. This paper discusses New York based architecture practice - SHoP’s project delivery strategies, to demonstrate an avant-garde methodology in pursuing architect-led project environments where optimised outcomes are achieved with digital workflows. The paper elaborates on how today’s Chinese architecture adopts global digital trends while certain barriers are impeding development of computationally integrated project delivery modes. Thirdly, the paper indicates the emergence of a new generation of digital architects in China, showcasing their practices to argue for the regional applicability of SHoP’s working mode. The paper concludes by summarising the disadvantages of the current Chinese architectural system, advocating the necessity of a systematic digitalisation, and discussing the Western potential in China’s modernising architecture.

Keywords. Chinese architecture; project delivery; digital paradigm; SHoP; digital workflow.

1. Introduction

In the West, technological developments are arguably keeping pace with ideological revolutions. Since Lynn’s “architectural curvilinearity” broke the conventional logic grid of orthogonal representations and Gehry’s multi-disciplinary materialisation strategies in non-standard forms, the Western architectural industry has been creating a digital environment for a wide range of potential results. In China, in contrast, the concept of “architect” was not even introduced as an independent profession until the 1920s when it replaced the traditional role “craftsman”. Since then, the impact of Chinese architects decreased along with a reduction in liability. The booming urbanisation in major Chinese cities has fostered robust real-estate markets where domestic architects are accustomed to a profession of “producing
quantity” rather than “designing quality”. Until now, the inertia of this rapid development shields Chinese architectural modernization from self-criticism. A monotonic project delivery (PD) mode remains sluggishly in responding to industrial informatization. To cope with these circumstances, Chinese architects have become “the most productive drafters” (Jiang 2005).

Arguing for the integration of Western trends in a Chinese environment, this paper presents New York based architecture practice SHoP as a case study of pioneers who advocate for a digitally integrated project delivery (IPD) mode that conveys new architectural complexities and computational representations. SHoP, founded in 1996, represents a generation of American architects that is redefining traditional “design-bid-build” (DBB) systems. More than in design tools only, computation is implanted in the firm’s organisation, communication, and management, increasing flexibility as well as profitability from design. SHoP contains four businesses, among which the coherence of SHoP Architects (SA) and SHoP Construction (SC) reveals its PD philosophy of being a “digital master builder”. SHoP eliminated tooling incompatibilities among multidisciplinary collaborations and centralised architect’s authority in projects.

2. A SHoP Mode of Working

“SHoP is the kind of architecture firm that builds” (Nobel 2012). The firm is a digital avant-garde company who sees PD as communications and collaborations. It formalised a contemporary IPD methodology that included computation and was informed by manufacture industries. Neither the “hard-to-imagine” architecture from parametric enthusiasts nor the “hard-to-draw” sculptures by formalists, SHoP is pursuing the materialistic outcome of design value.

2.1. SHOP = SHOP ARCHITECTS (SA) + SHOP CONSTRUCTION (SC)

One of the criterion for SHoP to sustain a digital PD system is the architect’s control over the project materialisation. Founded in 2007, SC bridges virtuality and reality; idealism and materialism. This agent provides engineering services in building rationalization and coordinates conversation between designers and makers/builders. With various professional backgrounds besides architecture including political science, engineering, marketing, real estate development, and art history, the five founding partners cognize SHoP’s architecture through perspectives of philosophy, aesthetics, technology, finance, and administration (Nobel 2012). Through collaborating with software company Dassault Systèmes, SHoP brought managing software ENOVIA and engineering tool CATIA (Digital Project) on the Cloud, to create a holistic digital environment where schedules, building model, fabrication information and business requirements integrate. Therefore, the firm’s precedence in digital technology provides the advantage of financial efficiency and simultaneously frees design explorations.

2.2. TECHNOLOGICAL STRATEGY

From the aviation industry, SA learned how a performance-driven taxonomy can be used to reduce design compromise. “Design optimisation” plus “direct fabrica-
tion” is the core strategy of his project materialisation. Project “A-Wall” (figure 1, left) is a showcase of this approach and consists of an irregularly curved surface engineered by 496 unique triangles, of which material utilisation and geometrical undulation have been maximally preserved. SHoP here established their philosophy of computationally balancing project rationality and performance, which was expanded in their later practices.

The project “290 Mulberry” (figure 1, right) was a pilot project of the IPD mode (BIM). The building sits in a specific coding zone that requires masonry cladding on its north and west facades, and restricts ornamentation beyond the planes of the building envelope up to 10 percent of every 100 square feet. The project is a showcase of the firm’s workflow in 1) constrains inputs; 2) design optimisation; 3) direct fabrication; and 4) quality management.

1. The input constraints include code regulations, material performances, and fabrication parameters. For example, besides aforementioned site rules, brick cantilevers are required to be within three-quarters of an inch to its neighbour for structural purposes (Moe 2008). Here, SHoP used GenerativeComponents (GC) to calculate design limitations before exporting the model to Digital Project and Autodesk Revit for detailed engineering. Early collaboration with fabricators and installers enabled the architects to achieve the maximum amount of projection for each undulating panel, while incorporating casting and shipping demands.

2. Design optimisation translates formal complexity into manufacturing simplicity. With information models, SHoP balances rational cost and aesthetic goals. In this case, Rhino and GC helped SA to maximise undulation varieties with the minimal amount of master molds and form liners (SHoP Architects 2009). Customised scripts were developed to control panel iterations in normal, corner, and window conditions (figure 2, left).

3. CNC fabrication guarantees the direct data feed from Digital Project - “direct fabrication”. In “290 Mulberry”, the early collaboration with the fabricator Architectural Polymers has tested the brick layout flexibility in mock-ups. Form liners
and master molds in optimised variations were cut out in rubber directly from SC’s output (figure 2, middle), then embedded with bricks sequentially.

4. “Direct fabrication” eliminates errors from the miscoordination between design documents and shop drawings. The information model helps installers precisely locating each prefabricated component. Furthermore, key data related to financial, marketing, and scheduling plans is extracted for various team members, facilitating better communications with both administrators and clients.

Figure 2. (left) Façade panel variations; (middle) CNC milling form liner (both taken from Autodesk Gallery: http://www.autodesk.com/gallery/exhibits/archive/290-mulberry, 2016); (right) Cantilever of “The Porter House” (taken from SHoP’s website: http://www.shoparc.com, 2016).

2.3. FINANCIAL STRATEGY - A “GAMBLE” FOR A “DREAM”

Interest hierarchies between client and architect are not always aligned. Architects often are requested to reduce design complexity or step back into a “safe zone” where his/her ambitions do not conflict with the investor’s priorities. To bypass these “inevitable” limitations, SHoP links the firm’s profit with the added-value it creates in a project. Through becoming the investing partner, SHoP aligns its financial interest with aesthetics pursuit. SHoP’s subjective engagement with a project’s financial structure and political discussion establishes its predominance in design delivery. Their strategical interpolations have revised the role of the modern architect and turned him into a digital master builder.

“The Porter House” is one example where SHoP engages in project finance. Here, the firm linked its service fee to the sale prices of the condominiums. Not only did they believe the added design value would increase sales prices, but receiving part of the project ownership freed the architect in design and ceased debates in concept generation. The proposal of “The Porter House” introduced a six-floor cantilever - an expensive proportion that most of the developers rejected (figure 2, right). With a holistic calculation in the digital environment, SHoP distributed technical cost accordingly. Cladding variations were minimised in the design, and the financially efficient zinc was used. Thus, a large funding portion was spent on formal innovation while the project still ended up with a secured profit.
3. Barriers in China

Chinese architecture has been following Western paradigms. More than seventy percent of first-generation architects who founded the “Architectural Society of China” (the first Chinese architectural association) in 1927 were returnees (Jiang 2005). Additionally, in 1995, a Western trajectory-based national architectural system was established when the State Council released the “Detailed Rules for the Implementation of the Regulation of the People’s Republic of China on Registered Architects.” A nation-wide “plan-design-bid-build” PD mode was created since. In a sustainable economic growth, domestic architects are acting as interpreters of a national ambition to urbanise and maximise economy growth.

Chinese policy did facilitate the digital paradigm shift among industries. In 1992, the ninth “five-year plan” initiated “throw off drawing boards” - a national manifesto that encouraged industries to adopt the computer-aided software. Since then, both architectural practice and pedagogy have admitted two aspects of computation: the 2-dimensional representation of building sections and the 3-dimensional visualisation of model. CAD companies started booming and AutoCAD became the standard industry tool. The eleventh “five-year plan” “throw off paper drawings” has been promoted since 2006, aiming to fully integrate a “CAD to CAM” workflow. Yet, a rather “hands-off” mode of project development permits the architect to reduce financial risk, yet simultaneously traps him in a domain of conservative cognition in materialisation. Chinese modern architecture has built up an inflexible hierarchy to which domestic architects succumb. In this paradigm, limited progress has been made since the first manifesto was accomplished in the year 2000. Compared to the West, Chinese architecture is arguably responding sluggishly in this second phase for three reasons: 1) the dispersion of project authorities, 2) the architect’s role and liability differences between China and the West, and 3) a weaker system integrity than that in manufacture industries.

3.1. CHINESE “ARCHITECT” = ARCHITECT + SUPERVISION ENGINEER

Historically, both the RIBA system (UK) and the AIA mode (USA) defined “the architect” as a professional who is authoritative in material selection, permit application, implementing consultancy, contract management, and general supervision (Jiang 2005). The Chinese system, however, removes more than half of the above. Unlike the tripartite Western PD organisations which include owners/clients, architects/engineers, and contractors, China introduced a unique fourth party: the “supervision engineer” (SE). Not only does this isolate the architect to a singular role of drawing, it also heavily cuts down the architect’s profits. In 1996, the “Construction Law of the People’s Republic of China” stipulated SE as a neutral fourth party that guarantees both the ethical and professional execution of work by engineers and contractors. Even though contractually he represents the client/owner in project rationalisation, paradoxically his role impedes an integrated workflow or complexity innovation because:

1. Disordered early-stage management: in concept generation, the segregation between SE and architect increases financial uncertainties. Undetermined materials, equipment, and techniques lead to pragmatic empiricism. As is often the case,
computational applications barely contribute to architectural ontology other than enlarging ornamental vocabulary. This authority dispersion results in SE nor architect being committed to the financial management or scheduling in an early-stage planning.

2. SE is a profession without expertise. The SE is neither an independent discipline in Chinese college education nor a technical ability developed from any systematic training. A third party not involved in the design of architects/engineers takes part in the project. His neutral status results in the lowest commitment to project completeness and does not enable providing technical support during construction. Solely supervising the translation accuracy of construction documents to on-site implementation, the Chinese SE has become a slave to intermediate products that encumber “CAD-CAM” integrity.

3. A low digital-threshold: the SE’s liability ambiguity makes him a mixture of public administrator and a for profit organisation. His traditional managing approach requires low software competence and no compatibility with an integrated digital environment. The computation revolution aims to eliminate unnecessary interruptions in the workflow, thus directly challenging the SE’s existence.

3.2. COMPARISONS WITH THE US SYSTEM

An architect-led project delivery (ALPD) inspires both ideological and technological evolution in the digital age. The evolution of the US system from the 1970s’ “design-bid-build” (DBB) mode to the current “integrated project delivery” (IPD) (AIA 2012) is a process of architects gaining workflow autonomy. Given all-round responsibilities, US architects utilise digital power to precisely control progress and reduce risks while potentially increasing profit. The Chinese system, in contrast, continues the DBB mode, reducing the architect’s profit due to his liability reduction. Financial criteria restrict digital power as a facilitator with which Chinese architects could potentially optimise their benefits from the current mode.

Figure 3. Diagram of the Architect’s liability distribution in “design-bid-build” modes in the Chinese and AIA system.

The IPD mode of the AIA system emphasises the need for the architect’s engagement with both the client/owner and contractors in the early stage to integrate accessible constructability and restrictions in conceptual design. Yet, Chinese ar-
chitects are only involved in the design-related discourses of the budget, time, and organisation. In other words, there are strong incentives to perform conservatively to survive in this lowest-cost competition. Furthermore, in the planning phase Chinese architects are not required either in 1) making construction plans, 2) optimising construction techniques, 3) supporting submitted documents, or 4) consulting contractual issues. In the meanwhile, during construction and use phases, they are removed from 1) oversighting on-site implementation; 2) supervising technical execution; 3) on-site design modification; and 4) evaluating as-build quality. Liability distribution (figure 3) has isolated Chinese “architects” into a single-functional discipline, impeding the development of a computation-aided IPD mode.

3.3. COMPARISON WITH MANUFACTURE INDUSTRIES
Since the 1940s, Western aviation, automobile, and high-tech industries have been endeavoring to achieve an intelligent integration of computational design and automated production. From Gehry Partners to Gramazio & Kohler, the architectural industry is catching up as well. Western pioneers are pursuing a business-industrial mode, where architectural autonomy equals objective productization and subjective personalization. Chinese manufacture industries have adapted this trend rapidly. For example, the Pearl River Delta (PRD) area has become the largest cluster of high-tech manufacturers and innovative business, where companies such as DJI (a drone manufacturer) and HUAWEI (a mobile manufacturer) have developed mature PD systems to establish their international competitiveness. Nevertheless, Chinese architecture comparatively lacks.

Firstly, the separation of stakeholders matters. Profits of manufacture industries are tied with project planning, design, production, and sales, as they invest in digital/technological innovation for long-term paybacks. Yet, unlike cars or cell phones whose appearance are as crucial as their functionality, Chinese architects are neither paid for building aesthetics nor for as-built qualities, but by project floor area charges or ratios. As they are only the author of the “design” - an added-value defended by architects but ignored (in most cases) by owners, architecture’s investment remains limited in China. Secondly, the opportunity to invest in short-term labour-intensive activities is replaced by avoiding the financial risk of possible “unnecessary investments”. Participants join the modern architectural activity through separated bidding, where imbalanced digital competence and incompatible software environments may compromise an architect’s initial intent. As in above-mentioned circumstance, most large architectural corporations in China are using digital/BIM technology to accelerate the billing process while hiding in a conventional system.

4. The Applicability of SHoP’s Strategies in a Chinese Environment
SHoP is evolving project delivery and management, inspiring change in the architect’s role in an integrated digital environment. In China, developments in architecture behave differently. At the time when SHoP established its philosophy, the US’s digital revolution had already been accepted both in terms of software and hardware. Along with the increasing cost of the labour force there, the dig-
ital paradigm shift encountered less socio-cultural obstacles than China did. On average, China’s construction industry today is 15 years less-developed than Germany’s architectural manufacturing business (Yuan and Ge 2011). As a population of 40 million remains in the construction industry, computational design software is spreading much faster than CNC manufacture. China’s architecture requires regional adjustments when adopting the SHoP’s mode of operation.

4.1. TECHNOLOGICAL ADJUSTMENT - “LOW-TECH” IMPLEMENTATION BY “HOME-GROWN” ARCHITECTS

“Home-grown” architects (Williams 2015) make up a new generation of returning Chinese practitioners who have been implementing modern Western ideology and methodology into the domestic market. Among them, a digital sub-group has started exploring regional expressions, integrating local productivities. Bridging the gap between computational design and fabrication, these avant-garde architects have adapted specific materialisation strategies. “Low-tech” implementation is one technological response to the applicability of the SHoP’s “direct-fabrication”: digital tools enable “home-grown” pioneers to increase formal complexity and output detailed information while making “changes” in the design optimisation to cope with a less-developed construction environment.

Figure 4. (left) Masonry façade of “Songjiang Art Campus”; (right) Brick setback iterations (both taken from Archi-Union’s website: http://www.archi-union.com, 2016).

Among Chinese digital firms, Archi-Union is one of those succeeding in a regional integration between innovative exploration and building rationality. The firm is seeing computational power as an extension of existing material cognition and craftsmanship. In the “Songjiang Art Campus” (figure 4, left), “low-tech” strategies were applied to the gradient of a masonry façade. Compared to the “290 Mulberry” by SHoP, Archi-Union achieved a similar performance in ornamentation by digital tools including Rhino and Grasshopper. A fully manual implementation, in comparison, characterised a Chinese unique workflow mode. First, the “Flemish bond” was adopted which contains two headers between one stretcher. Through pushing bricks outside sequentially, architects achieved the pattern in the digital environment and labelled each setback for output. Then, however, the labourers encountered difficulties in construction. Not only the variations of brick
setback led to an uncontrollable inaccuracy: the continues gradient confused the bricklayers. Archi-Union then adjusted the script to match the on-site demands. Brick setbacks were reduced to 5 iterations and all the “headers” were fixed as a reference grid for “stretchers” (figure 4, right). In addition, contractors spontaneously invented customised tools such as wood indicators and ropes to assist implementation. With computational optimisation and “low-tech” adjustments, this project secured the financial efficiency and simultaneously represented the digital materiality of a traditional material.

China will remain a semi-digital construction environment for a long time in the current socio-economic environment. Like Archi-Union, digital pioneers such as Studio Pei-Zhu, HHDFUN, and Atelier cnS also experimented with non-standard practices including a “low-tech” philosophy. In the “Rizhao Public Bathroom” by HHDFUN (figure 5, left), architects simplified 3D curves into a combination of line segments and arcs (Wang 2012) to reduce fabrication complexity and improve implementing comprehensibility. Another example by Atelier cnS integrated the parametrically generated façade pattern with industrial modulization in the “Foshan Art Village” (figure 5, middle). To rationalise financial challenges in production, the firm considered regional productivity and panel installation techniques in the early-stage modelling phase.

4.2. FINANCIAL BYPASS AND CHINESE “MASTER BUILDER”
Comparing to SHoP’s merging of financial criteria with design intent, ambitious Chinese architects have emerged to challenge the inflexible DBB mode by proposing an Architect-led design to build (ALDB) - a “turn-key” workflow (Jiang 2005). This holistic strategy emphasises architect’s control over processes and requires direct collaboration with manufacturers, contractors, and shipping companies. To bypass potential barriers, practitioners have ventured into rural areas in China where modern construction techniques became inconvenient. Professor Zhu Jingxiang and his team from The Chinese University of Hong Kong (CUHK) have for example been endorsing a digital IPD mode supported by customising ARCHICAD
software. In the “Playroom” case (figure 5, right), the financial argument considered minimizing cost while maximizing spatial experience. The team engaged a wood factory for prefabricating building components which guaranteed a “direct fabrication” workflow integrity and achieved an equilibrium in architectural performance. Cutting-edge digital technologies have been introduced to China by digital “home-grown” architects as well. Professors Yuan Feng from Tongji University spearheads the first generation of enthusiasts in robotic tectonics.

5. Conclusion

The barriers that prohibit modern Chinese architecture from revolutionary change in the digital era can be summarized as 1) the inadequate authority architects have in the project organization, and 2) the disperse project delivery integrity in comparison with manufacturing industries. The world is witnessing a universalization of computation in architecture. The adoption of this trend both ideologically and materially in China has become their manifesto of the 21st-century modernization. Meanwhile, the inertia of China’s booming urbanization ensures one of the largest building markets until 2030. Investments in the disciplinary innovation of architecture appear necessary. SHoP’s strategies amplify an architect as director, engineer, and manager - a digital master builder. Not only does the firm thus manage to convey explorative design languages, they guarantee increasing profit as well. Yet, a fundamental difference from the Chinese context lies in the liability differentiation. In China, new architect returnees have emerged to test the applicability of innovative strategies. Many have successfully bypassed an arguably immature construction system and achieved novel outcomes with regional practices.

References