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Skybridges: A History and a View to the Near Future

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Abstract

As many architects and visionaries have shown over a period spanning more than a century, the re-creation of the urban realm in the sky through connections between buildings at height has a vast potential for the enrichment of our cities. To many it seems nonsensical that, although the 20th and now 21st century, have clearly seen a push towards greater height and urban density in our major urban centers, the ground-pavement level remains almost exclusively the sole physical plane of connection. As the world rapidly urbanizes, greater thought needs to be expended on how horizontal space can be developed at height. This paper briefly describes the history, present classifications and uses, and potential future development potential of skybridges between tall buildings.

Keywords: Skybridge, Tall buildings, Development, Vertical transportation, Urban habitat

1. Introduction

The purpose of this project is to succinctly capture the development history of the skybridge, as well as put forward a set of principles for future development. The CTBUH believes it is likely we will see more skybridges, and more horizontal development at height between tall buildings, but there is no guarantee that these will be of high quality unless we begin to seriously analyze how well the existing spaces function, and learn from them. This research therefore marks an important milestone in the development of an urban space that has persisted through utopian visions and emerged as a practical, point solution in isolated cases, but now is emerging as a major design typology. We seek to provide a framework for better understanding the skybridge, and improving upon it.

The authors have received an 18-month research grant from thyssenkrupp to undertake a study of the potential use cases for skybridges in future three-dimensional cities, particularly in respect to their potential as transportation corridors in a future that anticipates the arrival of ropeless elevators capable of traveling horizontally. This paper relates to the initial scope of research, which includes a definition and historical evaluation of the typology.

2. Definitions

In general, a skybridge is defined as "a primarily enclosed space linking two (or more) buildings at height. "Enclosed means that the path of travel within the skybridge is surrounded by built planes (openable and/or static) on all sides. "Linking between buildings refers to the bridge being physically connected and supported in its entirety between two or more separate buildings. "At height means that no part of the bridge touches the ground. Generally, though not exclusively, this paper focuses on structures that are at least six full floors above grade, so as to distinguish them from typical pedestrian overpasses over roadways, canals and railways seen all over the world. Some exceptions to the above definitions may be made for illustrative examples of trends and special circumstances.

In the preliminary research, the authors have identified four general types of structure that can be classed as 'skybridges;" however, two of these will be selected for more expanded analysis during the course of the research project. All typologies are discussed here in brief.

2.1. Enclosed Circulation

An "enclosed circulation" skybridge primarily exists only to transfer pedestrians from one building to another. It will typically be enclosed in glass and be covered with a roof, and minimally decorated or furnished. It is likely the most common form of skybridge, as it practically serves the goal of passing from point A to point B without having to descend to ground level to pass between two buildings (see Fig. 1).

2.2. Enclosed Programmatic

An "enclosed programmatic" skybridge has all the characteristics of the "enclosed circulation" skybridge, but has some kind of distinct program that draws people to the space for a reason beyond passing from one building to another. This can include common-use areas for occupants of the two buildings that adjoin the skybridge, such

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Figure 1. The Highlight project in Munich, Germany (2004), is an example of the "enclosed circulation" typology. © Murphy/Jahn.

Figure 2. The American Copper Buildings, New York (2016), feature a two-story amenity deck between the two towers; it is a common-use area for residents and includes a pool on the lower level. Photo Credit: Max Touhey.

as gyms, recreation rooms, lounges, restaurants, etc., or other extensions of attached buildings" programs, such as office or residential space (see Fig. 2).

2.3. Skyplanes (Rooftops, Roofdecks, etc.)

"Skyplanes" are occupiable, horizontal structures which may either extend between two or more buildings, or extend past the perimeters of two or more buildings, at the level of the attached buildings" rooftops, or slightly above (see Fig. 3). These can be circulation-only footbridges, or they can be elaborately programmed with plantings, swimming pools, recreational equipment, amphitheaters, etc.

2.4. Building-as-Skybridge

In this configuration, the overall mass of a single building forms from at least two vertical towers and at least

Figure 3. Marina Bay Sands, Singapore (2010), incorporates a "skyplane" connecting at the rooftop level of its towers; there is extensive outdoor programming on the skyplane, including an infinity pool. © Safdie Architects.

one horizontal bar into a frame; the horizontal element of this frame is not readily distinguishable from the vertical elements. Typically, the horizontal and vertical elements will be several floors or window frames across or deep. Essentially, the combination of horizontal and vertical elements makes the composition appear or act as a single building, as opposed to two or more buildings connected by a third piece (see Fig. 4).

Figure 4. CCTV Headquarters, Beijing (2011), an example of "building-as-skybridge." (ccbysa)Verdgris.

3. A Brief History of the Skybridge

3.1. Early Skyscrapers and the Machine Age

Within 25 years of the appearance of the first skyscraper as a building form in Chicago in the latter part of the 19th century (Condit, 1952), cities of the future began to be sketched as dense agglomerates of skyscrapers, inhabited by teeming masses of people and vehicles. The precursor to these urban visions was the seminal image created by the American folk artist Erastus Salisbury Field for the Philadelphia Centennial Exhibition in 1876, entitled *"Historical Monument of the American Republic"*. Here, numerous classically-inspired towers reach into the sky, connected at their tops by an aerial railway network of skybridges upon which balloon-stack locomotives travel.

The painting had a clear influence on visionaries to follow. The work of the American artist-planner Charles R. Lamb and his delineator Vernon Howe Bailey, specifically their 1908 "Streets High in the Air" illustrations (see Fig. 5), show the same set-back blocks and orthogonal skybridges as in Field's earlier work, and the Visionary City project of the same year by William Robinson Leigh predates the start of spectacular science fiction cinematography by at least 20 years.

The most influential urban visionary work of the early

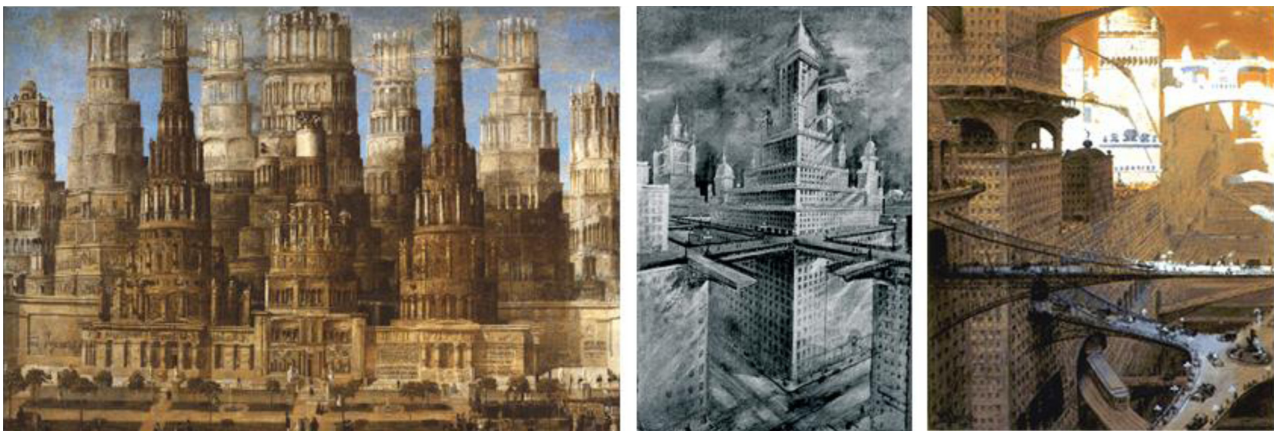

Figure 5. The earliest futuristic images to include skybridges: (a) 1876. 'Historical Monument of the American Republic'. Erastus Salisbury Field, for the Philadelphia Centennial Exhibition (source: Leeuwan, 1988, p.50), (b) 1908. 'Streets High in the Air'. Charles R. Lamb (source: Collins, 1979, Fig. 10), (c) 1908. 'Visionary City'. William R. Leigh (source: Corn & Horrigan, 1984, p. 34).

20th Century was that commissioned by Moses King, who embarked on a series of books which would become one of the defining texts of the early 20th Century American city – "Kings Views of New York". The first of these books – which primarily recorded, both photographically and statistically, buildings, monuments and views in the city – was published in 1896, with subsequent updated publications in 1903, 1905, 1908, 1911 and 1915. Subject to so frequent updates, the series of books became a living record of the rapidly evolving city and skyline.

It thus seemed natural then – given the process of recording the evolution of the city – that King would want to pre-empt what the future held and thus, in two later editions (1908 and 1911), King commissioned visionary images of what the city could become, perhaps as a "taster" for the next installment of the publication. For these, he commissioned two architect-illustrators. In the 1908 edition, entitled "King's Dream of New York", King commissioned Harry M. Pettit to produce an image of the "Cosmopolis of the Future," which served as the Frontispiece image.

The early skybridge-sky city portrayals came about as a direct response to very real urban issues which were pressing at the time. Primary of these urban issues was the impact that both tall buildings and increased vehicular traffic were having on the ground floor urban condition; tall buildings were increasingly growing in height and over-crowding the street, and the conflict between pedestrian and vehicular traffic was increasing. The reoccurring themes in all the early futuristic visions evolved as a response to these problems; both the stepped-back, tiered skyscraper and the multilevel circulation system. The stepped-back skyscraper was seen as a way to preserve light and air on congested, over-developed New York streets, and the multilevel circulation system a practical organizational tool to handle the vast number of new vehicles and people flooding into the city.

A response to the problems posed by both greater urban density and increased vehicular traffic thus became a key driver behind the early proposition of the skybridge. Transport, in all its myriad forms, became a key element in the early visions. As an insight into the relationship between people, transport and skybridges in these early visions, the two King's Views of New York frontispieces of 1908 and 1911 are worthy of further comment. These images mark the defining moment of the skybridge-sky city idea, consumed into the public conscience and reproduced many times since their origin. Though separated by only three years, the worlds portrayed are markedly different. In 1908 Pettit, despite a sky populated by huge airships, portrays an urban world dominated by people; pedestrians throng the elevated sidewalks at the ground plane and the skybridges link between buildings and the balconies / rooftop terraces of the buildings themselves (see Fig. 6). Though vehicles are present, they are predominantly tram and train in nature (also seemingly carrying throngs of people on the roof of the latter), with only a few automobiles present.

Three years later, Richard Rummell (taking Pettit's image-field as his starting point), portrays a world dominated by transport, almost devoid of pedestrians. Whereas the skybridges of Pettit's image carry pedestrians on two levels (within the bridge and on the roof), Rummell's skybridges seem primarily to support vast rail networks, with stations slung out along the skybridge routes. It is a similar story at the ground plane, where the elevated pedestrian thoroughfares of Pettit have been dominated by an elevated rail system, sandwiching trams and automobiles below at the ground plane. Even the pedestrian balconies and rooftop terraces have been swept away and the sky has become dominated by bi-planes. This three-fold action; reduction of pedestrians, dominance of trains and replace-

Figure 6. Differing cover illustrations for Moses King's seminal publications on New York; (a) 1908: King's Dream of New York (cover illustration *"The Cosmopolis of the Future"* by Harry M. Pettit), (c) 1911: King's Views of New York (cover illustration *"Future New York is pre-eminently the City of Skyscrapers"* by Richard W. Rummell).

ment of airships with bi-planes, has introduced an element of speed to Rummell's urban depiction that is not present in Pettit's. Though the level of activity is perhaps higher in Pettit's panorama, Rummell hints at a world where transport and mechanization has taken over. In this quest to portray the dominance of transport systems, Rummell has introduced many more strata of skybridges than Pettit portrayed. We can identify perhaps three or four higher levels in Pettit's image; a clear common circulation route linking several buildings at the $16^{th}/17^{th}$ floor level, a similar network at the $25^{th}/ 26^{th}$ floor level, and perhaps a further two levels implied in the distance, as the building heights increase. This is reflective of the increasing impact transport and vehicles were having on both the contemporary city and the conscience of its inhabitants.

Instrumental in the practical studies, and detailed proposals of, multilevel transport routes in the early 20th century American city was the architect Harvey Wiley Corbett. Corbett was both an urban visionary and staunch defender of the skyscraper city (Willis, 1986, p.159). Much of his career was dedicated to finding solutions to the urban problems of traffic and pedestrian circulation, and the multilevel city became a consistent theme in his work. Greatly influenced by the earlier renderings of Charles R. Lamb, Corbett elaborated on Lamb's idea in 1913 with his "City of the Future", published in the seminal journal Scientific American [see Fig. 7]. Now, however, instead of concentrating on the upper levels of the city, Corbett focused on the classification of traffic flow at street level and below. Two pedestrian walkways were superimposed above three levels for automobile traffic, a subway and a goods railway.

3.2. The Skybridge, Urban Planning and Transportation Nexus

Between 1921-29, the *Regional Plan of New York and its Environs* (Johnson, 1995) invited a number of external experts to create specific proposals for future developments in Manhattan. Corbett served on the architect's advisory committee for this panel, and presented an ambitious plan for the separation of vehicular and pedestrian traffic, based largely on reformulations of his earlier differential traffic level studies. These new plans were revised and illustrated in collaboration with the delineator Hugh Ferriss [see Fig. 7]. The plan included a sidewalk raised a story above street traffic, bridging the streets and connecting all buildings in a continuous pedestrian promenade. Differing options were portrayed for these promenades, some with the pedestrian walkways cantilevered out over the street, others with them recessed into "arcades" under the buildings above.

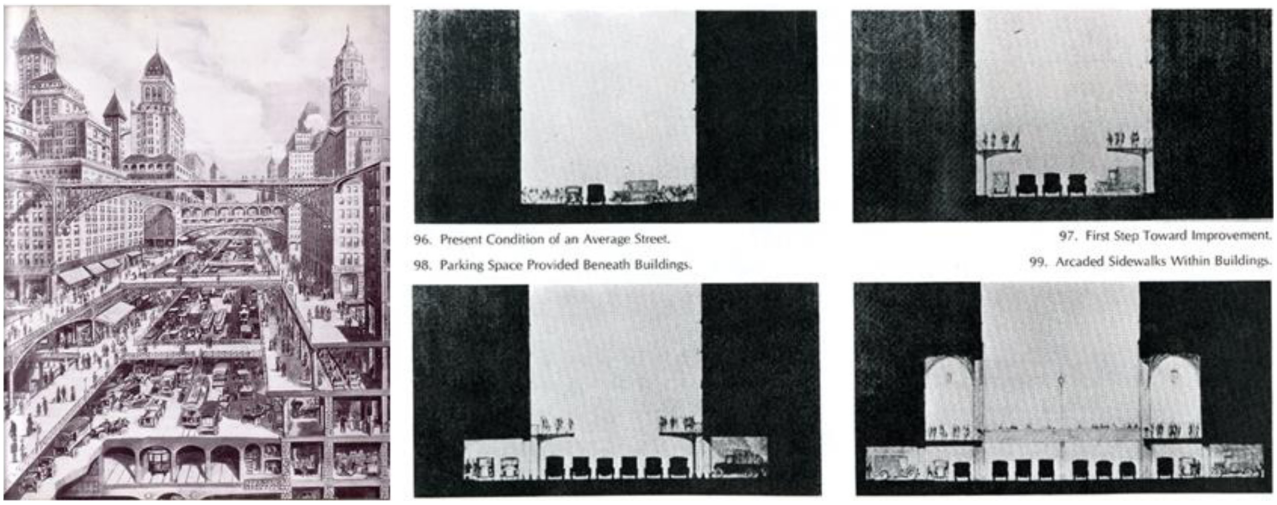

Figure 7. The influence of Harvey Wiley Corbett on the multi-level city; (a) 1913. City of the Future. Harvey Wiley-Corbett (published in Scientific American, 26 July 1913, with the article "The Elevated Sidewalk: How it will solve City Transportation Problems" by Henry Harrison Suplee), (c) 1923. Traffic Zoning Studies. Harvey Wiley-Corbett with Hugh Ferriss, for the 1929 Regional Plan of New York and its Environs (source: Tafuri, 1987, plate 186).

The relationship between vehicular traffic and the potential of multilevel circulation in New York is something that has endured for many decades beyond the early proposals of the 1920s. Even as late as 1969, the Regional Plan Association of New York – as a sequel to its 1929 Regional Plan 40 years previously (Johnson, 1995) – included a series of skybridge linked towers as part of its *"Urban Design Manhattan"* manifesto for the Second Regional Plan for the New York Metropolitan Region (Okamoto & Williams, 1969). This "access tree" arrangement for a cluster of office towers (with residential above) the size of three Rockefeller Centers, accommodating 120,000 office workers [see Fig. 8], attempted to solve the growing problems of inefficient circulation, a poor underground travel environment for most mass-transit commuters, the creation of an urban 'slab city" above ground and the very real problems of pedestrian-car conflict. 'skywalks" were proposed between buildings at every 10th floor, to provide flexibility in expanding horizontally as well as vertically.

Hugh Ferriss' contribution to the development of both the skyscraper and the American city is immense, not only through his various collaborations with Harvey Wiley Corbett, but through his rich, Piranesi-esque charcoal illustrations of skyscrapers and the publication of them in his seminal book *"The Metropolis of Tomorrow"* published in

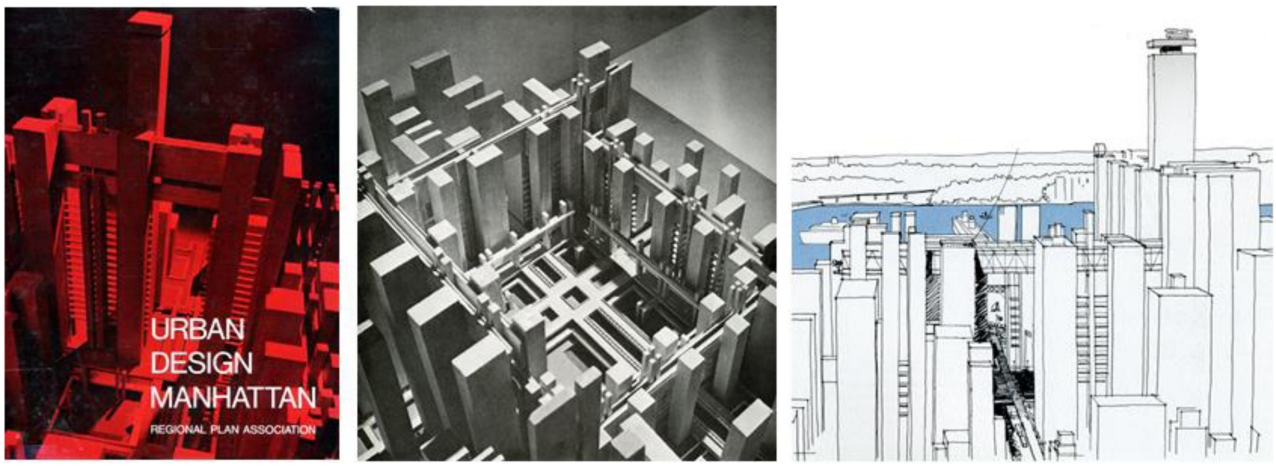

Figure 8. The relationship between traffic and the potential for skybridges is something that has endured beyond pre-war studies in New York; The Second Regional Plan of New York: Urban Design Manhattan, 1969 (a) report cover, (b) proposal for a new office cluster, midtown, (c) corresponding office cluster sketch (source: all, Okamoto, 1969, p.1, 97 & 103 respectively).

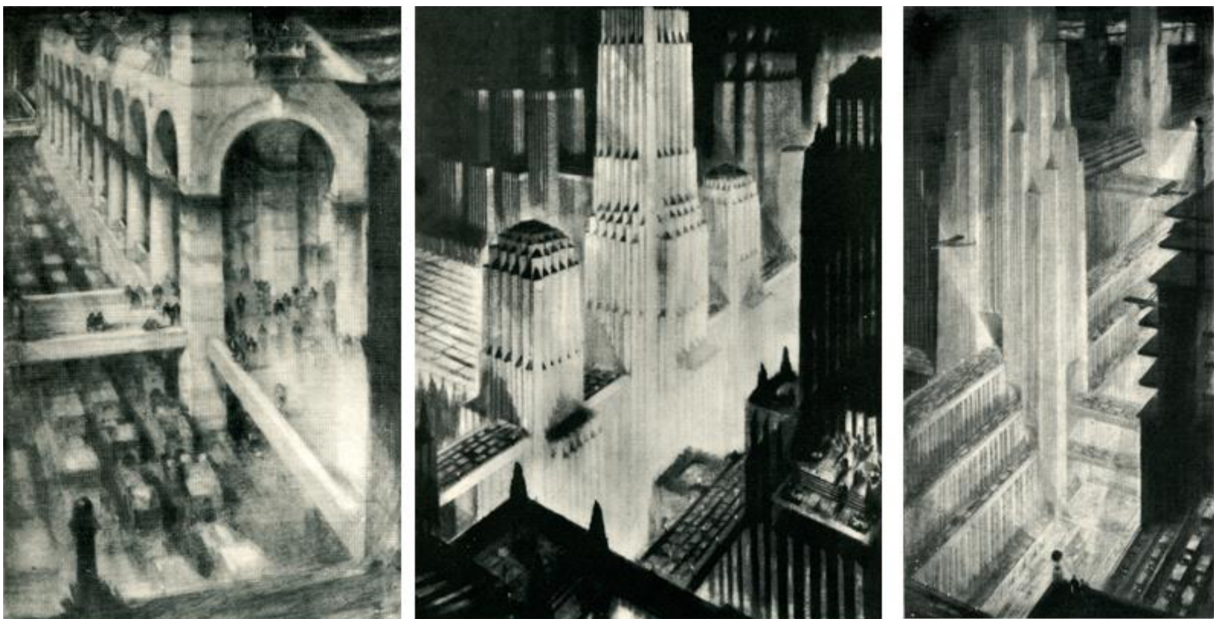

Figure 9. Illustrations from 'The Metropolis of Tomorrow', by Hugh Ferriss, 1929; (a) 1925, Pedestrians over Wheel-traffic, p.67, (b) 1926, Crowding Towers, p.63, (c) 1926, Overhead Traffic-ways, p.65 (source: Ferriss, 1929).

1929 (Ferriss, 1929).

It is in the second part of the book – "Projected Trends" – that Ferriss gives most prominence to the possibilities of the skybridge, showing several images of buildings connected at height [see Fig. 9]. These images draw on the worsening traffic situation and consequential traffic-zoning studies conducted earlier with Wiley Corbett, but elevate them to another dimension, with façade-hugging automobiles crowding the horizontal surfaces offered by each building setback.

Ferriss' publication of *"The Metropolis of Tomorrow"* in 1929 coincided with the Wall Street Crash and the 1930s economic depression that followed, which shook the commercial foundation of the American skyscraper city. Although Ferriss and others continued to produce a number of one-off visions of future cities incorporating skybridges during the 1930s, the intensity of proposals in the first three decades of the 20th century was never re-captured in America. It was left to Europe, and other parts of the world, to take up the challenge of the Sky City.

3.3. Pre-War Europe and the Skybridge

There had been some modest work on the multilevel city proposed in Europe as a response to the growing traffic problem prior to the reprinting of Corbett's seminal image (in France in particular: Eugene Henard's 1910 *"City of the Future"* and Louis Bonner's 1913 *"Multilevel boulevard in Paris"*) but nothing on the scale of the American visions. That, however, was about to change. Corbett's image was also reprinted in *L'Illustrazione Italiana*, Italy, and *Vokrug Sveta*, Russia, in 1913, where it was to have an influence beyond France - on the Italian Futurists and the Russian Constructivists.

The Futurists, and Antonio Sant Elia in particular, were fundamental in moving the possibilities of the vertical modernist city forward in Europe. They were especially interested in the power, force and motion of machinery, combined with a fascination for speed, and the images emanating from America very much appealed to them.

Of all the early Futurist work, it is perhaps Sant Elia's *La Citta Nuova* (The New City) scheme of 1912-14 that best shows the incorporation of skybridges [see Fig. 10]. This highly industrialized and mechanized city of the future is created as a vast, multilevel system of skyscrapers, factories, power stations and transport systems, interconnected by terraces, walkways and skybridges. Like the contemporary work in America, the towers themselves follow a stepped profile (though more incremental) and there are several levels for circulation to separate vehicular and pedestrian traffic.

Sant Elia (who was killed during the First World War in 1916) had an immense impact on other young avant-garde architects of the Futurist movement, for example, Mario Chiattone who proposed several "Elia-esque" urban schemes, amongst which *Costruzioni Per Una Metropoli Moderna* (Buildings for a Modern Metropolis) is perhaps the most powerful. Here, rows of streamlined skyscrapers are linked by steel suspension bridges above vehicular traffic.

Several of the Russian Constructivists incorporated variants of skybridges in their designs. El Lissitzky designed the cover to Richard Neutra's 1930 book *Amerika* showing notional high-level bridges, but it was his earlier collaboration with the Dutch rationalist Mart Stam on the proposal

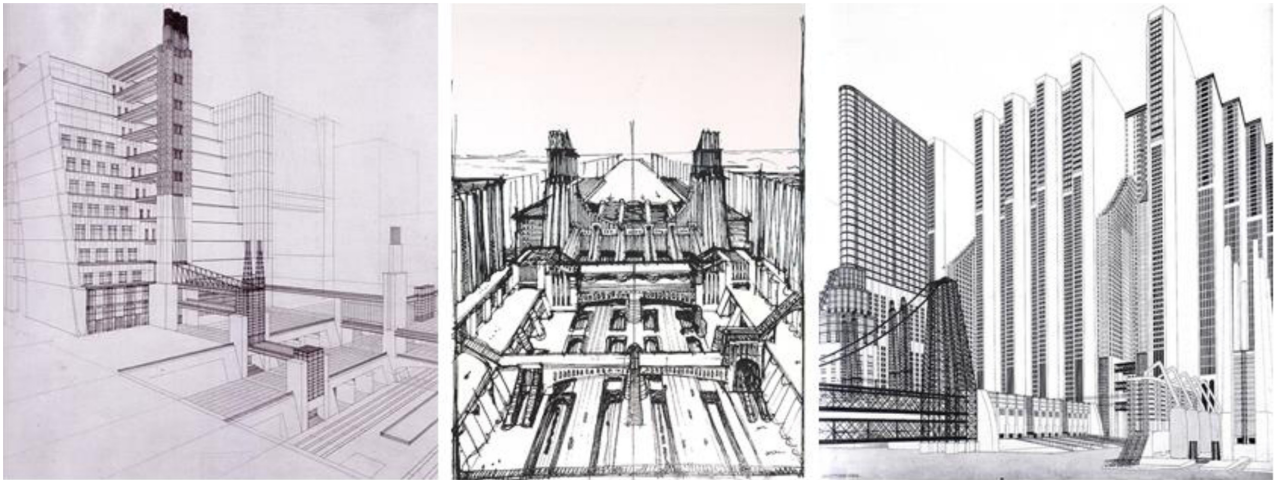

Figure 10. The work of the Futurists in promoting the multi-level Skycity (a) 1914. La Città Nuova. Sant Elia. (source: Cohen, 1995, p.35). (b) 1912-14. Stazione d'Aeroplani, Milan. Sant Elia. (source: Cohen, 1995, p.34). (c). 1914. Costruzioni per una Metropoli Moderna. Mario Chiattone (source: Cohen, 1995, p.37).

for the Russian state archive for literature building in Moscow, the *Wolkenbugel* (Cloud Strip) which most radically suggested alternatives to vertical skyscraper form [see Fig. 11].

The *Wolkenbugel* design included two towers connected at the top through a horizontal bridge, straddling the intersection of a Moscow boulevard. The bridging nature of the building thus grew out of a practical consideration of site. This project became one of the first indications towards creating the three-dimensional city in Russia; a forerunner of later international "floorplate-skybridge" buildings such as the Umeda Sky Building. Similarly, Ivan Illich Leonidov's 1929-30 project for the *House of Industry* shows a tower block with detached lift core connected at strategic levels through skybridges, almost 40 years before Erno Goldfinger realized a similar vision with his Trellick Tower in London.

Constructivism turned out to be a short-lived, but influential, movement in Russian history. Lenin passed away, and was replaced by the party secretary Josef Stalin, who put an end to the movement with his Five-Year Plan based on cutting down Western influences and concentrating on developments within the country. Theoretical ideas were considered taboo.

Figure 11. Several of the Russian Constructivists incorporated variants of skybridges in their design; (a) 1924. Der Wolkenbugel (Cloud Strip), Moscow. El Lissitzky (with Martin Stam). (Source: Tupitsyn, 1999, p.129). (b) 1930. Cover design for Richard Neutra's book Amerika. El Lissitzky (source: Cohen, 1995, p.96), (c) 1929-30. Competition project for the House of Industry. Ivan Illich Leonidov (source: Cohen, 1995, p.127).

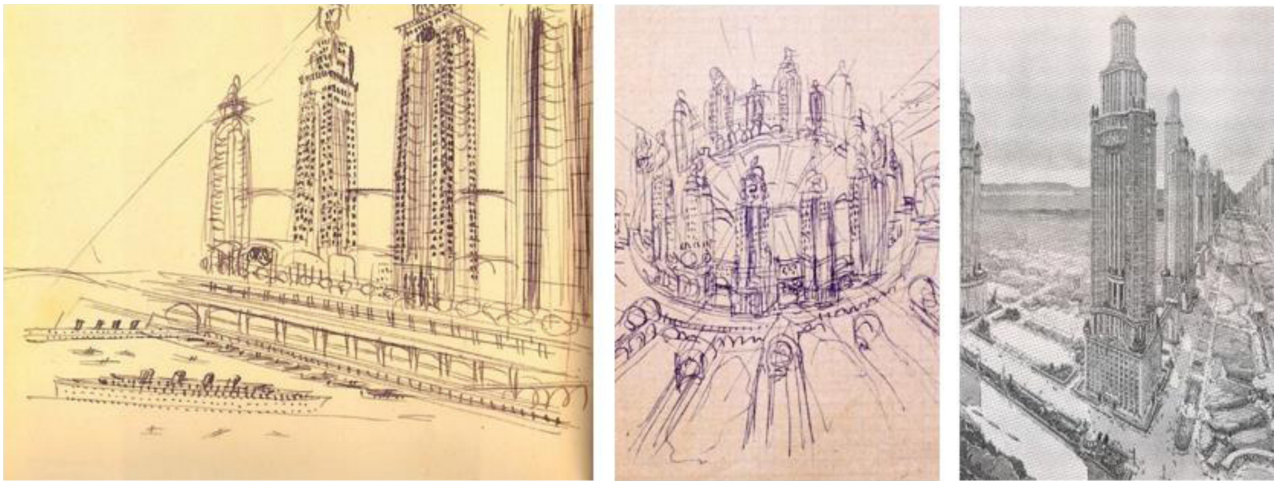

Figure 12. Auguste Perret was perhaps the most explicit of the early Europeans in the proposition of the skybridge; (a), (b) 1922-32. Ville Tours (Tower Cities) projects. (with Charles Imbert, draughtsman). Sources: (a) Cohen, 1995, p.116. (b) Britton, 2001, p.205). (c) 1922. Avenue of Residential Towers. (with Jacques Lambert, illustrator. Source: Cohen, 1995, p.118).

Of all the architects / urbanists working in Europe in the first half of the 20th century, it was perhaps Auguste Perret who most explicitly proposed the skybridge as a distinct architectural element. Perret's visionary research had circulated in the Parisian press for the first two decades of the twentieth century (making him contemporary with the work of Lamb and Corbett in the US, and predating Sant Elia, see (Bacon, 2001, p.10), but it wasn't until 1922 that his work actually began to be seriously published. The first of these theoretical projects was the *Ville Tours* (Tower City) scheme of 1922-32 [see Fig. 12].

From this one can deduce that Perret's primary motivation in proposing skybridges was to make circulation more efficient between two towers. He planned his city with towers sitting on top of columns, leaving the ground level clear for heavy vehicular flow (a theme consistent with the contemporary work in America). With the predominant pedestrian urban realm elevated 10 to 20 meters above the vehicular level, the towers were also further connected by skybridges approximately 60 meters above ground level. More so than even the earlier work emanating from America, one can see clearly the idea behind the skybridge in the *Ville Tours* scheme. Further, there is a very clear link to later realised skyscraper-skybridge projects, not least the Petronas Towers.

Perret's *L'Avenue des Maisons-Tours (Avenue of Residential Towers)* in 1923 was directly influenced by the *Ville Tours* proposals and shows an avenue of approximately 40-story residential towers, linked together by skybridges at a common level – sat on top of reinforced concrete plinths rising 10 stories from ground level. Perret later pushed these ideas even further, proposing a ring of linked skyscrapers around Paris, as well as a 20-kilometer- long, 250-meter-wide "*Voie triomphe*" boulevard near the forest of Saint-Germain, lined by one-hundred 60-story towers (Britton, 2001).

Auguste Perret's sky-city vision was very influential on Le Corbusier. And, although Le Corbusier did not take his first trip to America until 1935, no European architect wrote more passionately or polemically during the 1920s

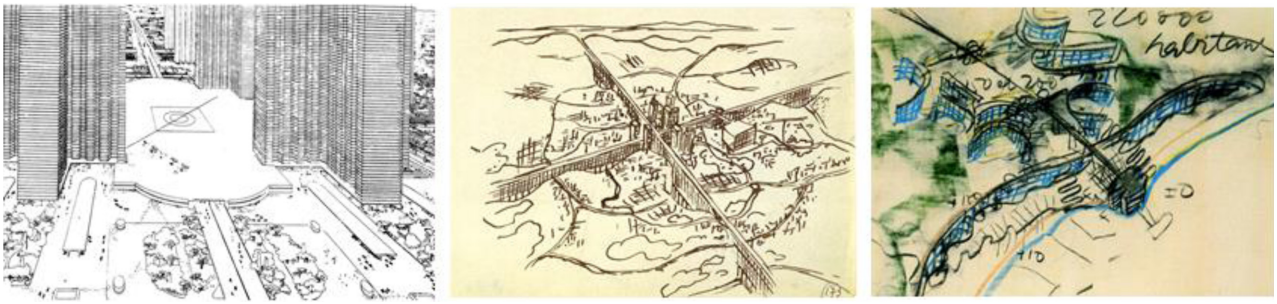

Figure 13. Le Corbusier's multi-level Urban Visions: (a) 1922. Central Station, Ville Comtemporaine - Contemporary City of Three Million Inhabitants. (Source: Bacon, 2001, p.9), (b) 1929. Scheme for Sao Paola. (source: McQuaid, p.69), (c) 1935. Scheme for Algiers. (source: McQuaid, p.87).

and 1930s than Le Corbusier about the American landscape, its skyscrapers and city plans, as well as its icons of machine age modernity (Bacon, 2001, p.3). Le Corbusier was thus well aware of the fantastical future city proposals on both sides of the Atlantic which, in turn, influenced his own urban propositions.

The first of Le Corbusier's grand urban-scale visions was his *Contemporary City of Three Million Inhabitants* exhibited at the *Salon d"Automne* in 1922 [see Fig. 13] (Abalos & Herreros, 2003). In this, Le Corbusier rejected Perret's pedestrian bridges spanning from tower to tower at height as being "*Futurisme bien dangereux"* (possibly very dangerous) and instead portrayed a city of dispersed, 60-story cruciform-shaped towers within a green urban plane. To achieve this green urban space, Le Corbusier elevated the urban roads above the green spaces which were joined at their ends by a peripheral highway system that bypassed the city altogether. In the center of the plan, he concentrated a multilevel transportation hub consisting of depots for buses and trains, highway intersections and – in an echo of Sant Elia's 1914 *Stazione d'Aeroplani* scheme – an elevated urban airport.

Le Corbusier's later urban schemes – and most notably his proposals for cities in South America (Montevideo, Buenos Aires, Rio de Janeiro and Sao Paolo, following a visit there in 1929) and North Africa (Algiers) show a marked development of this vertical segregation of pedestrian and vehicular traffic. Here, super-elevated highways are formed on the roofs of the tower blocks.

This is perhaps the most marked difference between Le Corbusier's vision of the skybridge city and the work of most others in the field – his placement of the automobile over the pedestrian at height. Most of the urban visionaries working with the idea of skybridges to date had used them predominantly for pedestrian circulation, with vehicular traffic confined to the ground plane (Ferriss' *Crowding Towers* and *Overhead Traffic Ways* proposals being rare exceptions, but, in Le Corbusier's schemes, the bridges high in the sky accommodated vehicular traffic, with the ground plane reclaimed by pedestrians. Although this has obvious benefits for the higher environmental quality of the ground plane for the urban pedestrian (green, free from traffic), it was hardly practical – connection of the elevated highway into the suburban ground road system, the logistics of physical incorporation and access from vehicle to building being but three of the considerable problems created.

3.4. Built Realizations Post-WWII

The first significant example of a skybridge at high-level in the post-war period is the 1960 National Congress Secretariat, Brasilia by Oscar Niemeyer [see Fig. 14]. Part of Niemeyer's grand vision for the Modernist capital of Brasilia, the 28-story twin Secretariat towers sit at the end of a monumental axis atop the podium building which house the Senate and the Chamber of the Deputies (Underwood, 1994). The two towers – with their three-story skybridge form spanning the eleventh-thirteenth stories – forms a framed termination to the grand axial urban view.

Though 30 years later than the Wrigley skybridge, the functional purpose of the skybridge was essentially the same; to create a more efficient circulation route for office workers from one tower to the other, without having to travel to the base of the tower, exit one tower and re-enter the adjoining tower (for more detailed information on the interface between this particular skybridge and tower cir-

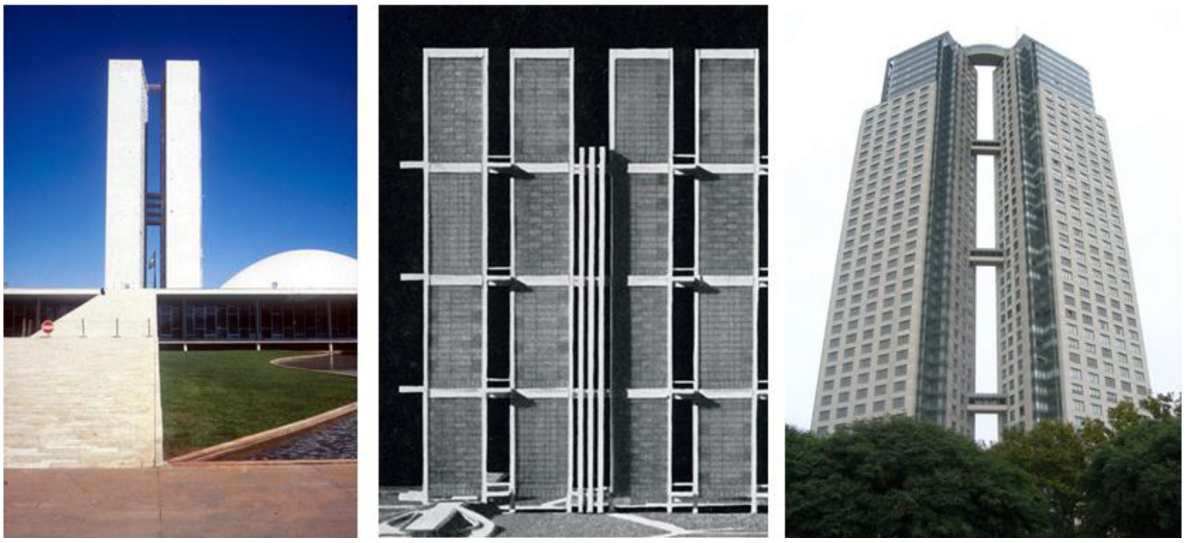

Figure 14. Skybridges in South America: (a) 1960. The first significant high-level skybridge project of the post-war period; *National Congress Secretariat*, Brasilia. Oscar Niemeyer (source: courtesy of Jonathan Hale, University of Nottingham), (b) 1957. *Superblock proposal*, Brasilia. Rino Levi (source: Conrads, 1962, p.110), (c) 2005. El Faro Towers, Buenos Aires (source: Marshall Gerometta, CTBUH).

Figure 15. Japanese Skybridges: continuing the theoretical work of the Metabolists into built form: (a) 1971. Kajima Corporation Headquarters, Tokyo. Kajima Design (source: Ross, 1978), (b) 1993. Umeda Sky Building, Osaka. Hiroshi Hara (source: Japan Architect, Autumn 1993, p.38), (c) 1994. St. Luke's Garden. Nikken Sekkei. (source: Binder, 2001).

culation system, see *Chapter 4.0: Skybridges - Implications*).

These projects, and Niemeyer in particular, have continued to exert a skybridge-influence in other parts of South America up to the current day. The 2005 El Faro residential towers in Buenos Aires – the tallest towers in Argentina when completed at 160 meters and 47 floors – take advantage of four separate levels of skybridges, including an extended communal relaxation / reading room at the uppermost level [see Fig. 14].

Given the strength of theoretical "city of the future" work incorporating skybridges and elevated networks through the Japanese Metabolist movement in the 1960s, it is not surprising that perhaps the most significant examples of built skybridges today occur in East Asia. In Japan alone, there are numerous seminal examples, the earliest being the three sets of single-story skybridges linking the two towers of the 1968-71 Kajima Corporation Headquarters Building in Tokyo, at the eighth, 12th and 16th of 21 floors [see Fig. 15].

Perhaps the most significant example of skybridge use in Japan is Hiroshi Hara's 1993 Umeda Sky Building in Osaka, which was originally envisaged as a single element in his interconnected *Sky City* vision. Here the two 40-story office towers are connected by skybridges in three forms; at level 22 a 6-meter-wide steel-framed bridge links horizontally between the two towers, between levels 34 and 38, "flying" escalators form a diagonal bridge and, at levels 38 to 40, the floor plate itself forms the physical link.

Skybridges are also a recurring element in the work of Nikken Sekkei architects of Japan (Bognar, 2000). The most high-profile use of an external skybridge in their work to date is in the 1994 St. Luke's Garden complex [see Fig. 15]. Here the twin towers comprise a multi-purpose complex complementing St. Luke's International Hospital; the taller tower contains rental offices and a sky restaurant on the 47th floor, whilst the shorter tower provides 175 residential units for hospital patients and a hotel with its own atrium for hospital visitors in the highest seven levels. The skybridge connects the office tower to this hotel atrium at the 32nd floor, thus making the hotel amenities available to office workers without having to exit the building at the ground floor and re-enter the second tower.

If the upper-level floorplate bridge of the Umeda Sky Building can be accepted as a form of skybridge, then there is a rich vein of "buildings-as-skybridge" in existence which can be interpreted similarly. Perhaps the first – and grandest – of these is the 1989 Arc De La Defense in Paris by Otto Von Spreckelson [see Fig. 15] and a clear line of development can be seen up to Rem Koolhaas" / OMA's CCTV Building in Beijing [see Fig. 3].

There are other variants of the skybridge-as-floorplate concepts, such as the "skybridge as skygarden" concept where, unlike the arch-shaped buildings portrayed previously, the skybridges are often as wide as the floorplate, but occur lower down the building, often at multiple levels and are usually open in nature (non-enclosed). Again, the best examples of these exist in Asia, including Kris Yao's 1995 Sky City Tower, Taipei and Kenzo Tange's 1996 Fuji TV Building, Tokyo. In the case of Yao's Sky City Tower, the 34-story, mixed-use development includes a pair of residential towers accommodating family units which are connected at the 5th, 14th and 24th levels with "skygardens" [see Fig. 17]. Similarly, Tange's Fuji TV Building creates a series of skygardens, but now for an office environment.

More standard tower-and-skybridge arrangements can be found throughout southeast Asia. The most famous of

Figure 16. Buildings-as-skybridge: a) 1989. *Arc de la Defense*, Paris. Otto von Spreckelson (source: Wood) (b) 1996. *Arcos Bosques Corporativo, Torre 1*, Mexico City. Gonzalez, Serrano & Tejada (source: Riley & Nordensen, 2003, p.63).

Figure 17. Variants on the skybridge-as-floorplate: (a) Skybridge as Skygarden: 1995. Skycity, Taipei. Kris Yao Architect. (source: Otmar, 2001, p.89), (b) 1996. Fuji TV Building, Tokyo. Kenzo Tange (source: Sacchi, 2004, p.201).

these is of course Cesar Pelli's 1997 Petronas Towers, Kuala Lumpur [see Fig. 18], but there are also significant examples increasingly being realized in other areas. This is especially true of China, which is witnessing unprecedented urban growth as it copes with massive rural-to-urban migration of its population. The embrace of the tall building as an element in new Chinese cities has been enthusiastic, from Guangzhou in the south to Beijing in the north, and the skybridge – often as an iconic rather than functional device – is increasingly being realized.

C.Y. Lee's 1997 Yuda World Trade Centre in Zhengzhou is a good example of a tower and skybridge arrangement in China. Here the 30-story office towers are actually linked by two skybridges; at the 15th level sitting above the glass atrium, and at the 30th level as a free-standing bridge element. Obermeyer's 2002 CLD Forum Building in Beijing is also a good example (Zaknic et al., 1998). Here the two-story skybridge at the 18th/19th story links the two office towers which exist above a low-level primary school.

Figure 18. Tower-and-skybridge arrangements in Asia; (a) 1998. *Petronas Towers*, Kuala Lumpur. Cesar Pelli & Associates (source: author), (b) 1997. *Yuda World Trade Centre*, Zhengzhou, China. C.Y. Lee & Partners (source: Binder, 2001, p.205), (c) 2002. *CLD Forum Building*, Beijing. Obermeyer (source: courtesy of Obermeyer Planen & Beraten GmbH).

Figure 19. Post-war built skybridges in the USA: (a) 1967. Peachtree Center, Atlanta. Edwards & Portman. (source: courtesy of Jake Pauls), (b) 1983. UN Plaza Building, New York. Dinkeloo & Roche (source: Wood), (c) 2004. Skybridge, Chicago. Perkins & Will (source: Wood).

Perhaps not surprisingly given the origins of the theoretical skybridge in late 19th century America and Europe, there are several post-war precedents in America. Post-war skybridges of significance in the US include the 1969 Peachtree Center, Atlanta by Edwards & Portman [see Fig. 19] and the 1983 UN Plaza Building, New York by Dinkeloo & Roche. The Peachtree Center high-level skybridge links two 27-story office towers and is one element in a lower-level urban network of skybridges that spans throughout the Peachtree complex. Dinkeloo & Roche's UN Plaza skybridges connect, at the second and tenth levels, the lower office floors within these 39-story towers, which also contain a hotel in the upper portion. The higher-level bridge (at the tenth floor) is effectively positioned at the mid-height of the office function, to expediate circulation of employers between the two linked areas.

4. The Contemporary State of the Art – Skybridges since 2000

Since 2000, there have been some significant advances in the typology, with a notable prevalence towards multi-story skybridges that span nearly every floor between two buildings or are contained within the building envelope;

Figure 20. Multiple-floor / 'within-envelope' skybridges; (a) 2003. *BOCOM Financial Tower*, Shanghai. ABB Arkitekten (source: Wood), (b) 2003. *Kyobo Tower*, Seoul. Mario Botta (source: Cappellato, 2003, p.191).

for example, ABB Arkitekten's 2003 BOCOM Financial Tower, Shanghai and Mario Botta's 2003 Kyobo Tower, Seoul [see Fig. 20]. The Kyobo Tower is an interesting case study since, as well as the lower-level enclosed corridor-skybridges, it contains a separate, larger skybridge at an upper level. This skybridge provides functional space rather than circulation however, creating an elevated lounge which can be accessed from both towers at either end.

Massimiliano Fuksas' 2001 Vienna Twin Towers project [see Fig. 21] has five sets of multiple skybridges connecting the two towers on approximately 60% of its levels. Even this "40% void" between skybridges creates a very differing aesthetic effect than the "every floor" skybridges of Botta's Kyobo.

Murphy/Jahn's 2003 Highlight Towers [see Fig. 1] set a strong precedent. The two Highlight towers' skybridges, which exist in two-story form at the 10th and 11th floors, and in one-story form at the 20th floor, are interesting, as Murphy/Jahn envisaged them as "clip-on" elements that can be added or taken away. This introduces a potential for both mobility and flexibility with the skybridge that has not been suggested prior. Michel & Partners 1994 Belgacom office towers in Brussels [see Fig. 22] are linked by a skybridge at the 26th of 28 floors, once again to expedite circulation of employees from one tower to another.

The final region of the world to examine the built examples of skybridges is the Middle East, and Dubai in particular. Perhaps not surprising given the incredible rate of tall building construction there in the headlong quest to create an instant "developed" city – the superlatives of construction in Dubai are numerous; world's tallest building, world's largest mall, world's longest indoor ski run, etc. These superlatives are extended to the 2003 Marriott Apartments, Dubai [see Fig. 23], with a 73-meter-long skybridge, which, like many others around the world, actually serves a very practical purpose; to link the communal facilities at the 19th of the 20 stories of these executive apartments for the benefit of occupants of both towers.

5. Implications for the Future of the Urban Form

As many architects and visionaries have shown over a period spanning more than a century (from the early 20th Century "King's Views of New York" to virtually all "urban vision" science-fiction cinematography, see Wood, 2003), the re-creation of the urban realm in the sky through connections between buildings at height has a vast potential for the enrichment of our cities. To many it seems nonsensical that, though the twenty-first century has clearly seen

Figure 21. The skybridge networks of the Wienerberg City, Vienna 2001. *Twin Tower*. Massimiliano Fuksas (source: Wood).

Figure 22. Belgacom (now Proximus) Towers, Brussels, 1994. Michel Jaspers & Partners (source: courtesy of Marshall Gerometta, CTBUH).

a push towards greater height and urban density in our major urban centers, the ground-pavement level remains almost exclusively the sole physical plane of connection.

Additionally, one of the major failings of tall buildings in architectural terms is that most are designed as stand-alone icons superimposed on – rather than integrated into

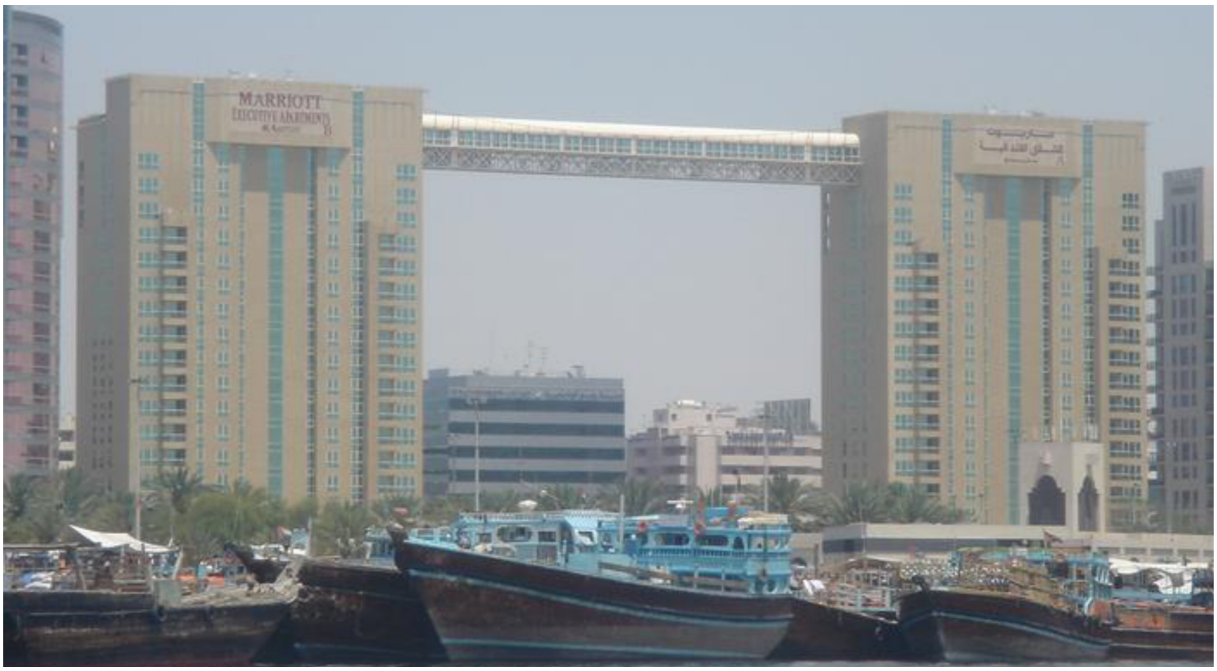

Figure 23. Marriott Executive Apartments, Dubai (source: Wood).

– the urban fabric. Despite the often significant vertical height of these buildings, very few of them connect to the city (or each other) at any level other than the ground plane, and often the very objective of the project brief is to "stand out," rather than to "fit in."

If cities concentrate perhaps ten or a hundred times more people at a given location through building tall, there is also a need to replicate the facilities that exist at the ground plane up in the sky, including the parks and the sidewalks, the schools and the hospitals, and other public/civic functions. The ground plane should be considered as a duplicable layer of the city which needs to be replicated – at least in part – at strategic horizons within and between buildings in the sky; not as a replacement of the ground plane but as an addition to it. Every tall building would then need to be considered as a vital element in an overall, three-dimensional urban framework, rather than as a stand-alone icon superimposed on a two-dimensional urban plan.

Though this idea might seem a fantastical proposition, skybridges are increasingly being realized – albeit in a piecemeal way – in cities around the world. Fig. 24 illustrates some of the more significant examples in recent years. There is perhaps also a reason that, of the seven final entries for the World Trade Center Tower competition, five of them proposed some form of direct linkages between towers (see Wood & Oldfield, 2005).

6. Conclusion / Next Steps

The authors will be undertaking the aforementioned research project, which is planned to conclude in mid-2020, at which time, several publications will bring this discussion up-to-date, and provide a new generation of informed speculation on the future of the skybridge, in the context of the three-dimensional city vision. The planned approach is as follows:

Assessment of the current state of the art. Through examination of built, under-design and under-construction skybridges around the world, the research project will seek common characteristics and identify best practices in design, construction, and operation of skybridges in a tall-building setting.

Development of design guidelines / future potential. Based on the assessment of the challenges and existing solutions articulated in the previous section, the research aims to develop a preliminary set of guidelines for future developers of skybridges, taking into account technological changes such as horizontal elevators, and urban changes that embrace skybridges more fully as part of the cityscape.

- What are the main challenges / barriers to the incorporation of skybridges in tall buildings – physically, logistically and operationally – and how can these challenges be overcome?
- What are sensible design considerations / recommendations, as first steps towards the incorporation of

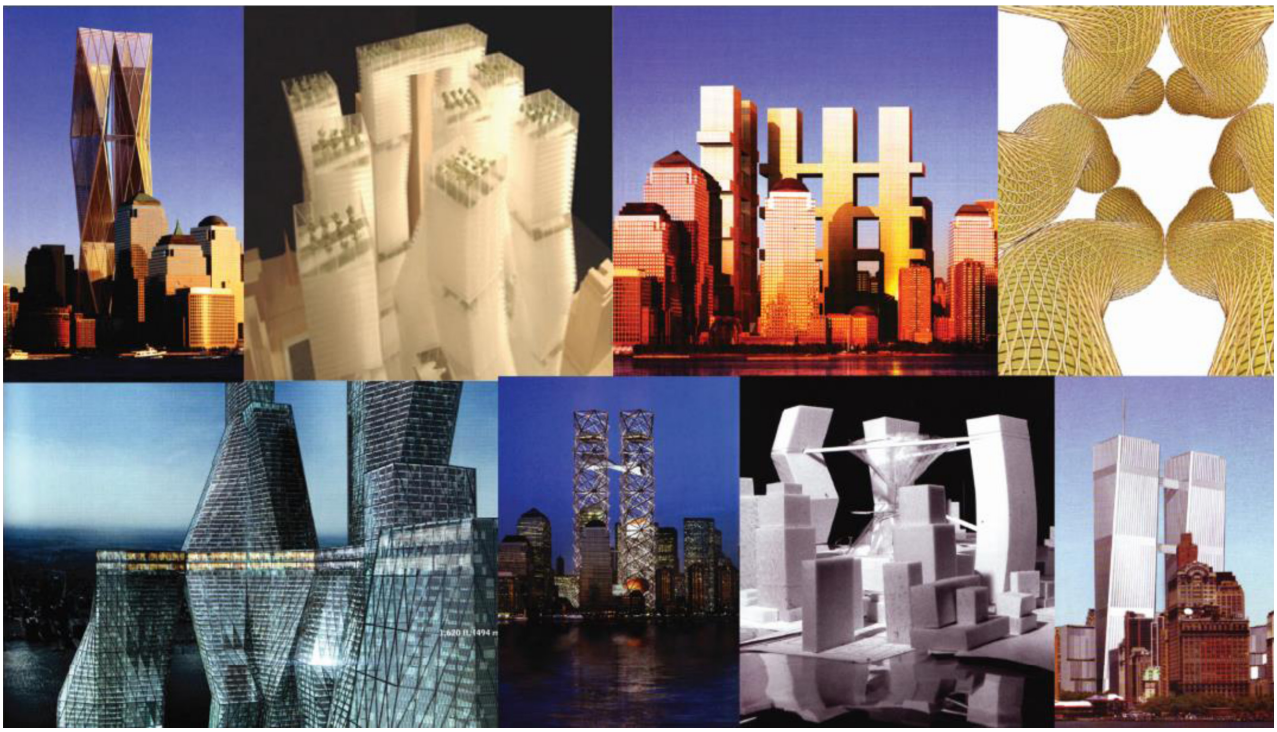

Figure 24. Many of the official and unofficial competition entries for the World Trade Center tower replacements proposed connections between towers at height, (A) Foster + Partners, (B) SOM, (C) Richard Meier et al., (D) Foreign Office Architects, (E) United Architects, (F) THINK Team (G) CoOp Himmelb(l)au (H) Richard Dattner (Source: Stephens, 2004).

skybridges in tall building design?
- What benefits could skybridges bring to our current and future urban centers?

Research Methodology

- **Literature Review.** Initial work will focus on studying: Existing peer-reviewed journal papers, news articles, historical archives, etc.; Existing performance data on vertical transportation, people flow, foot traffic, etc.; and photos.

- **Engagement with Design and Building Operations Teams.** The researchers will use the extensive CTBUH network to develop contacts and dialogue with the design and building operations teams of the chosen case study buildings. Interviews and feedback from these parties would be incorporated into the overall research.

- **On-Site Study.** Clearly, the best way to understand a space is to research it in person, and to analyze it using a systematic set of principles and criteria. Visit activities will include:
- Observance of usage patterns / dwell time in the space at different hours
- On-site user / property manager / maintenance engineer surveys or interviews
- Vertical-to-horizontal transportation traffic patterns
- Survey of security and fire-suppression/isolation systems and methodology

Through these activities, the authors believe that a clear vision of an integrated 3D city will emerge, incorporating skybridges in a way that has been foreseen a century and more ago, but has not been realized to date due to limitations of technology, political will, and economic and demographic pressures. With many megalopolises continuing to rise at or near a sea level that itself is bound to rise due to climate change, informed, advanced thinking about cities as three-dimensional propositions with options for connecting people and services at height, it seems the realization of these visions cannot come too soon.

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