

REPORT and COMMENTARY ON RECENT DEVELOPMENTS TOWARD OPEN BUILDING IN CHINA

Stephen Kendall / November 2016

On October 20, 2016, a one-day meeting took place in Beijing, titled “International Forum of Open Building Development and Practice – Construction Model of International Open Building and Housing Industrialization.” The China Institute of Building Standard Design & Research (CBS) organized and hosted the symposium with the support of Jia Beisi, Professor of Architecture at the University of Hong Kong and Partner, BE Architects. Dr. Liu Dongwei, Chief Architect of CBS chaired the event.

The October 20 Forum’s introduction said:

“The practice of open buildings in China dates back to thirty years ago in the 1980s. It guaranteed the quality of houses under limited economic conditions at that time and realizes the sustainability of house construction under the resource and environment pressure at present; it not only explores the flexibility and adaptability of commercial housing but also ensures efficient construction of Security (social) housing. The theory of open building has long been offering new thoughts to housing design and development in China.”

A partial list of speakers and topics highlights the conference’s focus and importance to CBS and the region:

- Introduction: Sun Ying / Chairman, Vice President of China Construction Technology Consulting CO.LTD, President of CBS
- Speeches:
- Open Building: The Basis for an Infill Industry: Stephen Kendall / Emeritus Professor of Architecture, Ball State University, USA
 - Adaptable Housing in Japan: Kazunobu Minami / Professor of Architecture, Shibaura Institute of Technology, Japan
 - The Openings on Four levels in Traditional Chinese Housing and Their Implications to Housing Industrialization: Jia Beisi / Professor of Hong Kong University
 - Contemporary Open Building Theory and Practice of China: The Future Based on Sustainable Development and Industrialization of Building: Liu Dongwei / Chief architect of CBS
 - Open Approach to Architectural Policy of Seoul City: Jaehoon Lee / Professor of Dankook University, Seoul
 - Two ends of an Open Line: Ming-Hung Wang/ Professor of National Cheng Kung University, Taiwan
 - Buildings’ Quality Question of Existing Residential in China and Solutions Based on Open Building Theory: Fan Yue/ Professor of Dalian University of Technology, China
 - Application Study of Industrialized Components in Existing Housing: Zhou Jingmin / Professor of Tongji University, China
 - Questions and Solutions on Long-term Durable Housing: Sun Zhijian / Professor of Yanshan University, China
 - Variable and Separation of Building: Industrialization VS. Elasticity: Shao Yu / Professor of Harbin Institute of Technology, China

During time in Beijing for this regional forum, I learned about what appears to be a turning point after almost 30 years of developments toward open building in China. I can say this not only because of what was presented in the forum by a largely younger generation of academics, but also from what I observed outside the conference. This included a visit to the 2017 International Housing Exposition, a site visit to a new project in Jinan now under development, and a site visit to an installation of one of - if not the most - advanced infill system company that I know of in the world and a visit to two “traditional” infill projects in existing buildings. I report on these visits later.

Early developments toward Open Building and the current S/I Approach

The first “Support” housing project realized in China was the Wuxi Experimental Project in Wuxi, in 1985. In the years since, developments toward Open Building in China were slow, with only a few experimental projects being realized. But then, things began to change. The first large project was built in Beijing (Little Universe - 2010) and was based on the Century Housing and “Two-Step” housing concepts already applied in Japan. It was promoted by the China National Engineering Research Center for Human Settlements (CNERC). Their goal was to solve the problems of short housing service life, emerging patterns of consumption, quality defects, and waste in renovation. They considered rapid technological changes and future uncertainty. They divided the building into “skeleton” and “infill”, but did not distribute control to current dwellers. The “flexibility,” which was obtained through division of S and I, contributes to future technological upgrades of the building, but does not focus on individual preferences and life styles. It was believed that varied preferences and life styles among users could be solved by the diversified housing supply in the housing market. (<http://house.focus.cn/loupan/6952/tu51727199.html>)

Also in 2010, The Centre for Housing Industrialization, attached to Ministry of Housing and Urban-Rural Development, published The Technical Guiding for Construction of China-Skeleton-Infill (CSI) Housing. In 2011, the government of Jinan Province built a small experimental project modeled on CSI.

During the last decade, under Liu Dongwei's leadership, the China Institute of Building Standard Design & Research has initiated a number of "S/I" projects, in Beijing, Shanghai, Jinan and Tianjin. "S/I" means skeleton/infill, and is the name given to open building in Japan. Liu studied in Japan, and maintains strong and frequent contacts with leading Japanese universities, construction, product-manufacturing companies, and with various Japanese government agencies, including UR (Urban Renaissance Agency).

I visited the Greenland Group's Shanghai S/I project in 2014. There, dwelling unit sizes are fixed, and within each dwelling, bathroom locations are fixed with their floors recessed lower than the rest of the unit's floor (see photo below). Light metal studs and gypsum board are used for interior partitions, and raised floors are used throughout the dwelling. Haier, a major consumer appliance manufacturer, was the primary organizer and supplier of the infill (see photo set below). The project offered a variety of floor plans.



Elaborate model of the entire development



Metal stud/gypsum board interior partition



Special steel channels used as wall-liners



Depressed floor at the bathroom only



Construction documents of the bathroom raised floor



Metal stud work at the ceiling

On this current trip, I joined several speakers at the symposium in a visit to an S/I project in Jinan (2 hours south of Beijing), under development by the Luneng Group Company, Ltd. This project is considered a success, having sold out in less than three hours after being put on the market. At the time of our visit, a contract for Infill delivery had not been let, and the first of the S/I buildings was still under construction. (See six images below)



Two of the available floor plans, each of which offers variants to the basic layout



Views of the interiors



The part of the much larger development dedicated to S/I



A display view of the raised floor



Showroom diagrams of the traditional (bottom) vs. S/I

China's Central Government Role

It is widely understood that the Chinese central government plays a pivotal role in all aspects of the national economy, and residential property development is no exception. CBS is a key player, has the cooperation of many large nationally owned property development companies and significant leverage with architectural design institutes, product manufacturers and other players.

CBS is also a central player in so-called "industrialization" in the construction sector. This has been and remains a major thrust of the Chinese central government. This emphasis is observable in other countries, which, since WWII, have moved aggressively to "catch-up" with developed countries in the breadth and depth of capacity in the building sector. Industrialization essentially means developing industrial production capacity in the manufacture of products and subsystems used in the construction of buildings, and improving management sophistication of logistics and site operations. It also means a reduction of the unskilled-labor component in building construction, an increase in so-called "dry" construction and prefabrication, and a sharp increase in quality assurance.

The 2015 annual report of CBS says:

"CBS was founded in 1956. It was a scientific research institution affiliated with the Ministry of Construction. In 2000 CBS was transformed into a state-owned science-technical enterprise. Now CBS is affiliated with the China Construction Technology Consulting Co., Ltd. Through developments of nearly 60 years, CBS has become one of the comprehensive enterprises engaged in scientific research, design and technical service in the urban and rural construction fields in China, covering architectural standards and design standards, urban and rural planning, construction engineering design, general engineering contracts, technical consultation, product manufacturing and installation, etc. CBS is a national-level high-tech enterprise, enjoying a high reputation in the construction industry as well as nationwide influence."

CBS has three basic businesses:

1. Standards and standard design
2. Architectural engineering design and
3. Urban planning design.

Its business sectors include: **Residential industrialization**, Underground space and civil air defense for subways, Steel structures, Shock absorption and isolation, Green building and energy conservation in building, BIM and information-based architecture, Building product application technical research and certification, and International cooperation.

In respect to its focus on "**residential industrialization**," the CBS report says:

"With the conception of comprehensive residential industrialization combining main body (Skeleton or Base Building) industrialization and indoor decoration (Infill or Fit-Out) industrialization, CBS is devoted to technical research and development, standards formulation and engineering practices. Combining the main body (Skeleton or Base Building) structure industrialization (PC and steel structures) with the indoor decoration (Infill or Fit-Out) industrialization advocated by CBS, it leads to the latest practices of residential industrialization in an all round way and discusses the new thoughts, new technologies and new projects of comprehensive new type residential industrialization. Also, based on some research, CBS is integrating advanced international advanced technical practices and extensively working with enterprises, manufacturers, research institutes and experts and scholars in conducting residential industrialization technical research, design and promotion to realize the support and conversion and a virtuous circle among these works." (PAGES BELOW FROM THE CBS Annual Report)

住宅产业化

Residential industrialization



- 关键技术
crucial technology
- 标准规范
standards and codes
- 示范工程
demonstration projects

多措并举推进全面住宅产业化 设计研发推广三位一体良性循环

Push for residential industrialization in all respects by all measures
A virtuous circle featuring integration of "design, research and promotion"

标准院多年来坚持主体产业化和内装产业化相结合的全面住宅产业化理念，致力于技术研发、标准制定和工程实践，将主体结构产业化（PC和钢结构）及标准院主导提倡的内装产业化相结合，引领全面住宅产业化的最新实践，探讨全面新型住宅产业化的新理念、新技术、新项目。并结合课题研究整合国外先进技术实践，广泛联合企业、厂商、科研机构 and 专家学者，开展住宅产业化技术研究、设计和推广工作，实现上述三者的相互支撑、相互转化，从而实现三位一体良性循环。

With the conception of comprehensive residential industrialization combining main body industrialization and indoor decoration industrialization, CBS is devoted to the technical research and development, standard formulation and engineering practices. Combining the main body structure industrialization (PC and steel structure) with the indoor decoration industrialization advocated by the CBS, it leads to the latest practices of residential industrialization in an all round way and discusses the new thoughts, new technologies and new projects of comprehensive new type residential industrialization. Also, based on some researches, CBS is integrating advanced international advanced technical practices and extensively working with enterprises, manufacturers, research institutes and experts and scholars in conducting residential industrialization technical research, design and promotion to realize the support and conversion and a virtuous circle among above three works.

CBS-NBS new industrialized building system comprehensive solution





基于全面建筑产业化理念和行业领军人物刘东卫博士等一流人才团队，通过多年来在标准设计、建筑设计、建筑节能、内装施工和产品应用等多领域的研发创新和工程实践，全面形成了新型装配式住宅、绿色保障性住房、老年住居等优势业务，开创了国内以装配式内装为核心的设计施工一体化服务模式，确立了行业领先地位。

Based on the concept of building industrialization, Dr. Liu Dongwei and his group devote themselves to the research and practices in the fields of standardization, building design, energy-saving construction, interior decoration construction, product application. Their dominant position is expressed in precast housing, green social housing, housing for the elders. In the meantime, they create the "integrated service mode" with the core of precast interior decoration, which establishes the leading position of Dr. Liu's group.

承担课题 research subjects:

national and provincial research subjects:

国家级、省部级科研课题：

new industrialized building system and crucial technical code for social housing

保障性住房新型工业化建筑体系与关键技术标准研究、

the research and practices of crucial technology in industrialized social housing

保障性住房工业化设计建造关键技术研究、

the research and practices of the industrialization technology of crucial precast products

可装配式关键部品产业化技术研究与示范、

the research on precast staggered truss housing system

装配式交错桁架住宅体系研究、

the research and practices on the integrated technology of building enclosure and insulation

新型建筑围护结构与保温一体化技术应用研究、

the research on the infill RC wall in semi-rigid structure

半刚性框架内填 RC 墙技术研究、

the research on the seismic performance of column root in high-rise steel structure

多高层钢结构柱脚抗震性能研究。

research subjects with the cooperation of enterprises

与企业合作研发课题：

the research on the construction technology of life cycle housing (with Lvdi Company)

绿地集团百年住宅建设技术体系研究、

the integrated technology of industrialized interior decoration (with Haier Company)

海尔家居工业化内装集成技术支撑体系。

标准规范编制 standard and code compilation

- ▲ 主编《装配式住宅建筑设计规程》、《建筑模数协调标准》、《建筑模数协调标准》
- ▲ Design specification for assembled housing; Standard for modular coordination of building; Norm, code and collective drawings of national standard;
- ▲ 主编《公共租赁住房建设标准》
- ▲ Design standards of public rental housing;
- ▲ 主编《建筑模数协调标准》
- ▲ Standard for modular coordination of building;
- ▲ 主编《装配式混凝土结构技术规程》
- ▲ Technical specification for precast concrete structures;
- ▲ 主编《装配式住宅建筑设计规范》
- ▲ Design specification for precast residential building;
- ▲ 主编《预制装配式结构技术规程》
- ▲ Technical specification for prefabricated and precast structure.

2013年，国务院办公厅[2013]1号文《绿色建筑行动方案》中

提出了关于全面推进城乡建筑绿色发展的要求，标准院凭借绿色建筑、

保障性住房建设等方面拥有的综合技术实力，承担了“保障性住房执

行绿色建筑标准技术导则”课题研究任务。

In "the proposal for green building action", which was released by General Office of the State Council of the People's Republic of China in 2013, green building has been advocated in both urban and rural districts. Since CBS has strong technological strength in the

field of green building and social housing, it undertakes the research subject of "technical

guide of the application of green building norm in social housing".



上海绿地南翔崧廉公馆——首个中国百年住宅示范项目

Further, CBS is focused on “assembly-based indoor decoration (Infill or Fit-Out): integrated service of design, construction and deployment.” (Page 48 below)

装配式内装：设计、施工、部品应用一体化集成服务。

Assembly-based indoor decoration: integrated service of design, construction and deployment

Interior industrialization technology and the application of integrated products

内装工业化技术和部品集成应用

CBS employs SI concept to improve the comfortability, safety, durability of housing, as well as the convenience of daily maintenance and replacement of interior decoration. It achieves housing industrialization through developing integrated technical method. Its objective is to improve the degree of housing industrialization by technical integrated system and to enhance housing performance and quality. In the research on technical method, the integration of related technologies and the improvement of building systems are emphasized, while the key integration technology, the separation of pipeline system in SI housing, the insulation technology of enclosure, floor heating technology, integrated kitchen and bathroom, the integrated technology of exhaust system, raised floor and its insulation technology, the comprehensive design and related technology of living environment, etc. technology and integration technology system.



同层排水系统 drainage system on the same floor 给水分水器系统 water supply and diversion system 架空地板系统 raised floor system



SI housing industrialisation SI住宅工业化内装部品体系 interior decoration products 新风换气系统 fresh-air system 适老化设计 design for the elders 整体厨房部品 integrated kitchen 整体浴室部品 integrated bathroom



轻质隔墙系统 light-weight partition 厨房横排烟 设计与部品 horizontal exhaust design and products in the kitchen 增进家人交流的 LDK 书房餐厅设计 LDK study room and kitchen design to promote the family communication 全功能收纳系统 项目内装实装 storage system



墙体与管线分离设计及其部品 the separation of pipelines from walls and related products 支撑体结构体分离的 SI 住宅体系 SI housing system in which the Support structure is separated.

The transformation and application of research result: projects and practices

研究成果的转换与应用——项目实践

Based on the concept of long-term effectiveness, the life-cycle housing in China focuses on the new-type industrialization system and related integrated technology in the field of planning, design, construction, maintenance, and renovation. It aims at realizing construction centered new-type industrialization system and application integration technology, force to fully realize construction industrialization, extending the service life of building, developing green and low-carbon housing, improving the housing value and achieving the sustainable living environment.

▲ The promotion mode of prefabricated interior decoration

▲ 装配式内装的推广模式

As the response to the requirement of life-cycle housing, CBS develops the new service mode in order to realize housing industrialization, provide one-stop service and achieve building sustainability.

提供设计施工运维一体化服务 provide one-stop service including design, construction, delivery and maintenance

解决产业化体系落地的现存问题 solve the existing obstacles of the application of industrialization system

总结经验，研发国内相关标准规范 sum up the experience, and develop the related national norms

探索适合中国的住宅工业化道路 explore the Chinese way towards housing industrialization

(Above pages translated by Dr. Li Shanshan, Beijing University of Civil Engineering and Architecture)

“Design for Standardization System” is a phrase used in the CBS literature and in Dr. Liu’s presentation at the international forum. He defined this as follows:

“The industrialized standardization system, which is conceived according to the actual building situation in China, is based on the concept of separating “Support” and “Infill.” Its objective is to improve the service life of residential building. In its process of design, construction and equipment supply, the priority is given to the consideration of construction method, users’ living mode and the possible impact caused by equipment and pipeline maintenance.”

The Development of an Infill or Fit-Out Industry in China

The first significant effort in China to cultivate an infill industry was the 1994 adaptable housing project in the Cuiwei Quarter of Beijing. Commissioned by the Ministry of Construction of China, as part of the National Building Research Program, this small nine-unit project, designed by Ma Yunyue and Zhang Qinnan, offered contracts to five partitioning companies including both foreign and Chinese providers. The goal was to showcase a variety of infill solutions as well as to promote “industrialization” of housing components. Mr. Zhang told me later that he was very disappointed in the quality of the Chinese infill products at the time; he believed, apparently correctly, that it was too early to expect a mature infill industry in China. Nevertheless, a variety of dwelling unit layouts was made in that project.

This early effort by the Ministry of Construction was an indication that the Chinese government was beginning to recognize long-term problems with their housing policy, due in part to impending massive demographic changes, but also due to rapidly rising consumer demands, rising incomes and future difficulties in finding skilled labor. Building tens of millions of apartments and then demolishing them a decade or two later because they no longer met rising expectations, while serving as an engine for the economy, was recognized to be unsustainable. This was a lesson learned in Japan a decade earlier, when the Japanese economy shifted from a “scrap and building” to a “stock maintenance” approach to building.

The launch of the S/I projects by CBS, starting in 2010 as mentioned above, signaled a renewed commitment to stimulate “industrialization” and an infill industry. This time, more than a decade after the Cuiwei District project mentioned above, the Chinese building-products industrial capacity had dramatically improved, Japanese infill subsystems had become available, and consumer demand for quality had sharply increased.

An infill industry was apparently seen by the central government as one avenue to addressing the problems in its housing policies. Such a development meant that properly designed buildings could last longer – they could accommodate evolving governmental space and technical standards, as well as meet the increased demand for quality and variety in the apartment stock.

Corporate Infill Initiatives

In my earlier visit to the Shanghai S/I project, Haier (a large Chinese multi-national consumer household appliance company) had the responsibility for the infill. Their name could be seen on the construction documents at the job site (see image on page 2 of this report). On this most recent visit (October 12-25, 2016), I met several advanced INFILL companies at the Beijing 2017 International Housing Trade Exposition (the same one in which our Infill Systems mock-ups of CableStud and Matrix Tile were displayed in 2014). This time, several “Interior Decoration” or “infill” companies offered solutions for “wall liners,” “warm floors,” and “raised floors” as the images below show.



One companies' wall-liner solution + warm floor system



Another companies' raised floor solution



The same company has another wall-liner product

PREFAB Interiors

One company (PREFAB INTERIORS – or UNITY TECH GROUP in their English name) is especially advanced. See the photos below from their display and also from a site visit. Their website has videos and images worth looking at.

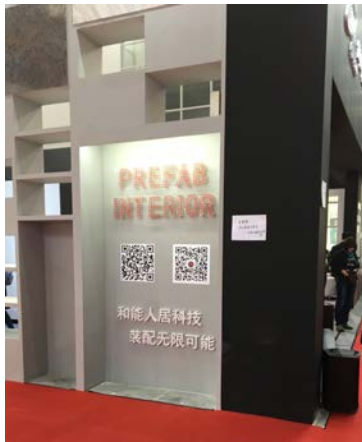
<http://www.henenghome.com/solutions/>

The company's president started in business developing and selling software to manage reservations (now used in 75% of Chinese hotels), and manufacturing a pharmaceutical for children (now used by most hospitals). He later got into real estate development. Ten years ago, seeing a market in the INFILL business, he started this company that now supplies thousands of infill packages to the public rental housing projects in Beijing (and perhaps elsewhere), and is also supplying the single-family luxury market and the condo market. They produce many thousands of infill units each year. They also have their own manufacturing facility to make everything from metal studs of various sizes, all panel materials for walls and floors, doors and steel door frames, door hardware, etc. etc. They deliver materials to the construction sites bundled and labeled per project, per building and per dwelling unit. Their "quick-connect" water piping system (one of 16 patents) does not require licensed plumbers. They complete a small apartment in about a month and are aiming for one week.

I took a tour of one 20-story public housing project under construction with a young woman who studied interior design in New York City, worked in the real estate industry in the US for several years, speaks fluent English, and is the daughter of the President of the Company. She had studied Interior Design in New York, and had worked in real estate before returning to China to help run the company.

PREFAB INTERIORS has the contract to deliver all infill for each of the 5 buildings in this project, and other "market-rate" developments nearby.

Their objective is to deliver everything to fill-in a raw space, delivering finished units ready for furniture. They serve the luxury villa market, for-sale condominium projects with floor plan variety, as well as rental public housing projects with two or three floor plans per building. Their logistics strategy is to deliver as much as possible from their own factory. Rather than delivering everything needed for each dwelling unit in dedicated containers, they deliver large quantities of each subsystem, with each delivery labeled as to which building, which floor and which dwelling unit a given bundle of parts is to be delivered.



The company booth at the trade fair



One of the apartment blocks using PREFAB infill



An empty unit receiving delivery of infill parts



Metal studs made by PREFAB, bundled and labeled per building/floor/unit.



A patented method of attaching wall liners using adhesive (to reduce noise)



PREFAB's patented raised floor with floor heating



WC is rear discharge; drain pipe under floor is from the shower



PREFAB's patented partition system

A series of questions produced important information about the company:

- 1) Is your factory able to handle a variety of floor plans in a given building (or in the case of a development of luxury villas, a variety of layouts in a given development) with equal efficiency?
Yes, we customize our products for different floor plans in a given building, while making unique corresponding product orders. But the more personalized, the lower the efficiency for our factory. So far, we have delivered 30690 units and we are also expanding our projects to hospitals.
- 2) Do you use any special software to manage the parts and subsystem production and handling, once you have a floor plan?
Yes, we have been looking forward to special software to help us manage the products data, but currently in China, there is no suitable software for our business, so we have to develop our own products data management system SAAS. It is currently being developed.
- 3) I was amazed that the stack of metal studs you showed me was "bundled" and "labeled" per building/floor/unit. Is it the case that each apartment in a project is a separate "accounting" or "budget" item for your company? This is important when there are different layouts to account for, and for when consumers want to choose their own floor plan...
Yes, every building/unit/ floor is separated by account and product coding, to ensure that every product from our factory can be accurately transported to every apartment unit, in order to meet the needs of each customer for the product.
- 4) Does one team of installers stay with a given apartment infill job from its beginning to its end? Is that team cross-trained (can they all do everything, or almost everything except, perhaps, tile work?)
Yes, the workers have been cross-trained to work on everything from project beginning to end except electricians (they need to be certified). This way, the overall installation fee will be a lot lower.

Traditional Infill

Accompanied by Dr. Li Shanshan (who took some of the images below) I visited two "traditional" infill projects in a Beijing development built in 2003. One remodeling project had official approval, while the other (in the same building) was, according to the worker we spoke with, "illegal." There was no perceptible technical difference. The first set of images below shows the "legal" infill job, undertaken by the Qingzhou Decoration Company, on the 21st floor. The old infill had been entirely removed. New electrical wiring was being installed (in plastic tubes cut into existing plaster or concrete walls), and an entirely new kitchen and bathroom would be installed soon, with new floor finishes, and new ceilings. No changes were made to the floor plan, or to the plumbing. New windows were also being installed. Three workers were assigned to the job. The 70-day schedule showed work beginning 9/13 to be completed 11/21.



Location of the Tianzhao Community and the building



Building Number 4



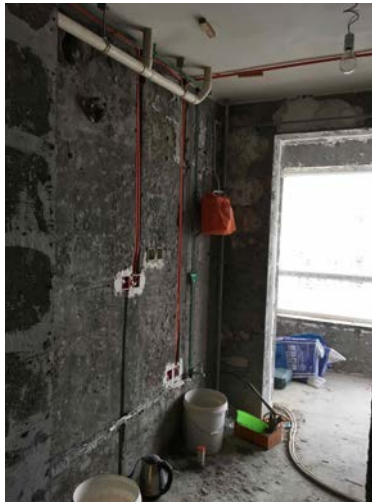
Building #4 entry



The front door of the apartment



The emptied unit



Drainage pipes serving the apartment above are visible
Electrical conduit is red, new water pipes are green



New window units having been installed



To conceal new wiring at the top of the walls, plaster
"cove" molding will be installed (the white products)



Gas piping and meter/ Shower drain from upper floor



A new electrical conduit in a trench cut into the slab



One of the workers beside the vertical pipe shaft

		Project Schedule																			
Task	duration (70 days for existing housing)																				
	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Confiling technical intentions																					
Demolition work																					
Basic materials approach																					
Identify the elevation and location of waterpipes and electric wires																					
Renovation of waterpipes and electric wires; tiles approach																					
Drop ceiling construction																					
On-site woodworking																					
Acceptance of concealed work Basic layer (in the kitchen and bathroom) treatment; wrap the pipelines																					
Tile the kitchen and bathroom																					
Product repetition measurement; order the products																					
Basic layer (of the walls) treatment																					
Mid-term inspection; interim payment																					
Waterproofing treatment of the floor in the kitchen and bathroom																					
Leveling for floor tile																					
Basic layer (of top surface) treatment																					
Oil ornaments surface treatment																					
The installation of power switches, sockets and lamps																					
The installation of customized products																					
Final acceptance																					
1	9/13																				
2	9/14																				
3	9/15																				
4	9/16																				
5	9/17																				
6	9/18																				
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Notes:
1. Basic layer treatment in kitchen and bathroom: wall surface waterproofing, basic layer leveling with cement mortar, wall surface stuccoes; check the firmness of existing stuccoed layers.
2. Installation of customized products: drop ceiling of kitchen and bathroom, water heater, wood door, cabinet, floorboard, plate-type furniture, shower cabin, and toiletries.
3. Basic layer treatment (the top of the walls): shovel the existing wall surface; paint the interfacial agents; make level by scraping the plaster, improve the internal and external corners.
4. The middle term: complete the renovation of waterpipes and electric wires; finish the basic woodworking; 70% of all the wall tiles has been stuck; deal with the basic layer of wall painting.
5. Complete the renovation of waterpipes and electric wires; all the tiles approach; finish the renovation of radiator pipelines; install all the PVC windows and doors.

The seventy-day project schedule above allows a detailed examination of how work is accomplished. (Translation by Dr. Li Shanshan, Beijing University of Civil Engineering and Architecture)

The “illegal” infill job, on the 22nd floor, was very similar, although with a different floor plan. In this case, one worker was doing all of the infill work, including some minor plastic water piping.



Drain from the WC + shower in the apartment above +new wiring and water lines



The single multi-skilled worker doing the “illegal” infill (along with Dr. Li Shanshan)

Summary and Commentary

The S/I approach, at its current state of development and implementation in China, appears to be integral to central government policy for stimulating industrial capacity in the manufacture of a wider array of products, thus strengthening “industrialization.” Although this was never explicitly stated, it is probably also related to central government efforts to increase consumer spending on “durable” goods.

While progress is evident, implementation of S/I housing, while very impressive compared to other countries, appears to be slow to “catch-on” so far, for several reasons. First may be dependence on specialized “infill” products in quantities too small related to the size of the Chinese market, thus increasing cost of Infill. A second reason may be overdependence on government - controlled developers (e.g. Landsea in Shanghai; Luneng Group Company LTD in Jinan; Tianjin Real Estate Development Group in Tianjin, etc.) to implement the S/I projects in the last 6-10 years.

A third reason may be a dilemma resulting from a conflict between goals of the central government. On the one hand, there is a need to improve employment opportunities for millions of unskilled workers. At the same time, the government advocates “industrialization” which will eventually depress employment by automated manufacturing and reduced on-site labor, two trends that could have serious negative social consequences, according to some experts in the real estate development sector I spoke to.

In the near future, it may be important for companies entering the infill market to move in the direction in which infill solutions would use more commodity and/or “conventional” products coming into the Chinese market and currently available in the market worldwide. On the other hand, it is understandable that in the beginning, companies would want to develop and use their patented products, to assure quality and dependable supplies and to differentiate themselves from their competition. Some of these products are of very high quality but are also very expensive and would have difficulty being accepted in Europe or the United States. I can only assume that these very expensive subsystems can be used only because as part of a complete single-sourced solution, they offer a significant reduction in management costs, speed of completion, reduced client risk, and a dramatic improvement in quality and reliability over the “traditional” approach.

In addition, given the tightening trained labor supply and the pressure to deliver infill quickly with minimal disruption and management overhead, development of multi-skilled worker teams – as used by PREFAB INTERIORS - may prove to be more broadly possible and more efficient, while not eliminating labor opportunities altogether – a deep concern due to potential social unrest felt nationally.

Stimulating consumer demand for S/I needs to increase. This means using social media and other new ways to get directly to consumers (not just developers). This also means making INFILL easy to buy, by making INFILL available in the open market, with consumer-oriented and competitive Infill Companies using products from highly reputable consumer-product companies, such as Haier, Kohler, IKEA, York, etc., something that the Japanese building products’ industry has excelled in doing.

Perhaps as the infill industry matures in China, “Certification” of such INFILL SERVICE companies, not individual projects, will begin. I could not find evidence of developments in this direction; however, certification of projects is already familiar, and many Chinese companies advertise that they are certified under ISO (International Organization for Standardization - <http://www.iso.org/iso/home.html>) standards. For example, inclusive cities / shared development is the 2016 theme of World Cities Day celebrated on 31 October. Many ISO standards contribute to improve quality of life in cities, including ISO 37101, which offers a management system for sustainable development in communities.

Moving from initial government control to an “open” sourced Infill service independent of central government control is probably necessary, although there is no certainty that this will happen. However, diversification of risk is critical, for parties both on the demand and supply sides. This is why government may not remain the only provider – or initiator - for very long.

For his part, Mr. Liu told me that he has a three-pronged strategy to advance his agenda: 1) giving lectures and talks to many organizations; 2) developing S/I standards and 3) implementing projects, so far depending on state-owned development companies for project implementation. He also told me that the term “open building,” when directly translated into Chinese characters, does not, in his opinion, give an accurate meaning: the word “building” in Chinese is too narrow. He prefers “open architecture” because it signals a much broader, and perhaps philosophical orientation – a much deeper change of mind than simply “open building” suggests.

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Sources

- Dr. Li Shanshan (2015), [A View of Flexible Housing in China](#); A thesis completed at the Politecnico di Torino.
- China Institute of Building Standard Design and Research, [2016 Annual Report](#)