Title:	**High-Rises From the Past and For the Future**
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Subjects:	Retrofit Urban Design
Keywords:	Density Façade Preservation Vertical Urbanism
Publication Date:	2019
Original Publication:	2019 Chicago 10th World Congress Proceedings - 50 Forward | 50 Back
Paper Type:	1. Book chapter/Part chapter 2. Journal paper 3. **Conference proceeding** 4. Unpublished conference paper 5. Magazine article 6. Unpublished

High-Rises From the Past and For the Future

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Abstract

In some an increasing number of cities, vertical expansion has been the only viable option, however efforts should also be concentrated on remodeling existing buildings. In order to do this, it must be understood how these structures can be upgraded with new technologies and materials in order to provide an improved environment for users, reduce energy consumption and ensure enhanced connections with their surrounding contexts. If we accept that the structures we build today will be the existing buildings of the future, the potential for future retrofitting should be embedded into the equation from the outset when designing new high-rises. The similarities and differences in the design approach for new-builds and retrofits are examined through project examples which illustrate how the possibility to one day retrofit new materials or technologies can be embedded, potentially changing the life cycle of our buildings.

Keywords: Densification, Performative Envelopes, Remodel, Retrofit, Vertical Cities

Introduction

Cities all over the world are facing urgent challenges regarding densification in the near future. By 2050 an additional 2.5 billion people will be living in urban areas. This raises a number of pressing concerns: How do we ensure that our cities can adequately cater to this immediate growth, environmentally, socially and economically? How do we ensure that our cities become resilient to ongoing densification over time? How can we create workable strategies for the integration of new materials and technologies in the built environment? And lastly, what steps do we have to take to ensure that the buildings we design today are adequately resilient and future-proof?

Some design approaches for high-rise new-builds and retrofits address the possibility that one day a new retrofit will be required and therefore extend the lifecycle of the buildings.

Looking to the Past

In 1950, New York and Tokyo were the only two cities in the world whose populations exceeded 10 million. Since then, the rise of the megacity has taken hold. In 2015 the OECD released estimates predicting that by 2030 the number of megacities will increase globally to an estimated 41 to 53 million, with seven of the world's top ten megacities located in Asia. Looking back at select models of urban densification in fast growing areas, these cities have turned into megacities due to the growth of high-rise development at an enormous speed. The evolution of the skylines of cities such as New York, Shanghai, and Singapore, demonstrates quite clearly that the architectural response to densification principally relied on the high-rise typology.

In the simultaneous evolution of the construction industry, we have witnessed the development of curtain wall façade and unitized façades. The perceived lightness of an all glass high-rise—typical of the previous century—is simply no longer tenable in light of today's energy saving ambitions. Today, the building skin needs to be climate responsive in order to improve the internal conditions, lower energy use and reduce carbon emissions. What then can be done in order to upgrade previously built buildings? Aside from seismic retrofitting and repurposing, the refurbishment of the building skin has become an essential task for architects today.

Looking to the Future

Increasing numbers of people continue to move to cities in search of work, better housing and improved quality of life, and this trend shows no signs of abating for years to come. This growth creates an enormous challenge for our cities environmentally, socially and economically. In order to prepare for this widespread future densification, cities will need to accept expansion in one form or another. They will have to provide adequate means to serve the needs of their growing urban populations, particularly with regard to transportation, energy systems and housing, as well as for employment and services such as education and healthcare. For all of these services, digital technology and the connectivity of our global cities become key factors in paving the way forward and creating strategies that correspond with the cities' physical densification.

Logically speaking, there are three possible options to cater for future densification: build downwards, build outwards, or build upwards. The first option may have its quirky appeal, but aside from questions concerning potential negative effects on human health, this option only provides a growth model for a limited number of urban functions. Developing the fringes of the city, or creating satellite housing developments, is a tried and tested method. This option however can face staunch Greenbelt policies or lead to long commuter journeys and a sense of segregation for those who cannot afford to live within the city limits. Vertical expansion is therefore still the preferred option for many of today's cities and metropoles. In fact, many proponents argue that such expansion is necessary in order to counteract urban sprawl, which threatens valuable farmland and therefore much needed food production. These same advocates also argue that well planned urban densification drives energy efficiency, as the energy required for heating, cooling and transportation can be distributed more effectively in dense (rather than sprawling) conditions.

In the fastest growing cities, urban planners and developers are rejecting urban zoning concepts—which separate programs such as working, living, retail, and leisure—in favor of centrally located, large scale, holistic, mixed-use developments. In these developments working, living, and leisure activities are within walking distance of each other and the use of (valuable) urban land is maximized. As a result, we are now building cities within cities and creating neighborhoods in the sky.

The Here and Now—In with the Old, Out with the New?

UNStudio has designed a number of mixed-use, high-rise, new build developments and are only too aware of the many and complex challenges involved. Immediate considerations include the integration with existing nearby infrastructure and public transport nodes; an appropriate conceptual and formal response to the cultural context of the host city; the seamless integration of public programs at street level and (at times) up into the buildings; the organization of complex flows and separate access to the different programs within the towers and, of course, a considered solution to the overall massing of the development, eventual phasing opportunities and adaptability for future use. In addition to these design related challenges, architects also must work in line with economic considerations, planning and policy regulations, and last but not least, the overall design must express the unique identity of the host city—something that links to our urban experience, emphasizes the uniqueness of a place and becomes part of the city's identity.

The role of the architect is however not merely to problem solve, it is to add value—not least with a view to designing for the future. As such, each of the separate program typologies in a mixed-use development requires in depth knowledge of all related tendencies, trends and projections, while the design must principally be user-centric, providing quality of space, flexibility for future change and the integration of new technologies. Whether the program be one catering to the hospitality industries, to future living, working, retail, culture or entertainment, architects need to design spaces of experience pertinent to each one in order to maximize cross-fertilization of use, minimize distances and make the mixed-use development an efficient and self-sustaining part of the city.

In recent years however, a fast-growing concern and increasing opposition to the "throw away culture" that evolved on many and varied levels towards the end of the previous century has emerged. More often than not, in the face of densification, urban planning resulted in the automatic replacement of old structures with bigger, taller and shinier new buildings. Today we recognize that we have an environmental responsibility to save valuable resources and take a sustainable and circular approach to the built environment. As such, where possible, refurbishing, remodeling and re-purposing are increasingly becoming a preferred option. But when is this possible? What are the essential considerations in such a decision? And what challenges and opportunities does this present to architects?

The integration of new technologies that can adequately service today's buildings is one such challenge when retrofitting an existing high-rise. The various sizes of HVAC systems almost always have to be carefully calculated to fit, with the challenge of then being able to maintain appropriate floor to ceiling heights. Adding additional technologies and newer equipment to an existing building will influence the free height. Furthermore, the floor-to-floor heights that were acceptable in the past, cannot compete with those of newer buildings.

In addition to this, when retrofitting a new façade system, the structural capacity of the building can sometimes pose a problem, especially when trying to add a cavity façade or heavier and cantilevering constructions, such as balconies. This can be the case when repurposing an office building for residential use, for example. Alongside the calculation required for additional loading, the quality of the existing construction determines whether the structural joints will be sufficient over time.

As buildings are often planned to fit exactly within building boundaries, increasing the depth of the façade will inevitably sacrifice the available floor area. If the existing building has a deep floor plate, setting back the façade line establishes an even better solution for the interior space. On the other hand, if the depth of the floor plate is reduced, this may result in inefficient use. Frequently such economic considerations drive the decision to retrofit, or not, an existing structure.

That said, and considering that most of the world's tallest buildings are designed for office use, contemporary work places no longer adhere to the layout and usage models that were used in the past. A flexible and versatile use of space in today's offices means that more people can be accommodated on the work floor. As such, retrofitting an existing building provides an opportunity to upgrade it to more efficient usage models, which in turn results in economically beneficial solutions for the client. In this instance densification can also be achieved on the building scale in accordance with the occupancy allowance.

Even if these challenges can be adequately overcome, the risk of unexpected discoveries during the demolition of existing façades and fit-outs always remains. Given how complex it can be to custom-fit solutions even on a new construction, when refurbishing an existing building, exact measurements are essential to avoid having to resort to improvised, ad-hoc constructions. Part of the solution certainly lies in the detail that connects the existing with the new, as this can help to avoid the need for on-the-spot, impromptu fixes.

Given the above, some of the most pertinent questions that arise for today's architects are: what must we include in the craftsmanship required of the new-build that will enable and ensure its economic, technological and material longevity? And what tools do we have at hand now that will enable us to adequately prepare these new structures and their many components for retrofitting or repurposing in the future?

Reverse Engineering the Future

Every project offers unique opportunities. By being aware of the challenges involved in retrofitting, when we design today, we know much of what is required to prepare our buildings for the future.

The structural calculations of older buildings are often difficult to retrace from the archives, and sometimes they simply do not exist. But this can certainly change in the future. With computation and the capability to integrate a building's analytics with BIM, today it is possible to create a full building passport that contains the information that was created during the design and engineering process; information that will prove extremely valuable, should the building undergo alteration in the future. As such, a material passport will enable the disassembly and replacement of the different constructive elements. As designers, we are actively engaging with bringing these digital technologies to such a level that the basis of all design data can later be used to dismantle the building, recycle its components and find creative solutions for repurposing.

In the meantime, building technologies continue to evolve, and given the recent addition of new sensor and data technologies, it seems fair to assume that we will soon have to accommodate more and more technology in our buildings. As this may mean that more space is required in the future, we can anticipate strategic locations and channels for the infrastructure. More equipment also means that more access points will be required. And while digitally controlled systems will tell us where maintenance and equipment upgrades are required, having several sub-systems requires solutions for the building's infrastructure and consideration of the required flexibility to combine these sub-systems when, for example, the tenants require different unit sizes.

If we look at the façade in more depth, the most essential factor is how the envelope components are connected to the building, and how flexibly these can be adjusted or replaced at a later date. Such questions start with geometry and with the repetition of elements—an approach that in today's world of mass-customized production remains a significant differentiator in price and effectiveness. A façade system in which panels can easily be replaced, begins by using the same measurements and fixing system. The infill is then the upgrade, which—as the innovation of new building materials develops—can make a significant difference for the energy use/loss of the building.

Where unexpected discoveries in the future are concerned, designers and planners need to ensure that a detailed planning without any failures can be achieved, and that all information that was created during the design and engineering process is archived in order to be accessible for use at a later date. Having a digital twin of a building makes the whole construction process transparent—from the design work to the final, completed building. Once such technology becomes the new standard of our construction industry, then we can have an in-depth understanding of existing structures and will have significantly more technically relevant tools at hand to work with in the future.

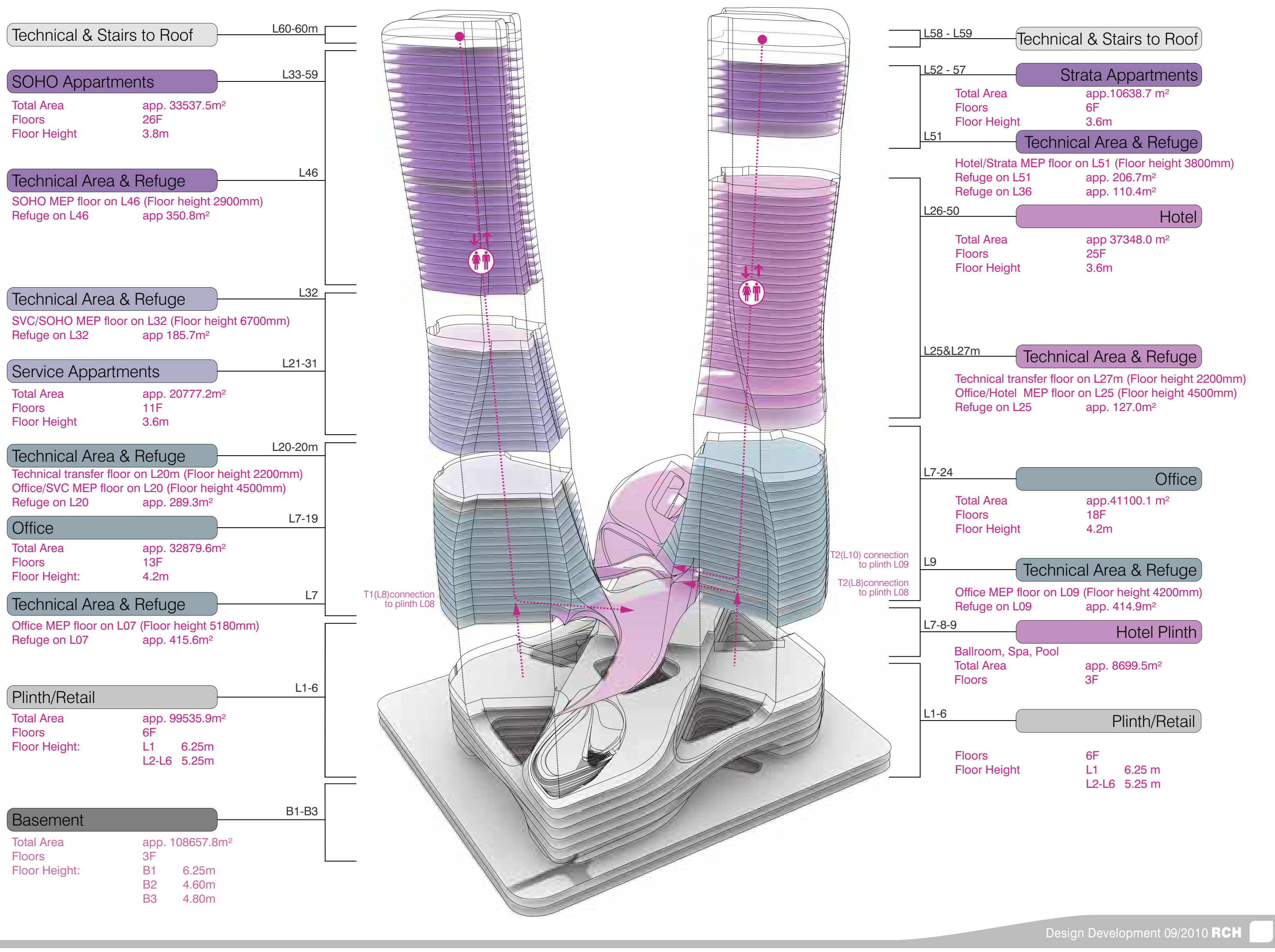
Example 1: New Build—Raffles City Hangzhou, China

Raffles City is a sustainable urban hub for living, working and leisure located in Hangzhou, one of China's most picturesque cities. Strategically situated in Qianjiang New Town near Qiantang River, this mixed-use development occupies one street block measuring 100 meters by 150 meters and is a major landmark along the green axis of the city's new CBD.

A rich mix of 24/7 functions occupies almost 400,000 square meters within two streamlined towers set atop a retail podium and landscaped plaza (see Figure 1).

Featuring stunning views of the river and West Lake areas, the sixty-story, 250 meter-tall high-rises contain residential units, Grade A offices, serviced apartments, the Conrad Hotel and a rooftop helipad. The 116,000- square-meter, six-story podium accommodates retail, restaurants, leisure facilities and parking and has a direct underground connection to the metro. Conceived as a lively vertical neighborhood and transit hub, Raffles City combines the most desirable program mix to be both sustainable in itself and to serve the wider neighborhood, being a new commercial focal point in town and responding to the integrated needs of new urban living. The design for this new build began in 2008 and the project was fully delivered approximately 10 years later (see Figure 2).

Figure 1. Raffles City Hangzhou is an "all-in-one destination" featuring twisted glass towers. © Hufton+Crow



* please note: diagram is simplified representation, and not most updated geometry. floors no's and sqm areas all updated dd 13/9/2010

Figure 2. Diagram explaining the program allocation within the mixed-use development at Raffles City Hangzhou. © UNStudio

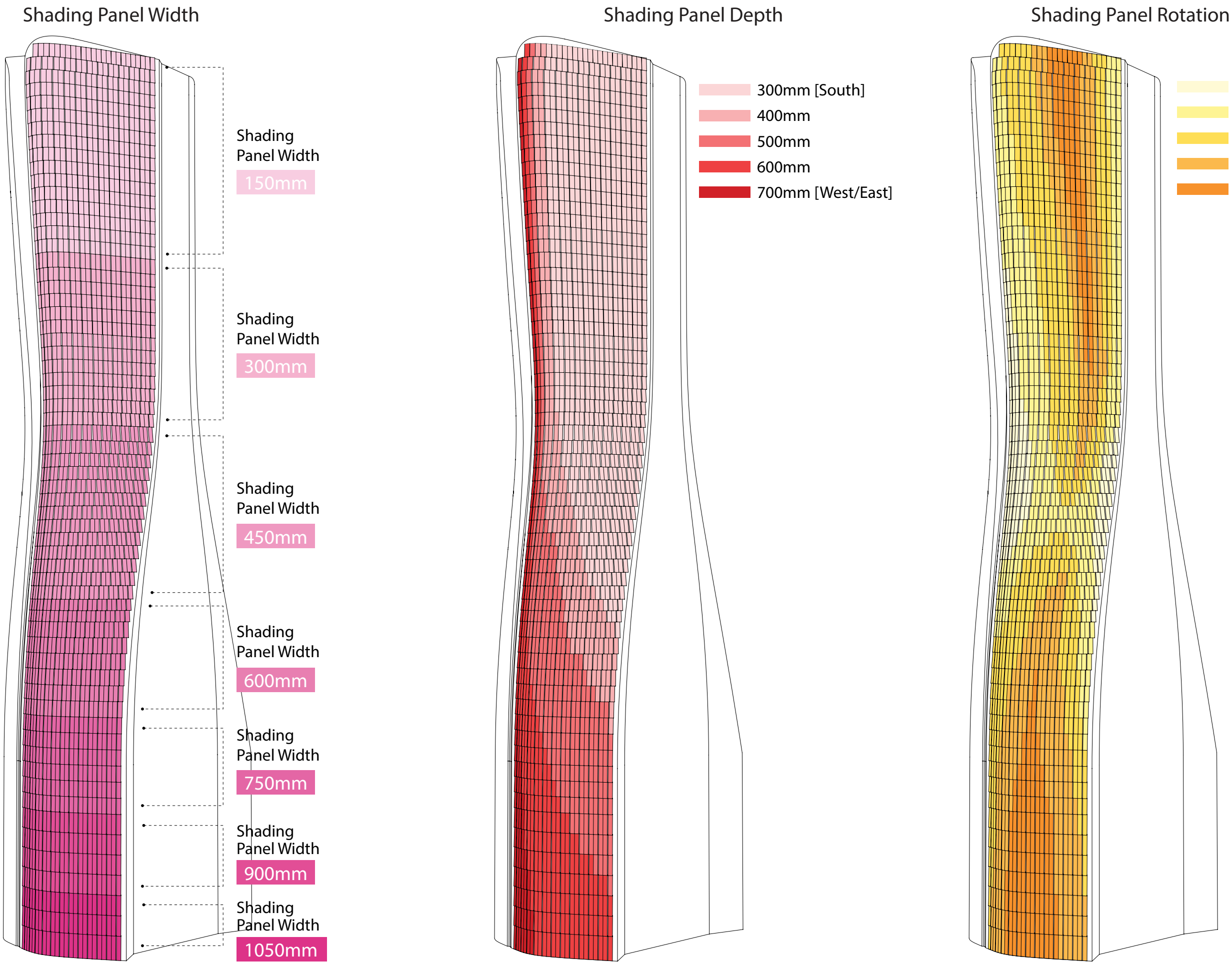


Figure 3. Diagram showing the parameters for façade panels and shading modules for the detailed design at Raffles City Hangzhou. © UNStudio

As the design for Raffles City focused on integrating the different uses in one efficient structure—while still catering to the specific needs of each function (as opposed to providing a generic, averaged out solution)—an optimum combination was achieved. For example, by stacking the vertical access, the elevator shafts are minimized and are reduced in size towards the top. The efficiency to be gained in the future is expected to be achieved through new elevator technologies, which will operate based on user analysis and smart solutions that optimize timing and stop based on both demand and predictability.

Designing a tailored mixed-use building resulted in dedicated floor plate sizes and floor-to-ceiling-heights, along with vertical accessibility in both towers. The vertical zoning is fixed and is either commercial or residential. Within these zones, the division walls and fit-outs on each floor establish a certain flexibility of use in the long run. For example, each office floor plate can be single or multi-tenant occupied. The serviced apartment units and hotel rooms can change in size or be combined. As such a certain degree of flexibility is created within the overall program mix. However, if such repurposing would need to be more radical, this would result in relatively high effort and costs.

The same can to be said of the façade, which can be refurbished based on the heights and geometry predetermined by the main structure—thus within the existing framework and potentially with all quantities and measurements available. It merely allows for the replacement of material, whereas the external shading elements of the so called "urban" façade can be dismantled independently from the glazed façade (see Figures 3 and 4).

Figure 4. Raffles City Hangzhou's so called "urban façade" with glazing panels and shading panels. © Hufton+Crow

Example 2: Retrofit—Hanwha HQ, Seoul, South Korea

The remodeling of the Hanwha Headquarters building, located on the Cheonggyecheon in Seoul, incorporates the renovation and retrofitting of the façade, the interior of the common spaces, lobbies, meeting levels, auditorium and executive areas, along with the redesign of the landscaping (see Figure 5).

The client, Hanwha Group, founded in 1952, is one of the Top-Ten business enterprises in South Korea, with domestic and global networks in three major sectors: manufacturing and construction, finance, and services and leisure. Putting strategic emphasis on renewable energies as its future growth engine, Hanwha Group has made successful advances in solar energy and positioned itself at the forefront of the global photovoltaic industry. It is currently the world's third largest photovoltaic producer.

Built in the nineteen-eighties, the existing headquarter office tower was seen to no longer reflect Hanwha as one of the leading environmental technology providers in the world and in recent years has been superseded by its neighboring buildings, following the promotion of nearby cultural projects by the city. Furthermore, the original office façade with its parapet walls and glazing was not performing sufficiently for the optimal use of the building—as is the case with many older buildings worldwide. During the summer months, the building would heat up quickly, resulting in a cooling overload, while during the winter, the insulation was not sufficient to economically keep the building at an appropriate temperature. The new envelope should therefore integrate façade technologies that have been developed in the last 50 years in order to upgrade the performance and energy use of the building.

For this reason, a new modular and repetitive skin was designed that also considered a range of modules in varying sizes. These modules also have different depths, depending on the orientation of each façade. They perform as a sunscreen and keep unwanted radiation out of the interior office spaces. In comparison to the initial façade, the depth increased, however due to the lightweight aluminum construction, the

Figure 5. The Hanwha HQ in Seoul during its first year of facade reconstruction. © Rohspace

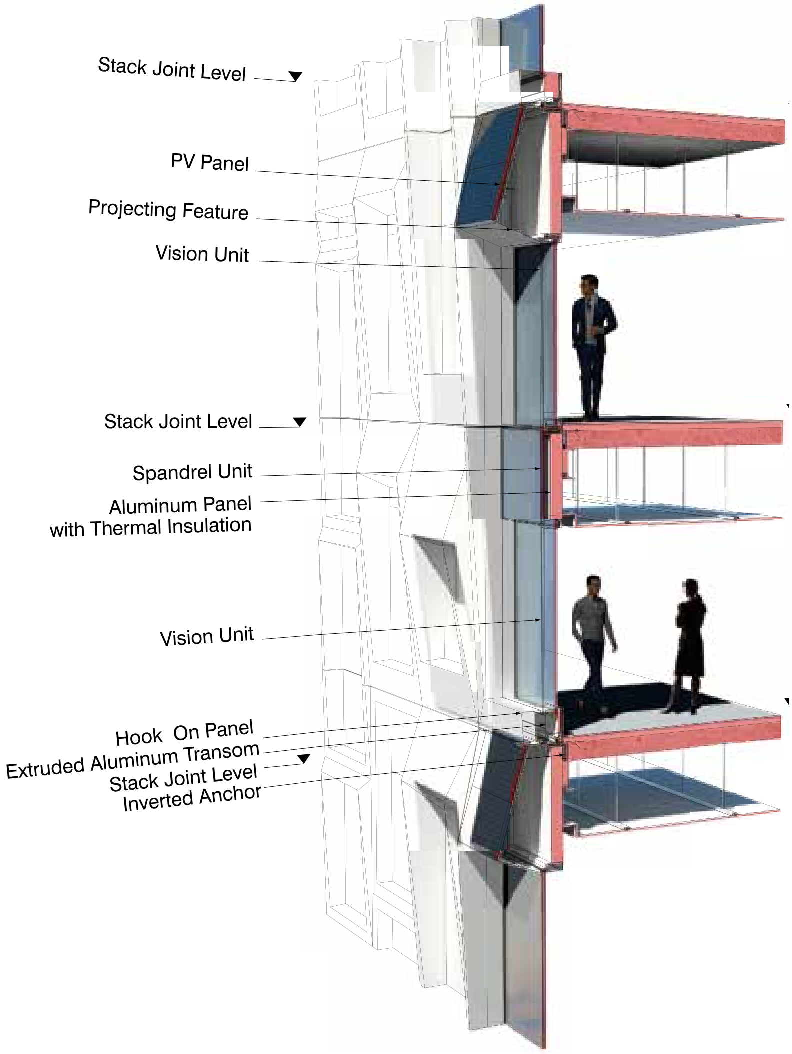


Figure 6. Axonometric of performative facade with allocation of modules. © UNStudio

building's existing structure could cope with the loads of the new façade (see Figure 6). The vertical extrusion of the tower, its columns and floor edges allowed for the creation of variation within the geometry, which can be found in the different façade modules. The addition of PV-cells in the angled upper surfaces of these modules were designed for and are integrated into the façade at the most effective locations for energy harvesting (see Figure 7).

The design of the Hanwha HQ retrofit project started in 2013 and was completed within one year. However, the construction only completed in 2019. This expanded timeframe is a result of the construction method that was chosen. Namely, to retrofit the facade and the interiors while the building remained fully occupied and functional, thus enabling the company to remain working in the building throughout the construction period. In order to enable this, three floors were refurbished at a time, in both the interior and on the facade (see Figure 8). The construction started from the ground floor and reached the highest level in June 2019. Electing to choose a construction method that would have minimal impact on both the operation of the company and on the environment may not have been the most economic option, however it serves as a good example for all stakeholders in the construction process to consider alternative parameters and sustainable measures that can be introduced when retrofitting existing buildings.

Conclusion

The two projects described above couldn't be more different from each other, yet both are examples of design approaches that offer solutions for densification and the upgrading of our cities. Whereas the new design for Raffles City combines all city functions into one balanced equilibrium—with shared public spaces, efficient building infrastructure and the potential to change over time—the retrofit of the Hanwha HQ tower optimizes work spaces and was upgraded to a modern construction with sensible material use and construction methods.

As architects we certainly understand that the structures that are built today will one day be the existing buildings of the

Figure 7. Integration of PV modules in the facade for Hanwha HQ. © UNStudio

future. Learning from the retrofit example raises the question whether architects today should design buildings for the future that are generic? If the future should prove the Raffles City project to be a success, the answer to this question can be no, not necessarily. Whether originally designed as a generic building or a tailored construction, the building skin and interior are often the first components in need of a retrofit. The main structure, the floor-heights, the shafts and the vertical circulation are normally not altered in full. As such, a bespoke design that is aligned with the requirements aligned to the planned use of the building, can provide the best basis for long-term use and adequate operation. And of course, in any tailored design we also have to embed the potential for future retrofitting from the outset.

As the current shift is towards designing and retrofitting highly performative, sustainable, human-centric, technology-driven, safer and healthier buildings, most of the innovations that will affect our buildings in the future are technology-driven. If such objectives are largely to be reached through the use of technology, can added value through architecture and space still result? As architects we believe it can—and should. The aim is always to create welcoming spaces that people will want to return to again and again. In all cases, whether retrofit or new-build, architects need to design efficient models that are in line with the client's plans, alongside relevant architecture that signifies and attracts. When we consider office buildings, the current war on talent means that companies are competing for the "best and the brightest" to join their workforce. In such instances, company branding and identity become an important attractor to potential employees and thus, an important function of the aesthetics of the building. As such, aesthetic considerations are not driven by a demand for "Instagrammable" buildings, they are moreover, and always, the result of the crossing points between function, form and context.

Figure 8. Construction method of refurbishing the building upwards with ongoing works at three floors at a time. © Rohspace