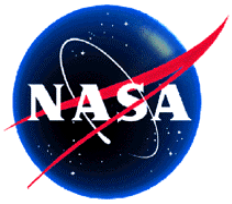

NASA Finance Cost Model
Version 1

Users Manual

Prepared for
National Aeronautical and Space Administration:
John C. Stennis Space Center

January 6, 2003

Executive Summary

Introduction

The National Aeronautical and Space Administration (NASA) Commercial Remote Sensing Program Office located at the John C. Stennis Space Center tasked Mitretek Systems, Inc. to develop a financial model that assists in the identification of unique commercial costs incurred in the development, launch and operational phases of a spacecraft mission. The Stennis Program Office will utilize this model to assist in evaluating proposals for cost realism on future remote sensing missions.

Mitretek researched current requirements, standards and industry practices. The model development team conducted interviews of representatives from the Government, the space insurance industry, the financial community and commercial providers of space-based services to identify the most accurate and current process and procedures for incorporation into the model.

Purpose

The purpose of this model is to display and report dollar values representing risk for Government or commercial entities for developing and flying a spacecraft. This model will assist the user to visualize issues concerning risks with potential delays caused by limited funding or hidden financial costs from the satellite development stage through on-orbit deployment.

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Table of Figures and Tables

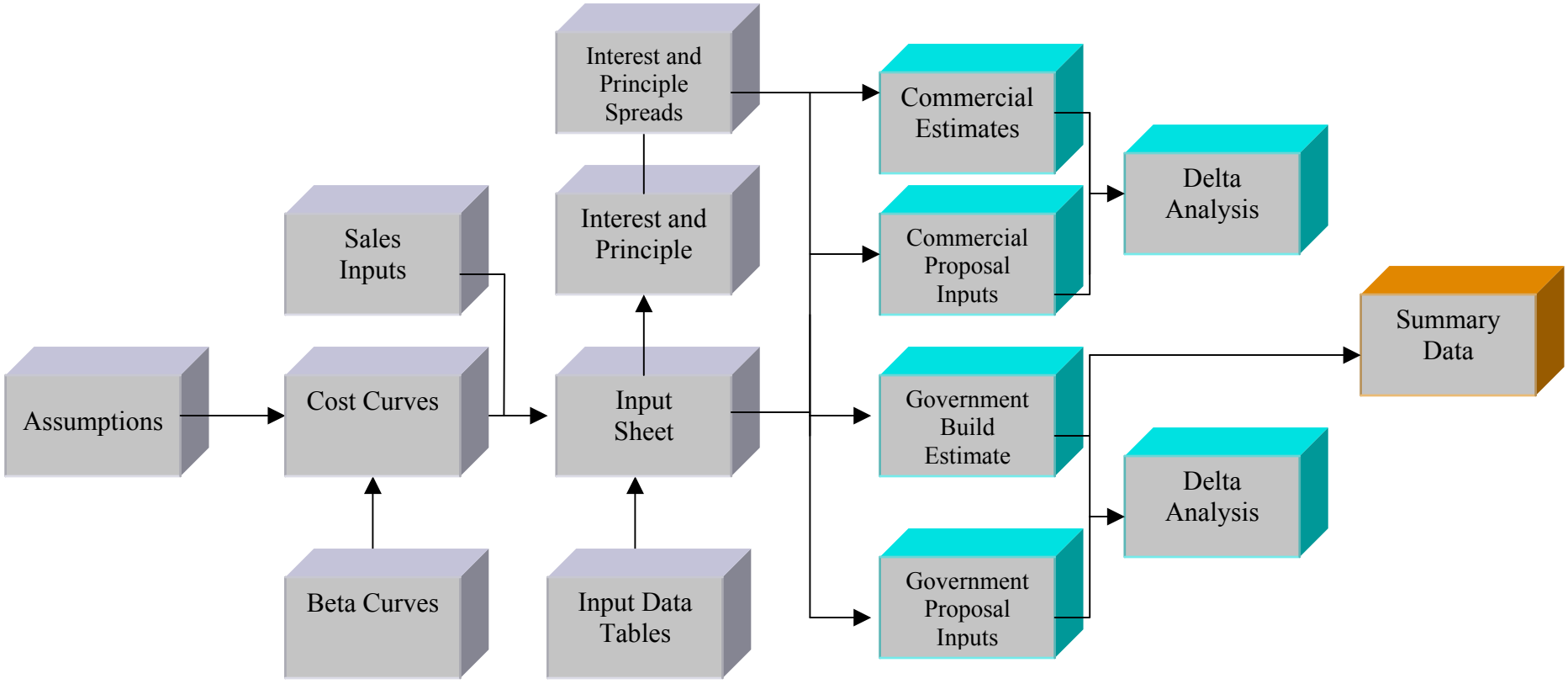
Model Organization

The model is divided into 17 worksheets, described in the table below:

Cost Model Worksheet	Purpose
Instructions	A worksheet that summarizes the model's worksheets and provides general help that can be used in conjunction with this User Manual, and other consultative help.
Assumptions	This worksheet provides the assumptions and documents the business rules and calculations for major model activities
Cost Curves	Time phased spreads of expected costs for three and four year development cycles. Curves employ the beta assumption common in the NASA cost estimation process. If the standard beta curve is not appropriate for the identified cost element, the user may change the curves to better fit the mission profile.
Beta Curves	Hidden sheet listing standard beta curves for mission life cycle.
Input Pull Down Tables	Hidden sheet listing data needed for input sheet's pull down tables.
Inputs	User enters the properties and attributes required to describe the development lifecycle environment of the satellite. This worksheet is where the user inputs the mission parameters including total cost, cost curve chosen, finance risk level, insurance risk level, launch vehicle chosen and expected return on investment for any mission that involves commercial sales or depends on equity financing. The sheet also includes estimates for sales expenses, commercial and Government revenues, and operating expenses.
Sales Inputs	A spreadsheet designed to break out pre and post launch sales revenues by major target market. The spreadsheet also allows for the user to adjust either upward or downward the sales projections. The adjustment factor can be applied to each identified target market, or can be applied to the whole estimate. Revenue data is then fed to the Inputs sheet where the user can decide if he/she wants to estimate sales with current year dollars or apply the time value of money to them by taking future estimates and discounting them to today's dollar level.
Government Build Estimate	This sheet identifies the mission specific costs that would be normally borne by a Government built

Cost Model Worksheet	Purpose
	spacecraft. The information on this sheet is automatically calculated based on the percentages input on the Inputs sheet. Commercial unique costs are not identified and are not included.
Government Build Actual	This blank worksheet enables the user to input costs as stated on a cost proposal to compare with the costs produced using average cost element allocation.
Delta Government	Calculates the difference for each cost element and quarter between the Government Build Estimate and Government Build Actual costs
Interest and Principle	Calculates associated interest and debt retirement for missions that will incorporate debt financing.
Interest and Principle Spreads	To maximize debt financing flexibility this worksheet time-phases the estimated debt loads incurred by the contractor. The sheet summarizes the available debt strategies onto one form which then feeds the Commercial Build Estimate sheet.
Interest and Principle Credit	To enable the user to construct a realistic financial strategy, the model allows for bank lines of credit to be used as a source of cash in addition to long term debt, equity and Government milestones. This spreadsheet calculates the interest and principle costs associated with securing cash inflows through a bank line of credit.
Commercial Build Estimate	Displays the calculated results from the User inputs in the Estimate column of the Input worksheet. This sheet calculates the expected cost profile of a mission that is not fully funded and operated by a Government agency.
Commercial Build Actual	This blank sheet enables the user to input costs as stated on a cost proposal to compare with the costs produced using average cost element allocation.
Delta Commercial	Calculates the difference for each cost element and quarter between the Commercial Build Estimate and Commercial Build Actual costs
Summary	Summary of the model outputs. Lists the expected total costs, identifies financing levels and cost ramifications and provides calculated net present value and internal rates of return for the mission. It also provides summary tables highlighting net financial position with respect to cash and profits.

Figure 1: Model Logic Interaction



Assumptions

Operating Environment

The model was developed using Microsoft Windows XP operating system and the Microsoft Excel XP application.

There are no known features that are not supported by earlier versions of Windows or Microsoft Excel. (If the model displays errors (e.g., "name?") check to see if the financial add-ins have been loaded to the application. The necessary add-ins are Solver Add-in and the Analysis Toolpak). The model can run under Office 2000 for Windows environments as well as Office X for Macintosh platforms.

The user is required to review each of the shaded input areas. The model does not automatically reset any of the user's inputs. The previous estimate entered in the model remains until the user overwrites this estimate. It is very important that the user reviews each shaded input box to ensure for correct data.

Insurance

- Total insurance costs will run between 15 and 25 percent of the affected mission elements. For example launch insurance will cover the cost of the launch, the satellite, and the instrument(s), but will not include the cost of ground operations. This range is based on interviews with representatives of the insurance industry. The range also assumes that reliable satellite technology and launch vehicles are employed.

- A fixed rate has been assumed for insurance costs. Industry treats insurance expenditures differently depending on the circumstances. To accurately reflect reasonable cash flows however, the insurance cost is split into three major buckets of costs. Launch insurance expenditures are up to launch, commissioning occurs the first quarter after launch, and on-orbit is expended throughout the first year of on-orbit operations. The total rate range for insurance is listed above, but segmented into three buckets depicted in the table below. If the actual insurance plan includes different rates that what is included in the model, the user can overwrite the insurance value that maps into the low, medium or high categories. The code choice will then apply the overwritten value to the model's calculations.

Development Phase	Percent of Total Cost	Comments
Launch	54%	Reliable vehicle assumed
Commissioning	32%	First month of orbit operations
In-Orbit	14%	Cost per year
Total Percent	100%	

Launch Vehicle

The launch vehicle chosen is a factor that drives the technical risk in the model. Depending on the vehicle chosen, the user must ensure that the insurance risk level reflects the expected reliability of the launch vehicle. The current commercial market provides companies with more options than before. Therefore, the model includes foreign made launch vehicles as well. Due to their recent similar success rates, the launchers Proton, Ariane, Long March and Rockot are grouped into the **Other** category. The only vehicle deemed high risk included in the model is the Zenit. The following launch vehicles are built into the model allowing the user to choose via a pull-down menu.

- Delta
- Pegasus
- Pegasus XL
- Titan
- Atlas
- Shuttle (STS)
- Titan+
- Other
- Zenit

The choice of launch vehicle also drives the lead-time needed for preparation. Cost profiles based on the vehicle chosen are incorporated into both the **Government Build Estimate** as well as the **Commercial Build Estimate**. Lead times per vehicle are listed on the **Assumptions** sheet of the model.

Financial

Financial assumptions focus on the stability and financial health of the contractor performing the mission. The firm's capital structure is evaluated with respect to debt to equity ratios. Although the D/E ratio is not the panacea for the financial health of a company, it does provide guidance with respect to expected interest rates that the firm would incur if it chooses to finance the mission using debt proceeds. The firm's ratio will drive the choice of interest rates assigned to the mission if the firm chooses debt financing.

For public companies, establishing the firm's risk is relatively straightforward. Financial statements are analyzed, investor information is studied and any additional published information that provides insight into financial stability is evaluated. If the company is private, and no financial data exists, the analysis of financial stability is more subjective. The firm's history and risk are evaluated with respect to successful missions and prior company affiliations. If the private firm has a partner, the partner's financial stability and strength are evaluated and applied to the firm itself. For public companies paired with another firm, the same level of analysis is performed.

Mission Cost Profiles

The model has numerous flexibilities built in. It will allow a user to input known sub-element costs directly and then apply the best fit cost curve to these values. It also allows for analysis of cost profiles based on historical information. Twenty-two missions that included either one or many instruments flying on a spacecraft bus were evaluated with respect to major cost drivers (e.g. instrument(s) cost, spacecraft bus cost etc.) The missions evaluated are listed below:

- Landsat 5
- Landsat 1
- Hawkeye Microsat
- GRO
- DE-1
- DE-2
- Magsat
- OSO – 8
- SMS – 1
- SME
- AE – 3
- ATS – 1
- ATS – 5
- ATS – 6
- COBE
- ERBS
- HEAO 1
- HEAO 2
- TIROS – N
- UARS
- TOPEX
- TOMS/EP

If the missions above are not representative to the mission under analysis, NASA's database of missions can provide additional details. With permission, this percentage based information can be incorporated into the model. To determine if the proposed data is reasonable, the analyst can evaluate the information using NASA based metrics. All that is necessary for the analyst to do is to complete the percentages on the **Inputs** sheet, ensure that the dollar column is accessing the percentage column, and input the total mission cost. The model then allocates accordingly. The model then applies general percents to the major cost elements to derive the commercial unique costs such as Insurance. It also identifies the amount of additional financing needed given a percentage for Government involvement.

Cost Curves

One major benefit that the model provides the user is flexibility. The user can either allocate actual dollars to each identified sub-element, or use supportable metrics to spread a total cost figure over all of the components. To capture the timing of the costs, however, the user must choose the appropriate cost curve to apply. There are two built in curves in the model – a four year development cycle and a three year development cycle. Each implies a different launch time-frame and therefore a different expenditure profile is produced. The default values for the cost curves information are based on NASA standard beta curves. For example, a beta curve of 60/40 implies that 60% of all the costs are expended half-way through the period of performance; thereby 40% is allocated after the mid-point. Although these are standard curves, the model allows easy edit capabilities to change the percentages to represent the expected expenditure profile. For example, if the launch vehicle will be paid in just two installments, the user finds the appropriate launch vehicle cost curve, and overwrites the default percentages. This will then be calculated on the **Commercial Build** sheet as well as the **Government Build** sheet. Not all cost elements have cost curves however. Costs that are derived from sub-element levels do not have curves associated with them. For example, insurance costs do not have a curve, but are tied to the development cycle for which they are calculated against. Interest and principle repayments also do not have curves; they are based on the interest and principle pay down schedules located on another sheet. These expenditure profiles are tied to their durations and not to a cost curve.

Input Data

This area of the model requires USER input. All shaded areas require input from the users. The first section to be completed by the user allocates the prime mission cost to all of the mission's major components.

Step 1: Total Mission Cost

The first step requires that the user have an estimate of the total cost of the mission. This can be either directly from proposals or from internal estimates produced by NASA. The model includes pre-set percentages for all major components needed for a mission. The user can either use the percentages as presented, thereby only inputting the total mission prime cost or the user can input mission element costs directly into the table. Each of the major cost elements is input as a total cost of the product. Profit is a separate line item and is excluded from subsystem cost. The costs are then spread depending on the development cycle chosen for this mission.

Values in Whole Dollars

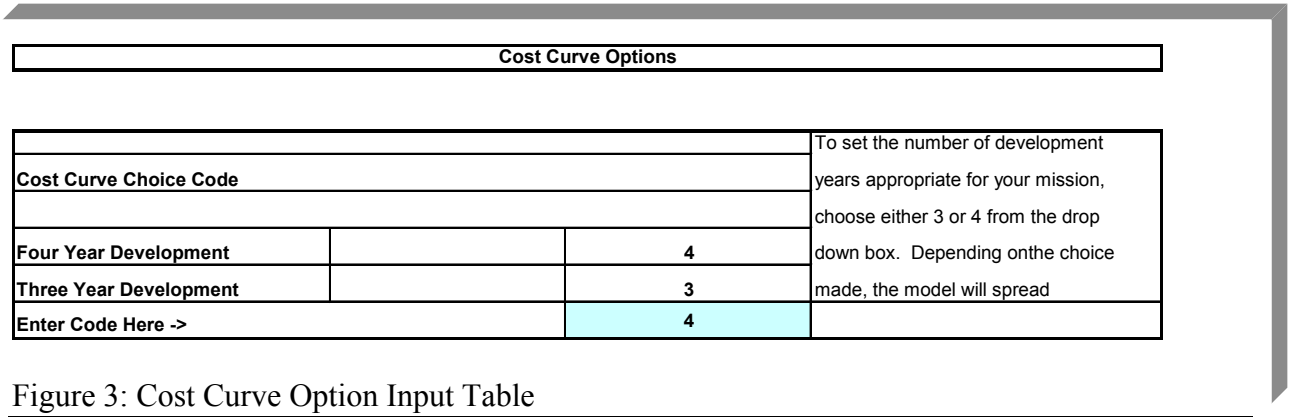
Mission Prime Cost	$ 100,000	Percents (can be overwritten)	Notes
Spacecraft Bus	$ 25,000	25.0%	All costs associated with spacecraft bus development
Instrument	$ 19,000	19.0%	All costs associated with instrument development
Ground Ops Development	$ 19,100	19.1%	All costs associated with developing ground station
Ground Operations	$ 22,500	22.5%	All costs associated with operating the ground station(s)
Program Management	$ 1,300	1.3%	Costs of management - Program Mgt., QA, etc.
Launch Vehicle	$ 12,000	12.0%	All costs associated with launch vehicle procurement
System Engineering	$ 1,100	1.1%	All costs associated with systems engineering during development
Profit	$ -	0.0%	Not applicable for Commercial Estimates
Working Capital (WC)	$ -		WC expenditures account for costs incurred associated with development
Direct Mission Price (Prime)	$ 100,000	100.00%	Direct Mission Price - Summary of all major components
Total Life Cycle Cost of Mission	$ 100,000		Includes price of mission as well as WC requirements
Launch Insurance Basis	$ -		Basis for launch insurance estimates
On-Orbit and Commissioning Insurance Basis	$ -		Basis for commissioning and on-orbit insurance estimates
Amount to Finance	$ 77,500		Total financing needs - may exclude ground operations and other costs that will be financed through operations

Figure 2: Mission Total Cost and Sub-Element Input Table

Note that there is a cell titled **Amount to Finance**. In many instances, the post launch costs will be covered by sales revenues to the commercial or other Government markets. Also, note that there is a cell titled **Working Capital.** This cell accounts for costs that will be incurred to stay in business, costs that may have to be financed in manners similar to the mission finance strategy.

Step 2: Choosing the Development Cycle

Once the total mission cost has been input, the user must determine if the mission is best represented by a three year development cycle or a four year development cycle. This choice affects the timing of the costs from Step 1. The choice is made through a pull down menu choice. Note that other development cycles for missions will be incorporated into later versions of the model. Also note that the expected development cycle for the Landsat Data Continuity Mission (LDCM) has been incorporated into the default curve values for a four year development cycle (code 4).

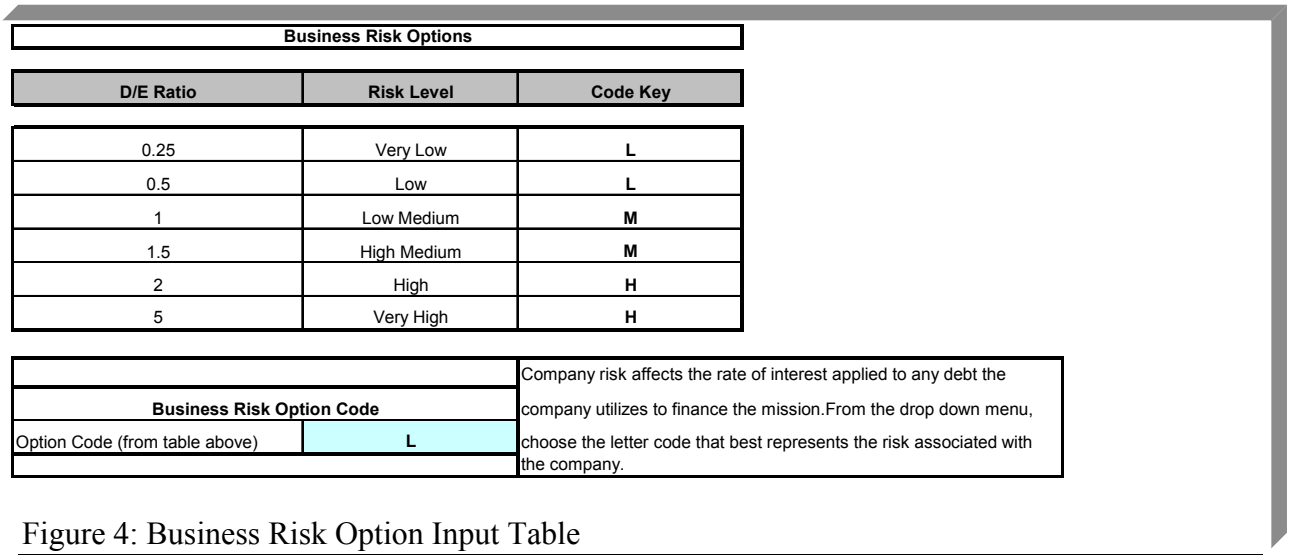


Cost Curve Options			
			To set the number of development
Cost Curve Choice Code			years appropriate for your mission,
			choose either 3 or 4 from the drop
Four Year Development		**4**	down box. Depending onthe choice
Three Year Development		**3**	made, the model will spread
Enter Code Here ->		**4**	

Figure 3: Cost Curve Option Input Table

Step 3: Setting the Business Risk Level

This step will require some preliminary research into the company's financial status. Three levels of risk have been identified – low, medium, and high. The risk levels are based on a firm's debt to equity ratio (D/E), which can be obtained from the firm's financial statements or other publicly available data such as Value Line newsletters. Once the user has determined a viable D/E ratio, he or she will match the ratio to the risk level listed in the table. The risk level chosen will then drive the interest rates assigned to any long term debt that the company may secure to finance the mission.



Business Risk Options		
D/E Ratio	**Risk Level**	**Code Key**
0.25	Very Low	**L**
0.5	Low	**L**
1	Low Medium	**M**
1.5	High Medium	**M**
2	High	**H**
5	Very High	**H**

		Company risk affects the rate of interest applied to any debt the
Business Risk Option Code		company utilizes to finance the mission.From the drop down menu,
Option Code (from table above)	**L**	choose the letter code that best represents the risk associated with
		the company.

Figure 4: Business Risk Option Input Table

Step 4: Setting the Financing Profile

Companies have a variety of capital resources available to them. They can raise equity capital through the financial markets, or from a pool of private investors. They can issue corporate notes, or bonds that will provide them with cash that must be paid back at a later date. Firms that work with the Federal Government have one additional source of cash, the Government itself. The Government can either get service in a pay as you go process, or through set milestones that are tied to contract performance. This step of the model requires the user to set the level of Government involvement, as well as the levels of expected debt financing and equity proceeds. The values picked will materially affect the cost profile of the mission since debt proceeds will incur transaction fees, as well as interest expenses, and equity financing will incur transaction fees.

The timing of the Government's involvement will affect the cost level as well. If the Government provides funding pre-launch, the company will require less financing during the costliest time of the mission life cycle. However, if the Government waits until post-launch the company would have to finance its development through debt, equity, or a combination of the two. The user can perform sensitivity analyses by manipulating the levels of debt versus equity financing.

Financing Profile

This section allows the user to set the amount of the mission that the government will finance. The user picks the percentage of government involvement, the percent of debt, and the percent to finance via equity.

Financing Options	Percents	Amount $$	Implications/Notes
Total Life Cycle Cost	100%	$ 100,000	Mission Cost Plus other Financial Needs
Amount to Finance	100%	$ 77,500	Total Amount to Finance
Percent paid by Govt	50%	$ 38,750	Amount to be financed by Government
Percent of MP financed by debt	25%	$ 19,375	Debt placement amount
Percent of MP financed by equity	25%	$ 19,375	Requires expected level of return
Remaining Financing Needs		$ -	Remaining MP - Contractor Share
Remaining Value to Finance		$ 38,750	Remaining MP at Cost Level
Percent financed by debt	50%	$ 19,375	Debt Feeder
Percent financed by equity	50%	$ 19,375	Equity Feeder

Figure 5: Financing Profile Input Table

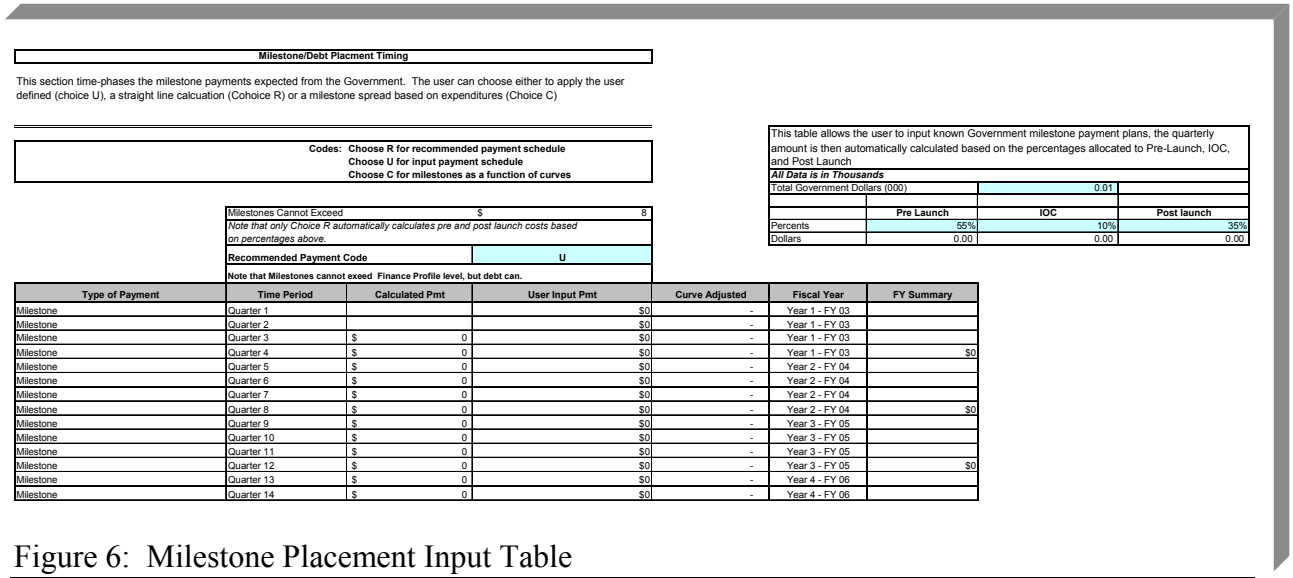
Step 5: Setting the Milestone/Debt Placement

Once the level of Government involvement has been set, the user will allocate the milestone payments through the period of performance. The model provides for debt as well as milestone payment options: For milestone payments, there are three codes available to the user that will set the timing of the milestone payments.

- Code R: Recommended milestone spread. This choice spreads the total Government level in one of three ways. Note that in Step 4, the user determined the percentage level of milestone payments that will be pre or post launch. That choice is incorporated in this step. Code R evenly calculates the total over the chosen period of performance.

- Code C: Calculated milestone spread. This choice is driven directly by the cost expenditure profile of the mission.

- Code U: User defined milestone spread. This choice allows the user to input directly into the table the dollar amounts per milestone payment. This method is ideal if Government budgets are known in advance, or if there are limitations to the order to which the milestones can be placed. Below is a partial snapshot of the Government milestone input section. This code is highly recommended if the milestones are known.



Milestone/Debt Placment Timing

This section time-phases the milestone payments expected from the Government. The user can choose either to apply the user defined (choice U), a straight line calcuation (Cohoice R) or a milestone spread based on expenditures (Choice C)

Codes: Choose R for recommended payment schedule
Choose U for input payment schedule
Choose C for milestones as a function of curves

This table allows the user to input known Government milestone payment plans, the quarterly amount is then automatically calculated based on the percentages allocated to Pre-Launch, IOC, and Post Launch

All Data is in Thousands

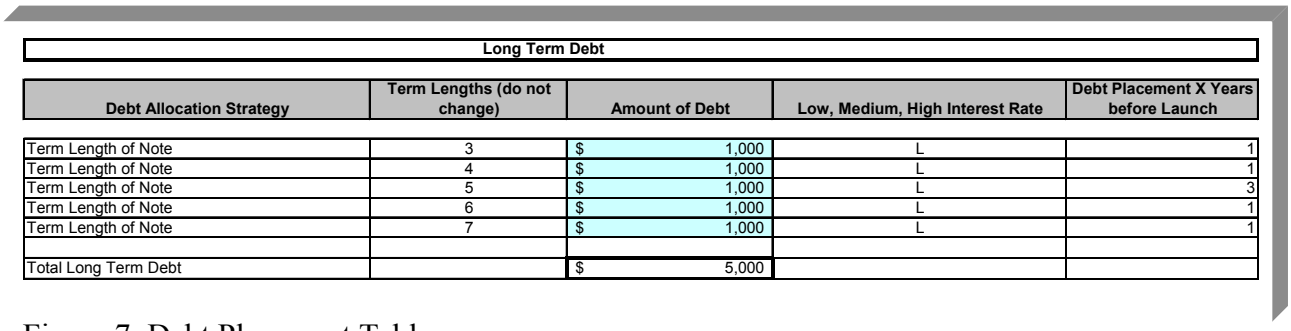
Total Government Dollars (000)		0.01	
	Pre Launch	**IOC**	**Post launch**
Percents	55%	10%	35%
Dollars	0.00	0.00	0.00

Milestones Cannot Exceed	$	8
Note that only Choice R automatically calculates pre and post launch costs based on percentages above.		
Recommended Payment Code	**U**	
Note that Milestones cannot exeed Finance Profile level, but debt can.		

Type of Payment	Time Period	Calculated Pmt	User Input Pmt	Curve Adjusted	Fiscal Year	FY Summary
Milestone	Quarter 1		$0	-	Year 1 - FY 03	
Milestone	Quarter 2		$0	-	Year 1 - FY 03	
Milestone	Quarter 3	$ 0	$0	-	Year 1 - FY 03	
Milestone	Quarter 4	$ 0	$0	-	Year 1 - FY 03	$0
Milestone	Quarter 5	$ 0	$0	-	Year 2 - FY 04	
Milestone	Quarter 6	$ 0	$0	-	Year 2 - FY 04	
Milestone	Quarter 7	$ 0	$0	-	Year 2 - FY 04	
Milestone	Quarter 8	$ 0	$0	-	Year 2 - FY 04	$0
Milestone	Quarter 9	$ 0	$0	-	Year 3 - FY 05	
Milestone	Quarter 10	$ 0	$0	-	Year 3 - FY 05	
Milestone	Quarter 11	$ 0	$0	-	Year 3 - FY 05	
Milestone	Quarter 12	$ 0	$0	-	Year 3 - FY 05	$0
Milestone	Quarter 13	$ 0	$0	-	Year 4 - FY 06	
Milestone	Quarter 14	$ 0	$0	-	Year 4 - FY 06	

Figure 6: Milestone Placement Input Table

The user also has debt placement timing tables available. The user can pick one to three years prior to launch for securing the debt. This flexibility is incorporated to allow contractors to secure non-mission specific debt. The debt market needs proof of existing customers, or potential long-term contracts before it will issue debt to the requesting company, so it is often difficult to get the debt until all of the available equity has been used.



Long Term Debt

Debt Allocation Strategy	Term Lengths (do not change)	Amount of Debt	Low, Medium, High Interest Rate	Debt Placement X Years before Launch
Term Length of Note	3	$ 1,000	L	1
Term Length of Note	4	$ 1,000	L	1
Term Length of Note	5	$ 1,000	L	3
Term Length of Note	6	$ 1,000	L	1
Term Length of Note	7	$ 1,000	L	1
Total Long Term Debt		$ 5,000		

Figure 7: Debt Placement Table

Debt estimates require evaluation of the company's risk. This business risk drives the calculated interest rate for 3, 4, 5, 6, and 7-year notes. The firm's Debt/Equity (D/E) ratio will directly affect the expected business risk of the contractor. Low risk firms will yield the lowest interest rate of 10%, while the more risky firms will incur a higher 15% rate for interest payments on the borrowed amount. The figure below depicts the associated interest rate dependent on the firm's D/E ratio.

Implications of D/E Ratio			
D/E Ratio	**Note Length (Years)**	**Note Interest Rate**	**Implications**
0.25	3, 4 ,5, 6, and 7 years	10.0%	Low Interest - Code L
0.5	3, 4 ,5, 6, and 7 years	10.0%	Low Interest - Code L
1	3, 4 ,5, 6, and 7 years	12.5%	Medium Interest - Code M
1.5	3, 4 ,5, 6, and 7 years	12.5%	Medium Interest - Code M
2	3, 4 ,5, 6, and 7 years	15.0%	High Interest - Code H
5	3, 4 ,5, 6, and 7 years	15.0%	High Interest - Code H

Figure 8: D/E Effects on Estimated Interest Payments

The user must decide two important drivers. First the user must determine the risk based on the D/E ratio. This step was covered under Step 3. Then the user must determine the note term length and set it by choosing the term length of the loan by picking the right term length in the drop down menu. Debt inputs are then fed to the **Interest Principle Spreads** sheet which summarizes the mix of debt strategies. To summarize:

1. User researches contracting firm and calculates its D/E ratio and inputs it under Business Risk Options covered under Step 3.

2. Depending on the development cycle chosen, the user places the pre-launch debt proceeds one, two or three years prior to launch. The user can mix the placement times to best match the firm's strategy. Note that the user cannot change the debt durations, but can mix and match placement times, and debt proceeds as necessary.

Step 6: Bank Line of Credit

Another source of cash is a bank line of credit. This resource normally bears a lower interest rate than long term debt, and usually has a much shorter duration. The model allows for a three year repayment schedule and integrates an interest rate of 6% for any monies secured through such a line. The user need only estimate the amount the contractor will need. The model limits the points in time when lines of credit can be accessed, but since the line of credit is a stop gap financial tool, it does not need the flexibility inherent in long-term debt. The table below is where the user inputs any needs for a line of credit.

Business Operations (Bank Line of Credit)			
Type of Payment	**Time Period**	**User Input**	**Notes**
Line of Credit	Quarter 9	$ -	6% Interest Rate
Line of Credit	Quarter 12	$ -	6% Interest Rate
	Total Line of Credit	-	**6%**
	Number of Years	**3**	

Figure 9: Bank Line of Credit Input Table

Step 7: Equity Placement

Up to this point the user has set the level and timing of milestone payments, as well as debt placements with associated term length. Setting the business risk code as appropriate has linked the expected interest payments based on the chosen term length of loan. Now the user can incorporate equity placements. Unlike debt, which incurs interest expense costs as well as the debt retirement, the only direct costs tied to equity are the transaction fees. However, there are also **shareholder expectations** that need to be addressed. The model approaches shareholder expectations by evaluating the expected return of the money acquired through equity placements. The Net Present Value (NPV) of the expected returns is calculated and compared to the NPV of the estimated cash returns over the mission's life cycle. Since benefits to the shareholders from any equity placement won't occur until after launch, the NPV calculation's start date coincides with the expected launch date. Note that venture capitalists normally require a higher rate of return for their invested capital than the public at large. The equity placement timing is assumed to be relatively early in the mission's life cycle. This is due in part to the fact that the debt market won't offer any monies until the contractor's equity has been exhausted.

Equity Placement (thousands)			
Type of Payment	**Time Period**	**Calculated**	**Implications**
Equity/Venture Capital	Quarter 1	-	Stockholders will expect a certain level of return from the company For example, if you issue $38.5M in stock, and investors expect 40% annual return from their funds, at a minimum, the cash generated from the mission must produce a favorable NPV.
Equity/Venture Capital	Quarter 2	-	
Equity/Venture Capital	Quarter 3	-	
Equity/Venture Capital	Quarter 4	-	
Equity/Venture Capital	Quarter 5	-	
Equity/Venture Capital	Quarter 6	-	
Equity/Venture Capital	Quarter 7	-	
Equity/Venture Capital	Quarter 8	-	
Equity/Venture Capital	Quarter 9	-	
Equity/Venture Capital	Quarter 10	-	
Equity/Venture Capital	Quarter 11	-	
Equity/Venture Capital	Quarter 12	-	
	Total Equity	-	
	Annual Return	40.0%	
	NPV of Expected Return	-	

Figure 10: Equity Placement Input Table

Step 8: Insurance Options

Two major types of risk have been identified; business risk and technical risk. Business risk is accounted for by choosing the company's risk level after careful analysis of the firm's D/E structure. The level of business risk is accounted for by the interest rate chosen for any debt proceeds. Technical risk has been addressed above with respect to the degree of reliability of the spacecraft design, instrument design, or launch vehicle reliability. To capture the level of technical risk, three levels of insurance have been incorporated into the model. The lowest level is 15% (L), the middle is 20% (M) and the highest insurance rate is 25% (H). The user chooses the code via a pull down menu that best represents the perceived technical risk of the mission. The table below provides a snapshot of this input section. Note that the user can overwrite the default percentages to better represent quoted insurance rates.

Insurance Options

The following ranges capture risk as presented in the insurance rates for the life cycle of the mission. High percentages for insurance implies that the technology is new including spacecraft bus, instrument, and launch vehicle. Low percentages for insurance implies that the technology has been successfully deployed before and that there are no new technological advances.The mid-point implies a risk point in between the high and low rates.

Phase	Low Risk	Medium Risk	High Risk	Percents of Total
Launch	8%	10.80%	14%	54%
Commissioning	5%	6.40%	8%	32%
In-Orbit	2%	2.80%	4%	14%
Totals	**15%**	**20%**	**25%**	
Code	**L**	**M**	**H**	
Total Insurance Costs	$ 0	$ 0	$ 0	

Insurance Risk Choice Option Code		To designate the level of technological risk associated with the mission, choose from the drop down menu to the left the code that best represents the technical risk.Technical risk is dervied by analyzing the maturity of the spacecraft's components including the instrument, as well as the failure risk associated with the chosen launch vehicle.
Insurance Code	**M**	

Figure 11: Insurance Option Input Table

Step 9: Choosing the Launch Vehicle

The launch vehicle is chosen via a pull down menu from the list of available vehicles. Although there are numerous models within a launch vehicle family, it is assumed that the lead times for the family are similar. The choice of launch vehicle will affect the associated expenditure profiles by spreading the cost over the lead time's period of performance. Note that the **Cost Curves** sheet includes estimated expenditure profiles for each available vehicle family. The user can use the information included in the **Cost Curves** sheet, or he/she may adjust as necessary to reflect the firm's strategy. The launch vehicle information was compiled from numerous sources including the web sites for Johnson and Marshall

Space Centers, 2002 briefings from the Futron Corporation, and proprietary data from the insurance firm, Aon Space. Please refer to the table below for the available launch vehicles.

Launch Vehicle Options

The following list captures the lead time and success rate for the chosen launch vehicle. The lead time drives the time period that costs will be spread against.

Launch Vehicle	Code	Avg. Success Rates	Risk Level
LV - Delta	Delta	96%	Low
LV - Pegasus XL	Pegasus	86%	Medium
LV - Titan	Titan	93%	Low
LV - Atlas	Atlas	93%	Low
LV - Shuttle	Shuttle	99%	Low
LV - Taurus	Taurus	83%	Medium
LV - Other	Other	95%	Low
LV- Zenit	Zenit	71%	High

LV Option Code	Code
Launch Vehicle Code	Delta

Note that the success rate of the launch vehicle chosen will affect the level of risk that is addressed throughinsurance payments.

Figure 12: Launch Vehicle Option Table

Step 10: Sales Inputs

The model provides the ability to estimate pre and post launch sales revenues by target market. Following the general **Inputs** sheet is a **Sales Inputs** sheet which lists several major target markets and provides for yearly inputs. The model then spreads the yearly inputs into quarters and transposes calendar years into Government fiscal years. Below the input tables is another table that includes percentages associated with each target market. The user can either upgrade or downgrade the estimates providing ranges of available sales revenues. The data is linked to the **Inputs** sheet which will then feed the **Commercial Build Estimate** sheet. Note that the user can also apply the time value of money to the estimated sales revenues by choosing "P" for present value modifications, or "C" to keep the sales revenue projections at current year dollars.

This section also includes the function of Sales Expense calculation. Sales expenses are assumed to be a function of sales revenues. The user inputs a value for the expected sales expense rate. The model then calculates the associated expense cost and feeds the data to the time-phased **Commercial Build Estimate** sheet.

Step 11: Operating Capital (Cash from Operations)

To account for the possibility that the contracting company will have other lines of business that are producing positive cash flows that can be allocated to new missions, the model includes the capability to account for such a cash stream. Note that this element is not the same as the Working Capital line item covered under Step 1. Working Capital in Step 1 is essentially a cash requirement, in that it drives the need for capital either through debt or equity. Operating Capital is a source of cash in addition to debt, Government milestones, line of credit, equity placements, and sales revenues.

Table 1: Summary of Steps

Stage	Summary Description
Step 1	Input major cost elements of the mission • Total direct mission cost • Each major sub element • Identify financing requirements
Step 2	Choose the development time-frame, 3 or 4 years. • Determines the cost curves that will be applied to the cost items • Adjust as necessary the percentages listed in the cost curve tables so that the calculated expenditure profile truly approximates the firm's expectations
Step 3	Identify the company's risk through analysis of their debt and equity positions. • Assign a code (L, M, or H) for Business Risk
Step 4	Based on financing requirements for the mission and the company, • Identify by percentages, the Government portion, as well as the amount to be financed through debt and equity
Step 5	Based on the Government portion from Step 4, • Allocate by quarter the expected milestone payments pre and post launch • Determine debt needs and allocate amounts to appropriate durations • Determine debt placement timing and assign accordingly
Step 6	Identify need for and allocate as necessary Bank Lines of Credit
Step 7	Allocate the needed equity amount that was identified in Step 4 • Choose timing of equity placement and input equity values
Step 8	Research technology risk of the mission, • Choose an insurance code that best fits the identified technology risk • Assign a code (L, M, or H) for Technology Risk via pull-down menu
Step 9	Choose the launch vehicle. • Note that the choice drives the needed lead time, and therefore will affect the expenditure profile • Choose appropriate vehicle via pull-down menu
Step 10	Identify and post by target market the expected sales revenues for pre and post launch time frames • Adjust upward or downward the adjustment factors for the sales forecasts
Step 11	Identify available cash from operations (if any), and populate table with this source.

Model Outputs

The model is designed to provide two major outputs. The first focuses on comparing the proposed values and strategies with known NASA metrics. The second provides financial metrics that help determine if the proposed strategy is financially viable.

Comparison Data

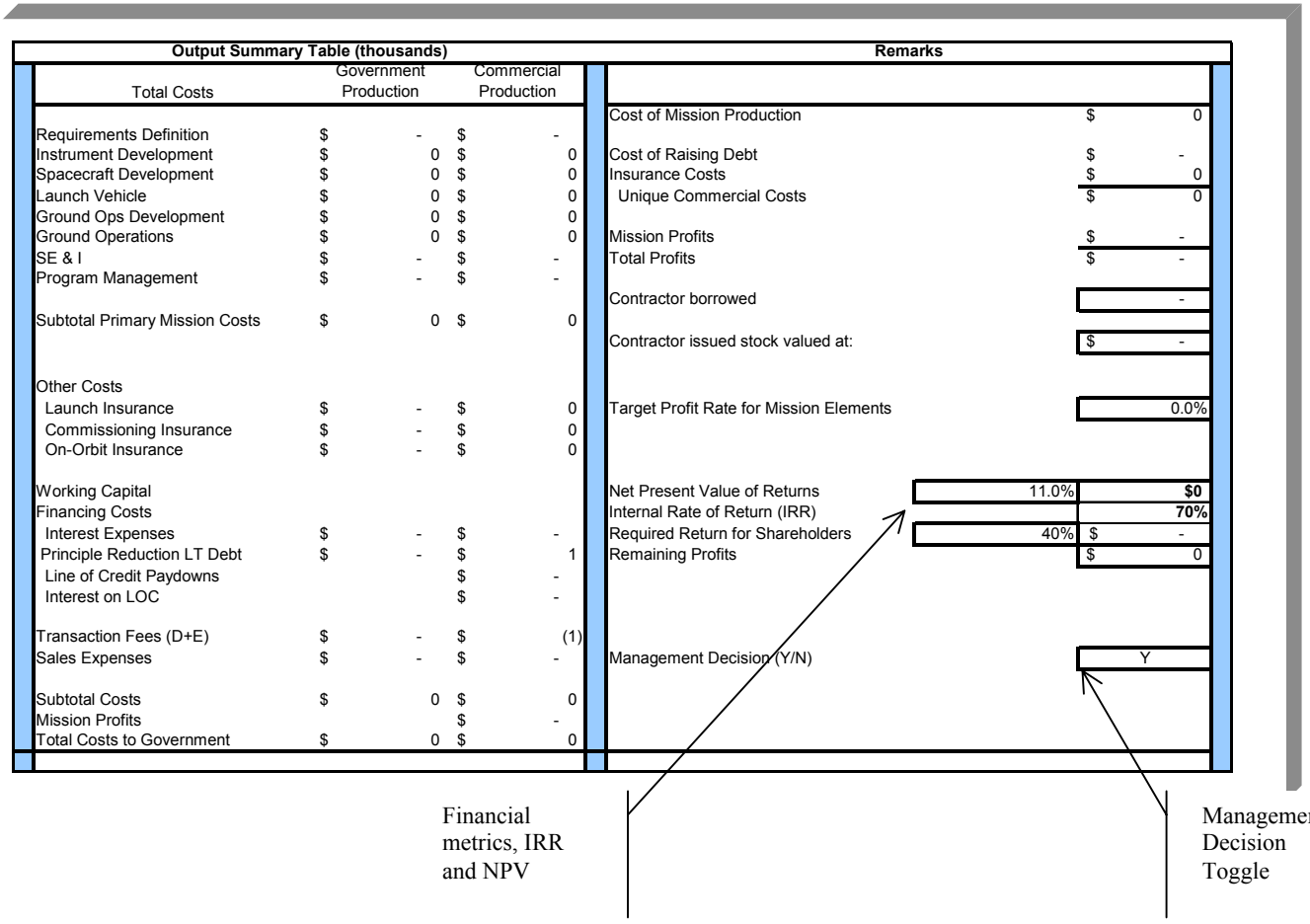
The model has been designed to allow for estimates based on past missions as well as for estimates based on known cost data. One of the major uses of the model is to compare the proposed information once it has been populated into the model with similar data based on NASA databases. Percentages for each major sub-element have been identified, and when chosen for use in Step 1, cost spreads based on these estimates can be used to compare with the proposed data.

The model will automatically populate the **Government Build Estimate** sheet with the same mission specific data as on the Commercial Build Estimate. The differences between the two sheets are the identified and quantified unique commercial costs. The sheet titled, **Government Build Actuals** is a sheet requiring user inputs. It is designed for inputting the costs that would be incurred if the mission were to be developed and operated by the Government. There is also a sheet entitled **Commercial Build Actuals** which is designed for the user to input actual proposed data from the contractor. The model allows for numerous methods for analyzing the data that is proposed. In summary:

- **Government Build Estimate** is populated with the same mission specific data as the **Commercial Build Estimate** sheet.
- **Government Build Actuals** is not automatically populated and requires user inputs.
- **Commercial Build Estimate** is populated with the same mission specific data as the **Government Build Estimate** but also includes the unique commercial costs such as insurance, the cost of debt, transaction fees, sales expenses and other costs not normally born by a Government only mission.
- **Commercial Build Actuals** is not automatically populated, and requires user inputs which he/she will incorporate from proposed data.
- The **Commercial Build Estimate** sheet can be used to compare the contractor's approach to the mission with the Government's own estimate for the approach.
    - For example, did the contractor imply that the spacecraft can be built in one year, while NASA records imply that development under one year is very difficult to attain and therefore cannot be used for a high technology system.

Summary Data

The model also provides certain financial metrics that can be used to compare with business plans from the contracting firms. Two metrics, Net Present Value (NPV), and Internal Rate of Return (IRR) are calculated based on the net cash flows that the mission profile produces. The NPV is also a hurdle rate when compared with the shareholder's expectations. Note that in Step 7, the NPV is calculated based on expected returns for the amount of equity secured. The NPV metric on the summary table (see below), is compared to expected returns, and provides the data for a Management Decision (Y/N) toggle.



Output Summary Table (thousands)

Total Costs	Government Production	Commercial Production
Requirements Definition	$ -	$ -
Instrument Development	$ 0	$ 0
Spacecraft Development	$ 0	$ 0
Launch Vehicle	$ 0	$ 0
Ground Ops Development	$ 0	$ 0
Ground Operations	$ 0	$ 0
SE & I	$ -	$ -
Program Management	$ -	$ -
Subtotal Primary Mission Costs	$ 0	$ 0
Other Costs		
Launch Insurance	$ -	$ 0
Commissioning Insurance	$ -	$ 0
On-Orbit Insurance	$ -	$ 0
Working Capital		
Financing Costs		
Interest Expenses	$ -	$ -
Principle Reduction LT Debt	$ -	$ 1
Line of Credit Paydowns		$ -
Interest on LOC		$ -
Transaction Fees (D+E)	$ -	$ (1)
Sales Expenses	$ -	$ -
Subtotal Costs	$ 0	$ 0
Mission Profits		$ -
Total Costs to Government	$ 0	$ 0

Remarks

Cost of Mission Production		$ 0
Cost of Raising Debt		$ -
Insurance Costs		$ 0
Unique Commercial Costs		$ 0
Mission Profits		$ -
Total Profits		$ -
Contractor borrowed		-
Contractor issued stock valued at:		$ -
Target Profit Rate for Mission Elements		0.0%
Net Present Value of Returns	11.0%	**$0**
Internal Rate of Return (IRR)		**70%**
Required Return for Shareholders	40%	$ -
Remaining Profits		$ 0
Management Decision (Y/N)		Y

Financial metrics, IRR and NPV

Management Decision Toggle

Figure 13: Summary Table

The Summary Table also provides all total costs of the mission. Mission specific costs are included as well as a summary of the unique commercial costs. In addition to the Summary Table the **Summary** sheet also includes another table that provides fiscal year summaries of the following:

- Total Government Milestones

- Equity Financing
- Debt Financing
- Total Financing
- Cost Expended
- Commercial Sales Revenues
- Net Cash Flows
- Year-end Cash Position
- Net Profit

The figure below is a snapshot of this fiscal year summary table.

Development Cost	$ 0
Launch Cost	$ 0
Ground Ops Cost	$ 0
Total Mission Costs	$ 0

Cost of Insurance	$ 0
Cost of Debt Financing	$ -
Debt Retired	$ 1
Total Non Mission costs	$ 1

Fiscal Year Summary

A	B	C	D	E		F	H	I	J	K	L
Mission Year	Fiscal Year	Total Government Milestones (Source of Revenue and Cash)	Equity Financing (Source of Cash)	Debt Financing (Source of Cash)	Cash from Operations (Source of Cash)	Total Financing (Sources of Cash)	Cost Expended (includes insurance, debt financing)	Commercial Sales Revenues	Net Cash Flows	Year End Cash Position	Net Profit Position (Profit = 0 = Breakeven)
1	FY 03	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	(0)	$ (0)
2	FY 04	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	(0)	$ (0)
3	FY 05	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	(0)	$ (0)
4	FY 06	$ -	$ -	$ -	$ -	$ -	$ (1)	$ -	1	1	$ 1
5	FY 07	$ 0	$ -	$ -	$ -	$ 0	$ 0	$ -	(0)	1	$ (0)
6	FY 08	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	1	$ (0)
7	FY 09	$ -	$ -	$ -	$ -	$ -	$ 1	$ -	(1)	(0)	$ (1)
8	FY 10	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	(0)	$ (0)
9	FY 11	$ -	$ -	$ -	$ -	$ -	$ 0	$ -	(0)	(0)	$ (0)
10	FY 12	$ 9	$ -	$ -	$ -	$ 9	$ 0	$ -	9	9	9
		$ 9	$ -	$ -	$ -	$ 9	$ 0	$ -	9	N/A	9

Figure 14: Fiscal Year Summary Table

Hints

1. Adjust the cost curves when you need to evaluate or change the expenditure profile.
2. The majority of input codes are activated via pull-down menus.
3. The formulas are located on the **Commercial Build Estimate** sheet, so if certain known expenditures are different than what is in the model; go to that sheet to make the necessary adjustments.
4. Cost data can be overwritten from Step 1, so you do not have to manipulate the percentages to get the dollars right.
5. Sales revenue estimates are located on the **Sales Inputs** sheet, which is then fed to the **Inputs** sheet. Do not overwrite the formulas on the Inputs sheet; it will remove the sales estimating flexibility.
6. Cells needing input are shaded in light blue.
7. This model is not and never was designed to duplicate standard financial statements. There are too many unknowns (what will be capitalized, inventory recognition, depreciable assets) to compare the data one for one. It is possible to extract information from financial statements (revenues, capital expenditures and such) to feed into the model, but the model will not produce standard financial statements.
8. Financial metrics such as IRR and NPV are mission or project specific. They are not applicable to the company as a whole, and should not be considered as such.

9. Print areas are all user defined.
10. You must have two functions installed in Excel to calculate the interest associated with debt and the bank line of credit to work. The functions are CUMIPMT (cumulative interest payment) and CUMPRINC (cumulative principle). The functions are listed under the Tools menu under Add-ins. The two Add-ins needed are the Analysis Toolpak and the Solver Add-in.

Glossary of Terms

Model Terms	Model Definition
Cost Element	Cost elements include total costs of the mission, as well as each major sub-component that makes up the cost.
Cost of Financing	Cost of financing includes the Transaction Fee cost (.25% in model), and all associated interest costs for debt and lines of credit. The repayment is not necessarily a cost of financing; rather it is a repayment of debts due.
Interest Payments (RFP Term: Interest Expense)	Costs associated with Long Term debt and Bank Lines of Credit. It is the additional cost expended to account for the receipt of funds through sources outside of the contracting firm.
Debt Servicing	Includes costs associated retiring long term debt needed for mission fulfillment.
Debt to Equity	A ratio of the company's debt load / stockholders' equity. This ratio measures the firm's capital structure with respect to debt and equity levels. There are benefits to both types of financing. Debt financing provides a tax benefit providing that the firm is profitable. Interest expenses are tax deductions. Equity financing does not bear additional costs such as interest, but does bear shareholder expectations. To satisfy shareholders, certain positive cash flows must be maintained to yield a favorable financial position for the mission. The underlying risk of a heavy debt load is if the company cannot make the interest and principle payments in a timely fashion, the holders of the debt can acquire ownership. Equity financing will not result in shareholders' direct ownership of the company, but poor performance will affect the company's stock price, which affects shareholder's wealth, which would then drive the firm's Board of Directors to make changes in the company.
Finance Option Code	A rating of Low, Medium or High that directly affects the interest rates applied to any Long Term debt acquired.
Financial Driver	Cost element in the **Commercial Build** sheet that tracks cash position over the life of the mission.
Government Payments	Milestone payments from the Government.
Ground Operations Development (RFP Term: Ground System Development)	Includes costs for items such as engineering telemetry and science data acquisition, transmission, processing and storage; design and development of the ground system; integrating the flight and ground data system and performing interface and end-to-end tests; documenting and analyzing test results
Ground Operations (RFP Term: Operations and Data Processing)	Costs associated with running the ground station including costs for the flight operations team, flight dynamics support and data processing, archive and distribution as well as associated costs required to plan and execute scientific objectives, such as observatory navigation, control, pointing, and spacecraft health monitoring.
Ground Support Equipment (GSE)	A cost sub-component of both Ground Operations Development and Ground Operations. The cost to procure the equipment is included, but the associated depreciation is not considered.
Insurance Expenses	Includes costs associated with launch service, commissioning, and on-orbit costs associated with insuring the spacecraft, instruments, and launch service through the on-orbit period.
Launch	This insurance covers the period from development and through actual launch of the satellite, and is tied to the cost of the spacecraft, the instrument and the launch service.

Model Terms	Model Definition
Commission	Post launch and through the one-month satellite check-out period.
On-Orbit (includes liability)	Insurance cost for the first year of on-orbit operations, includes a liability premium in case the spacecraft drops from orbit in a populated are.
Launch Vehicle (Launch Services)	Includes the costs for the launch vehicle, the spacecraft to launch vehicle integration, and placement of craft into designated orbit, analysis, post-flight mission data evaluation, payload processing, and mission unique hardware.
Instruments	Costs associated with the design, development, fabrication, hardware, software; launch support, on-orbit checkout and activation as well as documentation required for the scientific instruments. **Costs incurred for integration of the instruments to the spacecraft are included in this cost element for the model only. The RFP requests the data in another cost section "Observatory Integration and Test".**
Spacecraft	Costs associated with the design, development, fabrication, hardware, software; launch support, on-orbit checkout and activation as well as documentation required for the spacecraft. **Costs for integration and test are included in this cost element for the model only. The RFP requests the data in another cost section "Observatory Integration and Test".**
System Engineering	Costs associated with ensuring the technical performance of the mission components and overall system during development, launch and orbit checkout and activation. It is the project-level engineering required to ensure that all observatory functions properly achieve system requirements. Examples are engineering trade studies, review and evaluation of preliminary and detailed designs, performance of risk assessments, review of test plans, procedures and results, and to ensure that the electrical, mechanical and thermal performance specifications and interfaces are achieved.
Long Term Notes	An obligation having a maturity of more than one year from the date it was issued. The terms and amounts for Long Term notes can be picked by the user and includes 3,4,5,6, and 7 year durations.
Net Cash Position	Running cash position of the difference between sources of cash and the cash expended for development and operations.
Profits	Profits are a result of the mission revenues and expenses. Unlike a standard Government project, there is no negotiated fee or profit rate. Rather the profit is a result of the financial scenario.
Program Management (RFP Term: Project Management)	Costs such as labor, materials and other costs associated with managing the spacecraft system; resources such as workforce, financial management and schedule management; safety and mission assurance. This should include all efforts associated with project level planning and directing of prime and subcontractor efforts and interactions.
Running Financial Requirements	Identifies the financing needs throughout the life of the mission.
Sources of Finances	Sources include Government milestone payments, debt proceeds, equity proceeds, operating capital, bank line of credit receipts and revenues from commercial sales.
Spacecraft Development	Cost to procure, manufacture, integrate and test the spacecraft. Includes all non-recurring, recurring, engineering development units, as well as flight units.
Total Costs (TC)	Summation all costs associated with development as well as other costs indirectly associated with the development and operation of the spacecraft.
Total Price	Total cost plus profit – note that this is more appropriate for standard government buys and is not applicable to commercial ventures.

Notes