Title:	**Financial Aspects That Drive Design Innovations for Tall Buildings**
Author:	Robert Lau, Roosevelt University
Subject:	Economics/Financial
Keyword:	Economics
Publication Date:	2005
Original Publication:	CTBUH 2005 7th World Congress, New York
Paper Type:	1. **Book chapter/Part chapter** 2. Journal paper 3. Conference proceeding 4. Unpublished conference paper 5. Magazine article 6. Unpublished

Robert M. Lau
Roosevelt University

Bob Lau is a practicing architect with his own firm in the Chicago area, which he has operated for more than 15 years. He received his bachelor's degree in architecture from the Illinois Institute of Technology and went on to earn his MBA, with a focus in real estate, from Roosevelt University.

Financial Aspects That Drive Design Innovations for Tall Buildings

This presentation is based on a paper by the presenter and Dr. Sofia V. Dermisi, assistant professor of real estate at Roosevelt University in Chicago.

This presentation will discuss economic issues that drove design solutions for various tall buildings, addressing how investors and end users receive "more for the same cost."

The most significant component of a high-rise development is a project's financial efficiency — profitability for the developer/investor team. This presentation will focus on the financial aspects of these four comparable towers in downtown Houston and Chicago:

- One Shell Plaza, a 50-story building completed in 1971 and winner of the Legacy Award in 1991
- 57-story Three First National Plaza, winner of the SEAOI Award in 1981; the saw-toothed design of the building creates 13 corner offices in the lower levels and 9 in the upper levels
- 321 North Clark at Riverfront Plaza, a 35-story building with a very efficient floor plate, allowing extraordinary flexibility for all sizes of office users
- 111 South Wacker, a 51-story building completed in 2005, with interior spans that maximize flexibility of interior planning with minimum column interruptions of outdoor views.

These historic examples are the coordinated attempts by developers, users, and designers to create value for what have become known as "skyscrapers." The conclusion is that economic factors have driven forward design innovations for the economic advantage of the users and investors.

Financial Aspects That Drive Design Innovations for Tall Buildings

by Dr. Sofia V. Dermisi, Assistant Professor of Real Estate at Roosevelt University, Chicago
and Robert M. Lau, Architect, Chicago, Member of the Council since 2001

This paper will present economic issues that drove design solutions for Tall Buildings. Starting from the 19th century planning of Central Business Districts (rectilinear), we will address how investors and end users received value as 'more for the same cost' that made these projects financial successes. If financiers see good investment values, they will direct the designers to incorporate them into the project.

The first high-rise buildings in the U.S. benefited from the inventions of the elevator and structural steel. The most significant component of initiating a high-rise development, however, is a project's financial efficiency - profitability for the developer/investor team. Some early examples are the Auditorium Building (multi-use), the Second Leiter Building (flexible interior planning), and 860/880 N. Lake Shore Drive (efficient views) in Chicago.

The second part of the paper will focus on the financial aspects of four modern high-rise buildings of comparable sizes, located in downtown Houston and Chicago. One Shell Plaza is a 50-story office building in Houston, completed in 1971. Three First National Plaza is a 57 story building in Chicago completed in 1981. The saw-toothed design of this building creates corner offices. 321 N. Clark in Chicago is a 35-story building with a very efficient floor plate of 40-45-foot spans from the window to the core. 111 S. Wacker in Chicago, completed in 2005, has 50-60 foot interior spans to maximize the flexibility of interior planning with minimum column interruptions of outdoor views.

These examples are the coordinated attempts by developers, end-users, and designers to create value for what have become known as 'Skyscrapers'. The conclusion is that economic factors have driven forward design innovations, for the economic advantage of the end users and investors.

Key words: End users, financiers, innovation, rectilinear grid

Dr. Sofia V. Dermisi Assistant Professor of Real Estate Walter E. Heller College of Business Administration Roosevelt University 430 South Michigan Avenue Chicago IL 60605 Phone: (312) 281-3355 Fax: (312) 281-3290 sdermisi@roosevelt.edu	Robert M. Lau Architect, ++++

URBAN PLANNING

As Chicago developed in the early 19th century, the central business district formed in a rectilinear grid system. Lake Michigan on the east, the central branch of the Chicago River on the north, and the south branch of the Chicago River on the west were the natural barriers that formed the central business district. Since most people arrived from the east coast and the Gulf of Mexico by train, the railroad terminals formed the southern boundary. This clearly defined area of the central business district became known as Chicago's Loop. Instead of growing horizontally in area, which would be possible with other central business districts, the Loop was forced to grow vertically.

Other American cities have also adopted the rectilinear street grid for their downtowns. Manhattan Island is an example of natural barriers defining a central business district with a rectilinear street grid dividing it into blocks. Downtown Houston does not have natural barriers but has also adopted rectilinear blocks.

EARLY CHICAGO EXAMPLES OF INNOVATION

Auditorium Building

The new innovation of the elevator was put to good use in Chicago's new buildings at the end of the 19th century, a time of American urbanization. The rectilinear street grid system that was adopted maximized the usability of the available land. Innovative ways of using this land developed. A fine early example is the Auditorium Building by Adler and Sullivan in 1887 (Steiner 1998), located at Michigan, Congress, and Wabash. Because of the multiple street exposures of this block, the building was designed as a multi-use structure to take advantage of each exposure. The eastern Michigan Ave. elevation featured a hotel to maximize the views of Grant Park and Lake Michigan. The central part of the block, along Congress, is the entrance to the Auditorium Theater (Fig. 1, building with tower). A tower marks the entrance, which was the highest point in Chicago upon its completion. The western elevation was the office component of the project to be contextual with the commercial character of Wabash Ave. Within one rectilinear building there were three distinct functions. This was a new concept for the 19th century that maximized the site, for the benefit of the end-users. The Auditorium was one of the last buildings to use masonry-bearing walls but the magnificent elevations by Louis Sullivan preclude the modern architecture to follow.

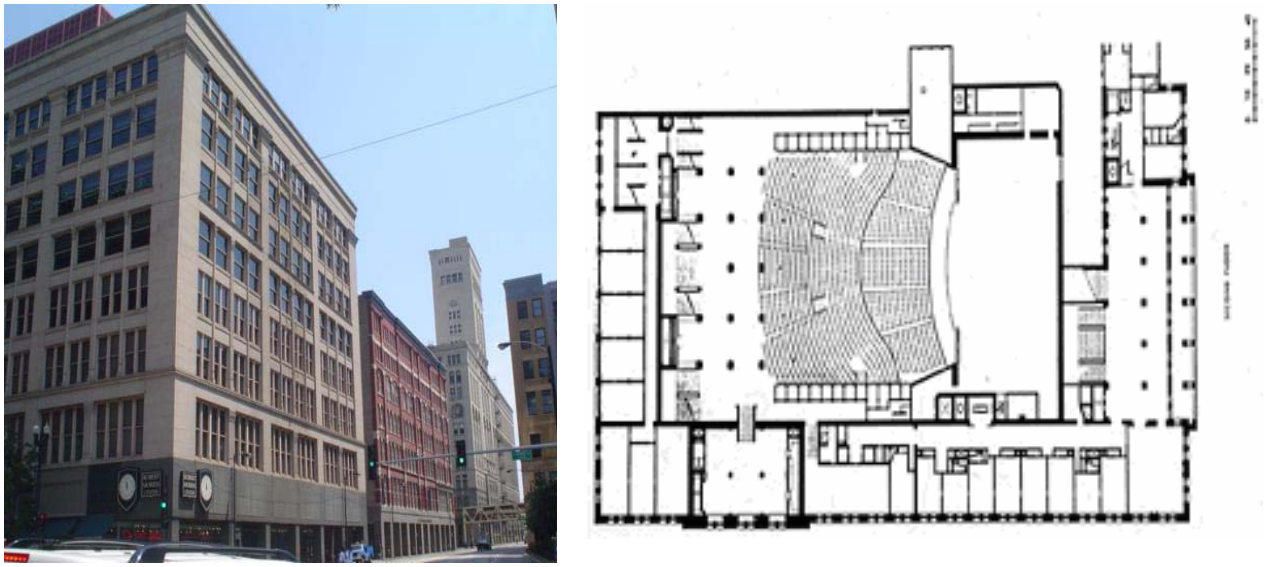

Fig. 1, Auditorium Building with tower, Second Leiter Building on left (Source: Lau R. & http://tigger.uic.edu/depts/ahaa/imagebase/intranet/slide_scans/961012/96.10.12.037.jpg)

Second Leiter Building

Another innovation is the use of the steel skeleton frame instead of masonry walls. A fine early example is down Congress Parkway from the Auditorium in the Second Leiter Building by William LeBaron Jenny in 1891 (Steiner 1998). The steel skeleton frame was chosen for this building to provide for flexible planning of the displays of merchandise and for allowing exterior natural light to enter the interior (Fig. 1, building on left). The interior flexibility was in the best interest of the retailer, at first Siegel, Cooper & Co. and eventually including Sears, Roebuck & Co. The elevator and the steel skeleton frame were now employed in the best interest of the end user in selling their goods. Designers have incorporated these innovations, for the benefit of the end users, in order to produce a profitable property for the financial investors. This early example of the steel skeleton illustrated the advantages of the system, to be incorporated into skyscrapers in the 20th century.

860/880 N. Lake Shore Drive

Fig. 2, 860/880 from the lake (Source: Lau R.).

One of the finest examples of modern architecture is the twin towers of this project (Fig. 2). Identical and 26 stories in height, they are set perpendicular to each other on the trapezoidal site to maximize the views available to Lake Michigan to the east, across Lake Shore Drive (Steiner 1998). Construction of identical towers concurrently is very efficient economically. The construction cost of $10.83 per square foot was very competitive for 1949. Therefore, for an average construction cost, the developer received a premier structure with maximized views to attract tenants. The financiers and the end users received a premium product but paid a standard price of a comparable structure.

MODERN EXAMPLES OF INNOVATION

From the 1970s until today downtown office developments are subject not only to local and national economic conditions but also the significant urban sprawl and competitive locations with lower taxes in the suburbs. Since three out of the four buildings covered in this section of the paper are located in Chicago, we would be remised if we did not highlight the marginal increase of downtown office space between 1970s and 1980s of only 3% compared to an average increase of 10% per year for the suburbs (Costello J., 2002). In the early 1990s, however, the suburban construction almost came to a stole, while downtown was overbuilt. Although the effects of the 2000dot com crash and 9/11 impacted significantly

the downtown area, newly constructed properties have done significantly better than the rest of the same class but older office stock.

One Shell Plaza

One Shell Plaza (Fig. 3) is located in Houston, Texas in contrast to the other three modern buildings. The booming economy of Houston in the 1970s, with its population doubling from 1950 to 1970 (U.S. Census), initiated a number of projects in the city from confident developers. One Shell Plaza was among the riskiest initial financial moves Gerald Hines took, as one of the first major projects the company initiated. The leasing and finance risk was assumed by Hines along with Royal Dutch Pension (Van Schaack, G.). Hines's insight, market confidence as well as the innovative design of SOM's Fazlur Khan launched Hines as a major office developer with this project. The building was completed in 1971 and included 50 stories with a total of 1.2 million rentable sf (Ali M., 2001). The high-rise design innovations of F. Khan (Khan F., 1964), highlighted in an ASCE paper in 1964, were materialized in this and his other buildings, improving significantly the design and cost efficiency of a concrete high-rise. The use of lightweight concrete also decreased the cost of columns and foundations in addition to the tube-in-tube construction, which resists lateral loads better than traditional bracing (Ali.M, 2002).

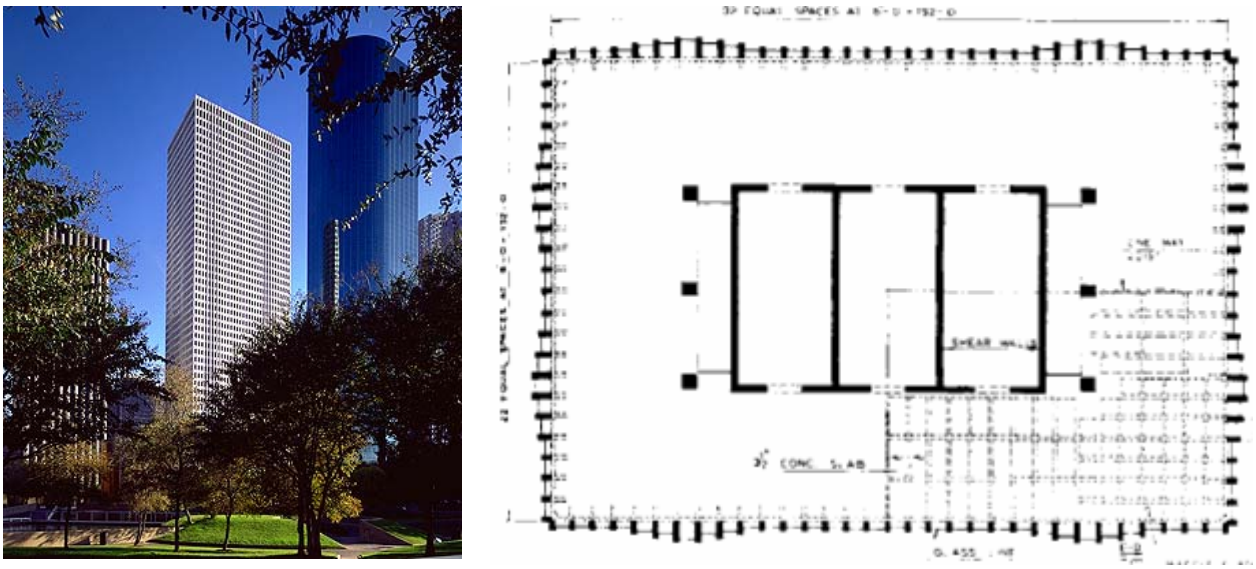

Fig. 3, One Shell Plaza (Source: Hines.com & http://www.somfoundation.som.com/waggoner_mark_essay.pdf)

Although the economy was booming at the time in Houston, the project was launched after the agreement by Shell Oil to become an anchor tenant with more than 30% of the available sf. As in the case of Three First National Plaza, the economic burden of equity and leasing risk was shared in half by the Royal Dutch Shell Pension Fund and Hines (Van Schaack, G.).

Three First National Plaza

Three First National Plaza (Fig. 4) is among the most interesting designs of the corner office era. Completed in 1981, the 57 floors include 1.4 million of rentable sf. The most defining aspects of the building are the interior and exterior design features. Externally, the building features a saw toothed setback design, which internally allows from 9 up to 13 corner offices (depending on the floor) and significant continuous column free office space for tenants. The other significant interior feature includes the two-level lobby and a 9-story atrium that includes both retail space and art exhibitions.

Fig. 4. East elevation of Three First National (Source: Lau R.).

This project came into fruition after First Chicago (Van Schaack, G.) leased over 30% of the rentable space, as an anchor tenant. The equity financing was provided in half by Hines and half by the Royal Dutch Shell Pension fund (Van Schaack, G.). In coordination with the architect, the developer (Hines) identified the most efficient and demanding type of design considering both the market needs and the building location, in the heart of Chicago's financial center. Currently, the building is in Hines ownership and, although the floor plates are not as efficient as they were when initially built, the perfect maintenance record and average rental rates for the market are still keeping this building financially efficient for the owner.

Three Twenty One North Clark

Three Twenty One North Clark (Fig. 5) is a perfect example of the era's architectural trend of stainless steel and glass buildings; the design innovation, however, does not lie on the external design but the efficient floor plate. The building was completed in 1987 and includes 35 stories with a total of 896,000 sf of rentable area. The building was initially developed by BCED, but in 2001 was acquired by Hines, due to its efficient floor plate. The tenants have significant flexibility due to the 5-foot planning modules and 40-45-foot spans from the window to the core.

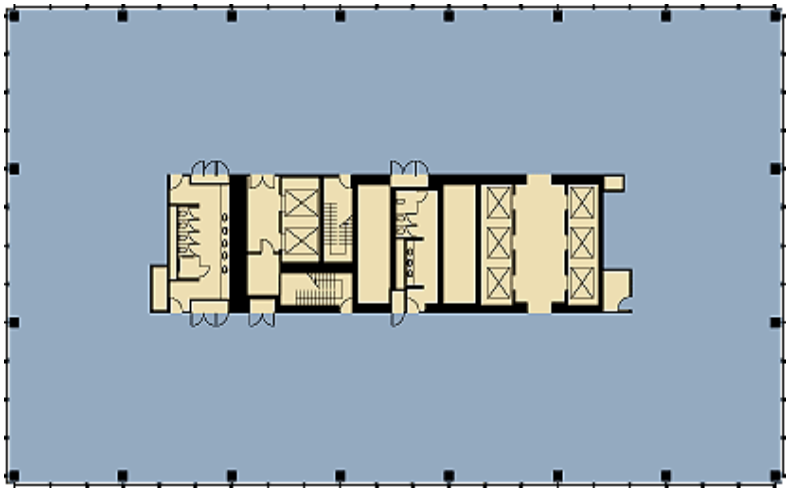

Fig. 5. 321 N. Clark from the southwest (Source: Lau R. & http://www.321northclark.com).

One Hundred Eleven South Wacker

Although the most noticeable and distinctive feature of 111 S. Wacker is the transparent cable wall from the ground level to the third floor, this is only one of the various design and technological innovations. 111 S. Wacker Drive was completed this year and as a composite structure it uses the 3rd through 12th floors as a megatruss that supports the rest of the building floors (Steele, 2004). With 51 floors and more than 1 million sf of rentable area the building has no interior columns, 50ft core to window dimension, 5ft planning module and high ceilings. These planning modules allow tenants to lease 5-10% less space than average buildings, offering significant cost savings and making the building more marketable compared to older generation buildings (Construction International Times, 2005). Among other technology innovations are the total redundancy in telecommunication, HVAC systems and uninterrupted power.

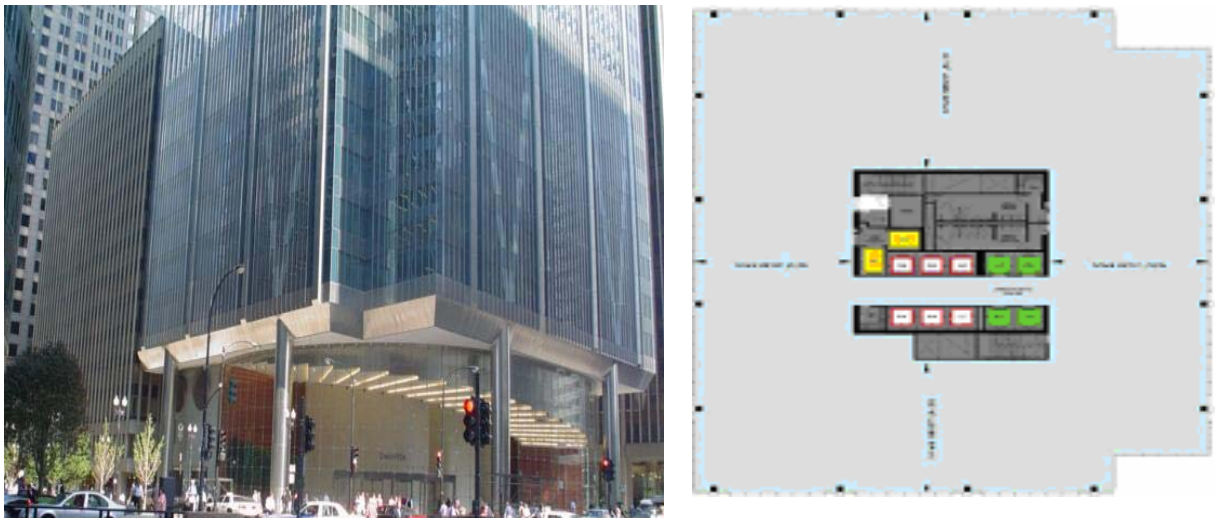

Fig. 6, west lobby of 111 S. Wacker (Source: Lau R. & http://www.111southwacker.com).

Focusing on the building from a financial perspective, the project went ahead after Deloitte & Touche became the anchor tenant with about 45% of the available sf. The total project cost was $300 million with a combination of funding from John Buck equity funds and a $217 million construction loan by GMAC Commercial Mortgages (Widholm P., 2005 and Construction International Times, 2005). Significant cost saving was accomplished at construction from the use of the previous building's (U.S. Gypsum Building) caissons, which decreased the new foundation cost to a fraction of what was expected for a building of such a size, since only a few more caissons needed to be added (Steele J., 2004).

CONCLUSION

Various technological innovations through time, such as the elevator, steel skeleton, lightweight cement, tube-in-tube structures, and others have improved a building's efficiency. Based on the experience gained from the modern buildings, however, there are two major financial aspects of high-rise development; the first is the identification of a potential anchor tenant, which will allow the construction funding to be provided, and the second is the identification of the design and other features, which will allow the building to be highly marketable but also cost effective. All the buildings highlighted in this paper presented innovative features, which the developer could financially bare mainly because of the cost savings in various aspects of the project. Although the developer is always exposed to the risk of low occupancy, the cost savings from technology improvements in building design have allowed more funds to be available for aesthetic and other high-tech features, attracting tenants requiring such features.

References

Ali M. M., ”Evolution of concrete skyscrapers: from Ingalls to Jin Mao”, Electronic Journal of Structural Engineering, vol.1, no.1, pp.. 2-14, 2001.

Construction International Times, “111 South Wacker”, http://www.citinternational.co.uk/namerica/?pid=3200&lsid=3207&edname=16802.htm&ped=16802, 2005

Costello J., “City Outlook - Chicago” NAREIT, web exclusive, January/February 2002 http://www.nareit.com/portfoliomag/02janfeb/city_outlook.shtml

Khan, F. R. and Sbarounis, J. A., "Interaction of Shear Walls and Frames in Concrete Structures under Lateral Loads," Journal of the American Society of Civil Engineers, 90 (ST3), June 1964

Steele J., “Future Force – 111 South Wacker Builds on the Past”, Midwest Construction, September 2004, http://midwest.construction.com/features/archive/0409_cover-2.asp

Steiner, F. H., “The Architecture Of Chicago’s Loop”, Sigma Press, 1998
Auditorium Building, p. 8; Second Leiter Building, p. 24; 860/880 N. Lake Shore Drive, p. 92

Van Schaack, G., Senior Vice President, Hines corporation (interview, 7/2005)

Widholm P., “Chicago is Back on the upswing”, National Real Estate Investor, July 24th 2005, http://www.nreionline.com/mag/real_estate_chicago_back_upswing/