CHAPTER 23

LIFE-CYCLE COST ESTIMATE

1. INTRODUCTION

Life-cycle costs (LCCs) are all the anticipated costs associated with a project or program alternative throughout its life. This includes costs from pre-operations through operations or to the end of the alternative. This chapter contains a discussion of life-cycle costs and the role they play in planning. Further information about the discount rates to be used in LCC analysis can be found in OMB Circular A-94, "Economic Analysis."

2. LIFE-CYCLE COST ANALYSIS

LCC analysis has had a long tradition in the Department of Defense. It has been applied to virtually every new weapon system proposed or under development. Industry has used LCC to help determine which product will cost less over the life of a product. For example, an R&D group has two possible configurations for a new product. Both configurations have the same R&D. One product has a lower manufacturing cost, but higher maintenance and support costs. LCC analysis can help to make decisions about which alternative has the lowest LCC.

A. Definition

LCC analysis is the systematic, analytical process of evaluating alternative courses of action early on in a project, with the objective of choosing the best alternative to employ scarce resources. The courses of action are for the entire life of the project and are not for some arbitrary time span (e.g, the 5-year plan). Figure 23-1 shows the stages of life-cycle cost over the life of a building.

By applying the principles of LCC analysis, it is possible to evaluate several building designs and select the one with the lowest LCC.

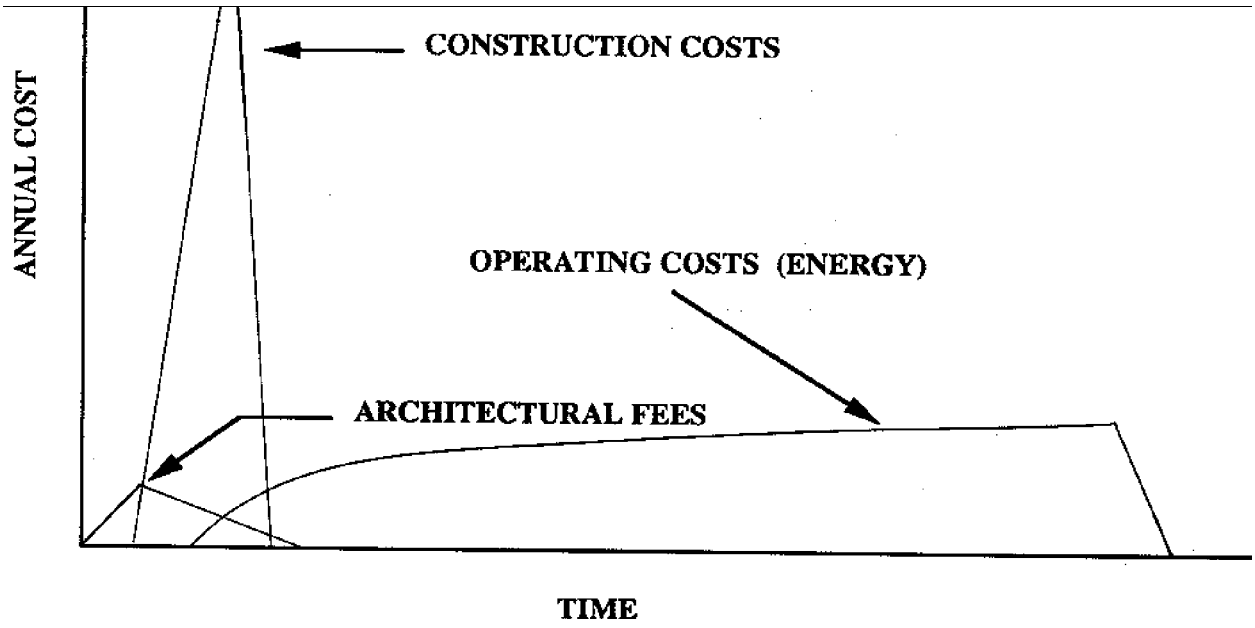

Figure 23-1. Stages of LCC

B. Process

LCC analysis is employed to evaluate alternative design configurations, alternative manufacturing methods, alternative support schemes, etc. The LCC process includes—

- defining the problem or project (scope),
- defining the requirements of the cost model being used,
- collecting historical data/cost relationships/cost data,
- defining the schedule, and
- developing the estimate and analyzing the results.

A successful LCC application will—

- forecast future resource needs, which when evaluated can identify potential problems or impacts;

- influence R&D or preliminary design decision making; and

- support future strategic planning and budgeting.

C. Limitations

LCC analyses limitations include—

- estimating early in the life of a project when the degree of accuracy has a broad range,
- assuming that the alternative has a finite life cycle,
- that the high cost to perform the LCC analysis may not be appropriate for all projects, and
- a high sensitivity to changing requirements.

D. Common Errors Made in Life-Cycle Cost Analysis

LCC analysis is an integral part of strategic planning. Therefore, we need to understand the common errors made during LCC analysis so effective decisions can be made. The following lists some of the common errors made when performing LCC analysis that could affect the outcome:

- omission of data,
- lack of a systematic structure or analysis,
- misinterpretation of data,
- wrong or misused estimating techniques,
- a concentration of wrong or insignificant facts,
- failure to assess uncertainty,
- failure to check work,
- estimating the wrong items, and
- using incorrect or inconsistent escalation data.

E. Typical System Profile

LCC analysis must be performed early in a project's life, or it loses its impact to make a cost effective decision on which alternative is best. Figure 23-2 shows that at the end of R&D, just prior to production or operations, 95% of the cumulative LCC has been committed.

Figure 23-3 is based on a typical DOD communication system acquisition profile. It shows that for each $7 to $12 that is put into R&D, $27 to $28 go for production, and $60 to $66 go for operation and support. Since most of the LCC is the operational support, it is evident that, for LCC to be effective, it must be implemented early in the program.

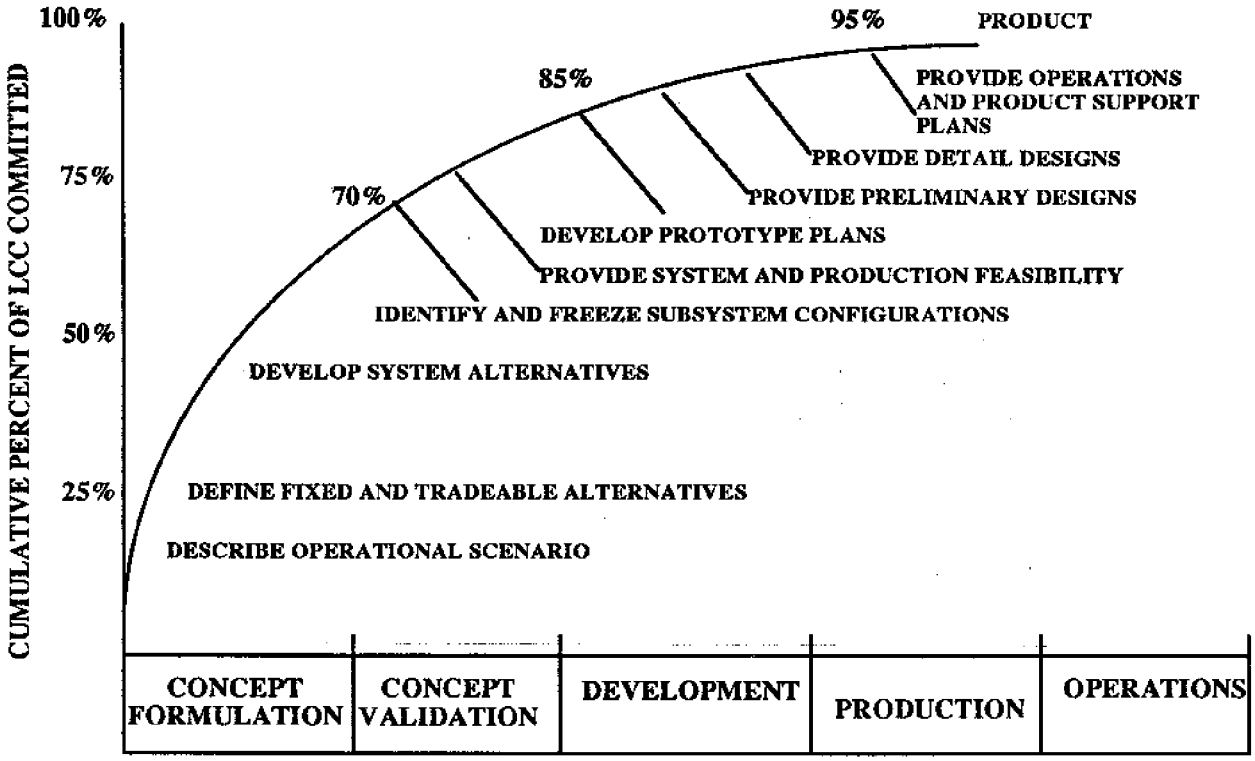

Figure 23-2. Actions Affecting LCC

F. Life-Cycle Cost Analysis Methods

LCC analysis consists of defining the LCC of each element and reducing each element cost to a common basis. Section 2 has discussed the definition of LCC. This section discusses the methods of reducing the LCC to a common basis using present worth calculations.

In LCC analysis, escalation and discount rates must be considered. The most used method of LCC analysis uses the net present worth method. In this method, costs are estimated in current dollars, escalated to the time when they would be spent, and then corrected to a present worth using a discount rate. When the inflation and discount rates are equal, LCC can be computed as current dollars, totaled for the project life and compared. When the escalation and discount rate are different, the escalation and present worth calculations must be performed. The following example assumes that the discount and escalation rates are different.

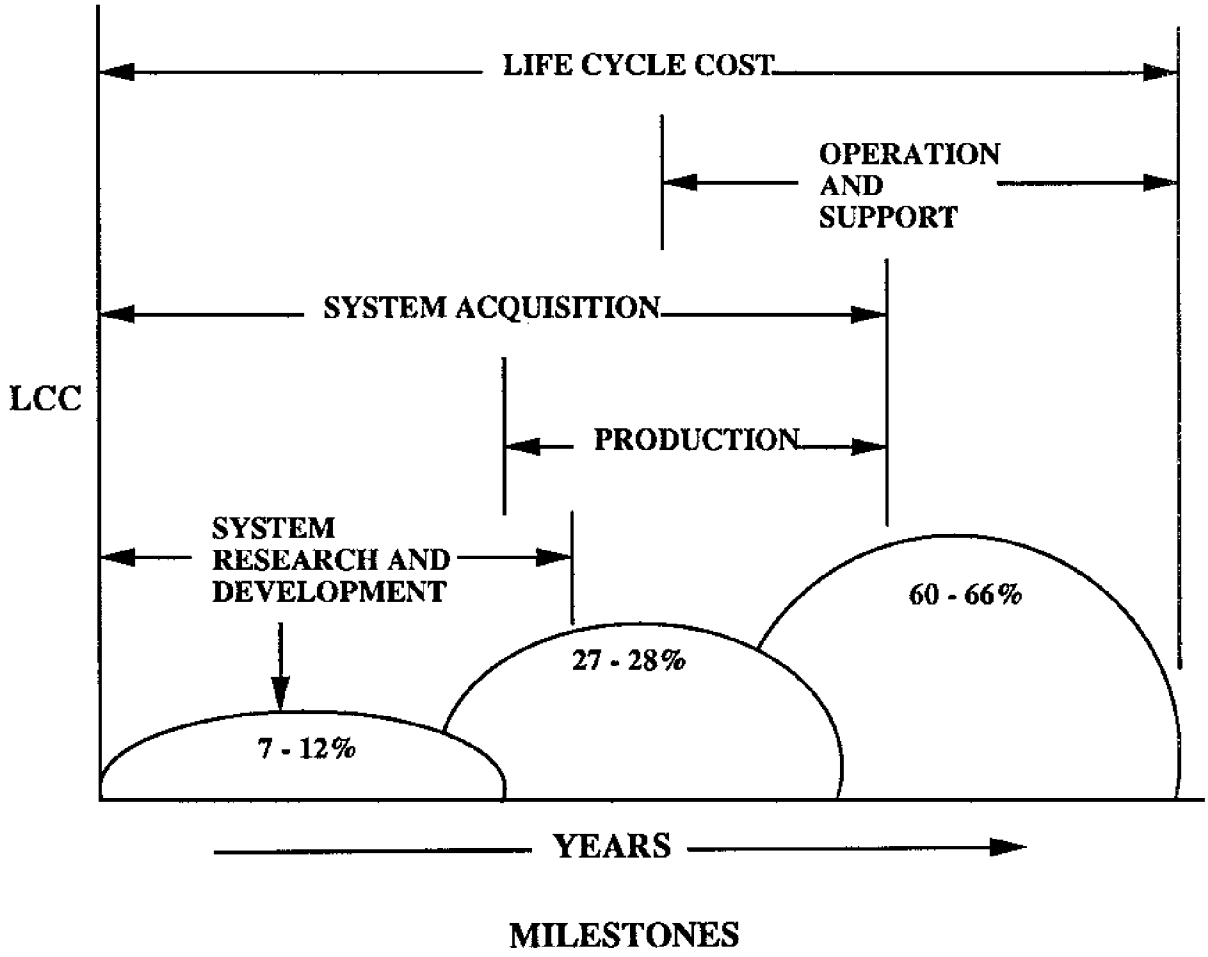

Figure 23-3. LCC Profile for System Acquisition

G. Example Life-Cycle Cost Analysis

The purchase of an automobile is given as a short simplified example of LCC analysis.

1. Definition of Scope:

Buyer wants to purchase an automobile.

Buyer has sufficient funds to purchase an automobile up to $25,000.

Definitive features are miles per gallon, estimated salvage value, costs of licenses and inspections, insurance, and estimated maintenance costs.

2. Assumptions:

All money is spent at the end of a year for a given year.

Buyer will trade the car in after four years.

All models use the same grade of gasoline at $1.25 per gallon.

The user drives 22,000 miles per year.

Discount rate is 10 percent.

Prices escalate 4 percent per year.

Insurance costs escalate 3 percent per year.

Salvage value is in dollars at the time of salvage.

3. Data collected:

CAR A: Purchase price of the car is $17,000, fuel usage is 24 miles per gallon, recommended maintenance is every 5,000 miles or 3 months, the average maintenance cost is estimated to be $250, and salvage value is $8,000.

CAR B: Purchase price of the car is $24,000, fuel usage is 26 miles per gallon, buyer would receive a dealer's special service package, which would give him free maintenance and service for the 4 years with unlimited mileage, and the salvage is $14,000.

CAR C: Purchase price of this used auto is $13,000, fuel usage is 15 miles per gallon, recommended maintenance is every 10,000 miles or 6 months and initial cost of $800 is estimated to remedy some problems, the average maintenance cost is estimated to be $350, and the salvage value is $5,000.

CAR D: Purchase price of the car is $11,000, fuel usage is 18 miles per gallon, recommended maintenance is every 7,500 miles or 5 months, and the average maintenance cost is estimated to be $125.00. The salvage value is $4,500. Installation cost of natural gas system is $3,200.

The following can be summarized:

	CAR A	CAR B	CAR C	CAR D
Purchase price	$17,000	$24,000	$13,000	$11,000*
Salvage value	($8,000)	($14,000)	($5,000)	($4,500)
Miles/Gallon	24	26	15	18
Miles Btwn Tune ups	5,000	5,000	10,000	7,500
Insurance/Year	$950	$1,350	$800	$700
SOLUTION:				
Initial cost	$17,000	$24,000	$13,000	$14,200
Salvage	($6,010)	($10,518)	($3,757)	($3,381)
Total Annual Costs (4 Yrs)	$11,595	$8,805	$12,243	$8,489
TOTAL	$22,585	$22,287	$21,486	$19,308

* Plus $3,200 initial cost of system.

From this LCC analysis, Car D is the most economical for the buyer. From this simplified LCC analysis its benefits and purpose can be recognized.

SUPPORTING CALCULATIONS FOR ANNUAL COSTS:

For converting the future values to present worth, a uniform capital recovery (UCR) factor will be applied. Using 10 percent rates, the UCR for the years 2, 3, and 4 are as follows.

UCR Year 2 (one year of capital recovery) $\frac{1}{(1 + .1)^1} = .9091$

UCR Year 3 (two years of capital recovery) $\frac{1}{(1 + .1)^2} = .8264$

UCR Year 4 (three years of capital recovery) $\frac{1}{(1 + .1)^3} = .7513$

FUEL

CAR A: 22,000 miles/24 miles per gallon = 917 gallons x $1.25/gallon = $1,146 for year one

	Action Costs		**Present Worth**
$1,146 for year one		x 1	= $1,146
$1,146 x 1.04	= $1,192 for year two	x .9091	= $1,084
$1,192 x 1.04	= $1,240 for year three	x .8264	= $1,025
$1,240 x 1.04	= $1,290 for year four	x .7513	= $969
Total - Car A:	$4,868		$4,224

CAR B: 22,000 miles/26 miles per gallon = 846 gallons x $1.25/gallon = $1,058

	Actual Cost		**Present Worth**
$1,058 for year one	= $1,058 for year one	x 1	= $1,058
$1,058 x 1.04	= $1,100 for year two	x .9091	= $1,000
$1,100 x 1.04	= $1,144 for year three	x .8264	= $945
$1,144 x 1.04	= $1,190 for year four	x .7513	= $894
Total - Car B:	$4,492		$3,897

CAR C: 22,000 miles/15 miles per gallon = 1,467 gallons x $1,25/gallon = $1,834

	Actual Cost		**Present Worth**
$1,834 for year one	= $1,834 for year one	x 1	= $1,834
$1,834 x 1.04	= $1,907 for year two	x .9091	= $1,734
$1,907 x 1.04	= $1,983 for year three	x .8264	= $1,639
$1,983 x 1.04	= $2,062 for year four	x .7513	= $1,549
Total - Car C:	$7,786		$6,756

CAR D: 22,000 miles/18 miles per gallon = 1,222 gallons x $0.79/gallon = $965

	Actual Cost		**Present Worth**
$965 for year one	= $ 965 for year one	x 1	= $ 965
$965 x 1.04	= $1,004 for year two	x .9091	= $ 913
$965 x 1.04	= $1,044 for year three	x .8264	= $ 863
$964 x 1.04	= $1,086 for year four	x .7513	= $ 816
Total - Car D:	$4,099		$3,557

MAINTENANCE

22,000 miles per year x 4 years = 88,000 miles

CAR A: 88,000 miles/5,000 miles per maintenance = 17.6 (use 17 maintenance visits since the last one will be at the end of ownership).

This equates to 4.25 maintenance visits per year.

	Actual Cost		**Present Worth**
$1,063 for year one	= $1,063 for year one	x 1	= $1,063
$4.25 x $250	= $1,106 for year two	x .9091	= $1,005
$1,106 x 1.04	= $1,150 for year three	x .8264	= $ 950
$1,150 x 1.04	= $1,196 for year four	x .7513	= $ 899
Total - Car A:	$4,515		$3,917

CAR B:

$0

CAR C: 88,000 miles/10,000 miles per maintenance = 8.8 (use 8 maintenance visits since the last one will be at the end of ownership).

This equates to 2 maintenance visits per year of ownership.

	Actual Cost		**Present Worth**
$350/maint. x 2	= $ 700 for year one	x 1	= $ 700
$700 x 1.04	= $ 728 for year two	x .9091	= $ 662
$728 x 1.04	= $ 757 for year three	x .8264	= $ 626
$757 x 1.04	= $ 787 for year four	x .7513	= $ 591
Total - Car C:	$2,972		$2,579

CAR D: 88,000 miles/7,500 miles per maintenance = 11.7 (use 11 maintenance visits since the last one will be at the end of ownership).

This equates to 2.75 maintenance visits per year.

	Actual Cost		Present Worth
$125/maint. x 2.75	= $ 344 for year one	x 1	= $ 344
$344 x 1.04	= $ 358 for year two	x .9091	= $ 325
$358 x 1.04	= $ 372 for year three	x .8264	= $ 307
$372 x 1.04	= $ 387 for year four	x .7513	= $ 291
Total - Car D:	$1,461		$1,267

INSURANCE

CAR A:

	Actual Cost		Present Worth
$ 950 for year one		x 1	= $ 950
$ 950 x 1.03	= $ 979 for year two	x .9091	= $ 890
$ 979 x 1.03	= $1,008 for year three	x .8264	= $ 833
$1,008 x 1.03	= $1,039 for year four	x .7513	= $ 781
Total - Car A:	$3,976		$3,454

CAR B:

	Actual Cost		Present Worth
$1,350 for year one		x 1	= $1,350
$1,350 x 1.03	= $1,391 for year two	x .9091	= $1,265
$1,391 x 1.03	= $1,433 for year three	x .8264	= $1,184
$1,433 x 1.03	= $1,476 for year four	x .7513	= $1,109
Total Ins. - Car B:	$5,650		$4,908

CAR C:

	Actual Cost		Present Worth
$ 800 for year one		x 1	= $ 800
$ 800 x 1.03	= $ 824 for year two	x .9091	= $ 749
$ 824 x 1.03	= $ 849 for year three	x .8264	= $ 702
$ 849 x 1.03	= $ 874 for year four	x .7513	= $ 657
Total - Car C:	$3,347		$2,908

CAR D:

	Actual Cost		Present Worth
$ 700 for year one		x 1	= $ 700
$ 700 x 1.03	= $ 721 for year two	x .9091	= $ 655
$ 721 x 1.03	= $ 743 for year three	x .8264	= $ 614
$ 743 x 1.03	= $ 765 for year four	x .7513	= $ 575
Total - Car D:	$2,929		$2,544

SALVAGE

	Actual Cost		Present Worth
CAR A	$ 8,000	x .7513	= $ 6,010
CAR B	$14,000	x .7513	= $10,518
CAR C	$ 5,000	x .7513	= $ 3,757
CAR D	$ 4,500	x .7513	= $ 3,381

The purchase of an automobile was chosen as an example of an LCC estimate to present an annual and fixed cost comparison. The use of this simplified LCC analysis demonstrates the vital role LCC analysis plays in evaluating alternative courses of action.