Assignment #5
"Time is Money"

Assigned: March 10, 2003
Due: March 19, 2003

Financing a Skyscraper

A simple cost model for the construction of a skyscraper could be based upon the following:

a. The land area (acres) and the price of the land ($0.1 to $10 million/acre)

b. The costs of clearing the land ($10 to $50,000/acre)

c. The foundation ($2-4 million/acre)

c. The weight-bearing structure

d. The exterior of the building, including windows, exterior materials, waterproofing, and insulation

e. The elevators

f. Heating, air-conditioning, ventilation

g. Creation of a dramatic entry area and mini-parks

h. Interior walls

i. Interior finishing

For a CEE project, we are generally considering whether or not to begin a particular type of project. We probably have several basic design and location options plus numerous minor variations on these options, e.g. variations in size or quality of components. From the underlying logic of the project, we can develop a function that relates the project costs to the design and location possibilities. Separate functions can be used to estimate the initial investment costs as well as the fixed and variable operating costs. As engineers, it is our job to try to understand

what options are available, including new designs or construction techniques as well as "tried & true" approaches.

Revenues

We also would like to estimate the demand for the services provided by our project, taking into account the quality of the service provided, the capacity of our project and competing facilities, and the price that we and our competitors charge. For a skyscraper, the revenues will be based upon the rental rates, commonly expressed as the annual rent per square foot. A skyscraper makes financial sense if the projected rents (net of any continuing expenses) will be sufficient to justify a mortgage sufficiently large to cover all of the costs of construction, including interest on a construction loan.

Timing and Cost Assumptions

For this assignment, let's just consider the example described by Karl Sabbagh in "Skyscraper", as summarized in the attached note. This is a great book describing the people and the processes involved in constructing a 50-story office building in Manhattan. As is the case with most engineering books, the focus is on the technical rather than the financial matters. Hence, in addition to the information presented in the note (which is about all there is in the book), we need to make some additional assumptions to evaluate various options for the project:

a. The time between land acquisition and beginning of construction is exactly 18 months. All of the engineering and architectural work is completed during this period.

b. The time from groundbreaking until the time that tenants can move in is exactly 24 months (i.e. months 19 to 42 of the project if the project is completed on time).

c. The permanent mortgage is obtained 3 months after the tenants move in (at the end of month 45 if the project is completed on time).

d. The tenants have 4 months (to fix up the interior) before they make their first rent payment (at the end of month 46 if the project is completed on time).

e. The fixed costs include the land acquisition, preparation of the case for development, the architects and engineers fees (assumed to be $90 million of the $145 million for fees and borrowing costs cited in the note), $45million of the construction costs (for the foundation, landscaping, entry, lobby and the roof), and $5 million of the project management costs.

f. The $90 million architect/engineering fees were paid uniformly over the first 18 months of the project; the $145 million construction costs were paid uniformly over the period of construction.

g. The construction could have been stretched out over 3 years with a savings in construction of $5 million and essentially no chance of an overrun.

h. The project costs were provided on a construction loan with interest of 10% per year charged from the point that costs were incurred. (This type of loan works like a checkbook – the owner writes checks for all payments, and the amount of the check is added to the outstanding amount of the loan. Interest is charged and added to the outstanding balance at the end of each month.)

i. $375 million of the permanent mortgage related to the office tower; the interest rate of this mortgage was 8%.

j. All invoice and loan payments are made on the last day of the month.

k. Additional space, if available, could likely be rented at $30/sq. ft. per year or more.

Questions

1. Project Cost (30 points) - Construct a spreadsheet that can be used to calculate the costs of construction, including interest costs on the construction loan. Structure the spreadsheet so that it shows the various cost categories across the top and the months (1 to 48 down the side). Have columns for total monthly cost in each of the various cost categories, a column for the total and another column for the cumulative costs as of the end of the month. With this information, you can calculate the monthly interest charged on the cumulative costs at the end of each month (remember to use the monthly, not the annual rate of interest!). You can also calculate the PW of the monthly cost (use discreet discounting compounded monthly). Have an area at the top of the spreadsheet where you can enter key parameters (including interest rate on the construction loan, length of the construction period, and the owner's discount rate) when doing sensitivity analysis. Use the spreadsheet to answer the following questions:

a. What will the total project cost be as of the end of month 45 when - if all goes well - the permanent mortgage is secured (i.e. estimate the interest costs paid on construction and add it to the other costs to come up with a total budgeted cost – which should be roughly comparable to the $370 million shown in the note).

b. What is the present worth of the costs as of the beginning of month 1 assuming a discount rate of 15% per year.

c. How would the total project cost (as calculated in part a) and the PW (as calculated in part b) vary if the:

- Interest rate for the construction loan were 8% or 12% rather than 10%
- The time required for construction were 30 or 36 months rather than 24 months
- The owner's discount rate were 12% or 18%

2. Project Revenue (20 points) - Assume that the project has one major tenant who pays $26/sq. ft. for 600,000 sq. ft. and another who pays $29/sq.ft for 200,000 sq. ft., while all other space is rented at $30/sq.ft. (these are annual rates per square foot for long-term leases)

a. Calculate the monthly revenue assuming that the building is fully leased from the outset

b. Calculate the PW of the revenue as of the beginning of the first month in which rents are received (use the owner's discount rate of 15%)

c. Calculate the PW of the revenue as of the beginning of month 1 (using the owner's discount rate of 15%)

d. From the owner's perspective, is this a worthwhile project?

3. Refinancing (10 points) - Once the building is up and rented, the owner can refinance the building at a lower interest rate, because the bankers now can see the completed building and the paying tenants.

a. Assume that the bank will provide a 30-year mortgage with the maximum amount equal to 80% of the net present value of the rents (calculated with a discount rate equal to the interest rate on the loan). What would the maximum amount of the mortgage be and what would the monthly payments be?

4. Selling the building (20 points) - Once the building is refinanced, the owners may get bored simply collecting rents and making mortgage payments. What is the minimum sale price that they should accept assuming that their discount rate remains 15%? Suppose they see great opportunities in South American gold mines where they expect to make a 25% return - how low would they go? Be sure to remember that the sales price must be sufficient to allow to pay off your loan!

5. Redesigning the building (20 points) - Suppose that, early in the planning stage, the city planning department offers you a chance to increase the floor area ratio to 15 (which would allow you to add 3 stories and 100,000 sq. ft. of rentable space). All you have to do is provide an enclosed, all weather walkways to neighboring buildings as part of a "downtown mall" concept. How much additional cost would you be willing to accept to be able to get the added rentable space? Would you be willing to pay an extra $1 million and delay the project for 2 months in order to get the additional rental space?

Bonus (20 points):

Depreciation and income taxes: suppose that the building is depreciated over 20 years using the straight line method. Assuming a marginal effective tax rate of 40%, calculate the annual tax savings provided by depreciation. How would depreciation affect the sales price of the building as of the time when the owners first begin to receive rents? 20 years afterwards?

Building an Office Tower in Manhattan

Based upon Karl Sabbagh, "Skyscraper", Penguin Books, NY, NY, 1989
C. D. Martland, May 19, 1998
c:\academic\skyscraper.lwp

A real estate developer is looking for opportunities to create value by constructing buildings. If the value of the newly created space is worth more than the development costs, then there is a development opportunity. For an office building, the value will be based upon the leases that can be obtained for the office space. The development costs will include the cost of the land, preparation of the site, design & engineering, construction, and possibly various costs related to the approval process (e.g. in return for building a new entrace to a subway station, the developer may be allowed to build more intensively).

In Manhattan and other urban centers, land becomes a very expensive resource, which causes strong economic pressures for intensive development. In very general terms, the value of a building will be proportional to the usable space that it contains, i.e. the space that can be leased to clients. Doubling the size of the building will therefore roughly double the usable space and therefore double the value of the building. On the other hand, development costs are not at all proportional to the size of the building. First of all, the price of the land depends upon the local real estate market, not the value of what you intend to build; whether you build a single story warehouse or a 50 story office building, the cost of the land will be the same. Secondly, there will be certain costs that will be incurred for the project, such as providing access to local streets, building a lobby, and adding the roof. Adding additional stories will, for a large building, simply mean replicating the designs and materials used for one story over and over again. While certain structural components will need to be stronger for a taller building, the added cost is rather minor for a steel-framed structure (this was not the case when all walls were load-bearing - buildings were limited to 10-15 stories simply because of the massive walls that were required to bear the weight of the building).

Since there are economies of scale in building, the incremental cost of adding another story will be well below the average cost, while the incremental value of another floor of leasable space will not diminish. Hence, adding more stories and maximizing the usable space on each story will increase the value of the project while decreasing the average development cost/square foot. The developer therefore has a strong incentive to build the largest possible building.

There are various constraints to the size of the building that can or will be built:

1. Zoning regulation may limit the portion of the site that can be developed or the total floor area ration (FAR, the ratio of floor space to the area of the site).

2. Technological capabilities may limit the height (although the limit is obviously 100+ stories and seldom if ever a real limit today)

3. Market considerations may limit the amount of space that the developer wishes to make available at one time.

"Skyscraper" tells the story of the construction of the World Wide Plaza between 49th and 50th Streets and 8th and 9th Avenues in Manhattan, on what had been the site of Madison Square Garden. This block was west of the prime office locations in Manhattan in a rather rundown part of the island. Developing this land as an upscale office building was somewhat risky, not because rents would be lower than in the best locations, but because it might not be possible to rent the space at any price. Bill Zeckendorf, the developer, bought the land for $100 million, but only when he was reasonably sure that the site would be able to attract tenants

The zoning regulations called for a FAR of 12, which was increased by the City to 14 as a bonus for Zeckendorf's agreeing to make some improvements to the subway station on the site and to provide an acre of open space as part of the project. This provided an opportunity for 1.9 million sq. feet of usable space, of which 1.6 million would be in a 50-story office tower. They expected to be able to lease this space at $20-$30 per square foot, possibly rising to $40 in the future, assuming that rates would be discounted by $5 per square foot from the rents achievable a few blocks to the east. At $20/sq. ft., the annual rent would be $32 million; at $30/sq. ft., the annual rent would be $48 million.

The estimated costs of the project were expected to exceed $500 million:

Land acquisition (office tower portion)	$58	million
Prepare case for development (architects & lawyers)	$5	
Architects, engineers, and borrowing costs	$145	
Construction cost	$145	
Project management	$17	
Total	$370	

On an overall basis, if the building were indeed constructed for $370 million, and if space were rented $30/sq. ft., the annual revenue would provide a return of 13% for the entire project (assuming that the operating expense of the building would be borne by the tenants). At $20/sq. ft., the return would only be under 9%, which would barely be enough to cover interest costs.

The building was actually constructed for about $380 million, as there were overruns in several areas related to construction or material problems. It was rented at rates of $26 to $32 per square foot, with the lowest rate going to a major tenant who became a part-owner of the building (and who leased 600.000 square feet of space). The next largest tenant obtained a rate of $29/square foot, which was lower than the owners wanted, but was accepted in the uncertain aftermath of the stock market crash of October 1987. Smaller tenants paid the rate of about $32/square foot.

The building was constructed on a "Fast Track" basis in order to minimize borrowing costs during the construction period. The major events were as follows:

1985	Bought site for $100 million
1985	Secured major tenant, who became a co-owner
Nov. 12, 1986	Ground-breaking ceremony
Nov. 25, 1988	Initial target for making space available to tenants
March, 1989	All tenants in, working on space
May 15, 1989	Major tenant starts to move in
May 31, 1989	Permanent mortgage obtained for entire project

The cost of the total project (not just the office tower) was about $550 million; the permanent mortage was $533 million, which was justified by the revenue stream from the leases. By the end of the project, interest costs were running close to $3 million per month, while deferring rentals was costing close to $4 million per month. The pressure to complete the work quickly is evident, as the opportunity cost of a 1-month delay totalled $7 million!

To get some idea of the individual cost components, consider the following:

Steel framework			
Material costs	7.0 million		
Fabrication	0.8		
Freight charges	0.6		
Erection	11.0		
Labor, overhead, profit	5.5		
Total Steel			$25 million
Mechanical & electrical systems			$50
Elevators		$11	
Interior work (paid by tenants)			$112

These numbers, while incomplete, show that the costs of the interior work are nearly as great as the construction costs for the building ($154 million). The mechanical and electrical systems are a major expense, plus they take up a 6-8% of the floor space. The break-down of the steel costs shows that the materials were relatively minor, compared to the costs of erection.

The overall viability of the building depended upon being to complete construction close to budget without major delays and being able to rent the building at something close to the expected rates. Both of these requirements were met. However, the objectives of the different actors were not based upon the overall perspective:

> *In this particular building, you have a pretty characteristic group. You have the architect, who has design as his main consideration. He wants to put up a monumental building, something everybody is going to see and say, "Hey, wow! That's great!" it's his entry into posterity. The construction manager, HRH, they're interested in having a building up that they don't get sued over, that's going to stay in place. Each of the individual trades have the same interest as the construction company. The only difference is, each of the trades says, "I'm only going to do so much. The rest is someone else's responsibility." So then you have to argue out who's actually doing what part of the interface between the various trades. The consultant is working to represent the interest of the owner. Again, he's after a viable building, something the guy can make money with. He's not investing money to lose it. he also wants to make sure it's sound. I tell you, he has about the same interest as the construction manager. (p. 199)*

The architect for the project said:

> *The whole magic of our industry is twofold. One is to build a beautiful building but, more important, it's got to be successful. The only way it becomes successful is if you start collecting rent. The sooner you start collecting rent, the sooner the building becomes more successful. The minute you start collecting rent, all the sins of the father are forgiven. Everything that we've done wrong they forget - we're all friends again. (p. 306)*

Another of the participants hit a similar note in the concluding quote from the book:

> *What it comes down to is pieces of paper, numbers, internal rate of return, the net present value, discounted cash flows - that's what it's all about. ... Sure, we want to build quality and we want to build something that is going to be a statement, but if you can't do that and still have it financed well and make a return, then why are we doing it? (p. 378)*