

## **1.011 Assignment 4**

### **"Time is Money: Financing a Skyscraper"**

*This assignment requires you to understand thoroughly the differences between interest rates and discount rates, the differences in risks as a project progresses from concept through implementation, and the differences in perspective of entrepreneurs, owners, and investors. This assignment should be viewed as the "ruling grade" of this class on project evaluation: to complete this assignment satisfactorily, you have an excellent grasp of the concepts and applications of equivalence and clear insight into the financial mechanisms underlying a large infrastructure project.*

### **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)
- d. The weight-bearing structure
- e. The exterior of the building, including windows, exterior materials, waterproofing, and insulation
- f. The elevators
- g. Heating, air-conditioning, ventilation
- h. Creation of a dramatic entry area and mini-parks
- i. Interior walls
- j. 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 plus some smaller buildings 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 are paid uniformly over the first 18 months of the project; the \$145 million construction costs are paid uniformly over the period of construction.
- g. The construction could be stretched out over 3 years with a savings in construction of \$5 million and essentially no chance of an overrun.
- h. The project costs are covered by 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. When the project is completed, the construction loan can be refinanced at a rate of 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 total project costs (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. Estimate the total project cost as of the end of month 45 when - if all goes well - the permanent mortgage is secured. (The total cost is the sum of interest cost plus construction cost, which will equal the total amount of the construction loan as of the end of month 45. This amount should be roughly comparable to the \$370 million shown in the note.)
- b. What is the present worth of the total project cost as of the beginning of month 1 assuming a discount rate of 15%?
- 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. Assume that the bank will provide a 30-year mortgage with the maximum amount no greater than the minimum of a) project cost or b) 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.

- a. (5 points) What is the minimum sale price that they should accept assuming that their discount rate remains 15%?
- b. (5 points) Suppose they see great opportunities in South American gold mines where they expect to make a 25% return - how low would they go?
- c. (10 points) What would you recommend as a reasonable sale price for the building? Why? [Assume that the new owners will take over the mortgage, and be sure to include the balance on the mortgage in the sale price!]

**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. Assume that it would take 2 months longer to construct the somewhat larger and more complex project. How much additional cost would you be willing to pay to construct the all-weather walkways in order to gain the benefits of the added rentable space? [Be careful to consider all of the relevant costs and revenues.]

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Resource: Project Evaluation: Essays and Case Studies  
Carl D. Martland

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