COURSEWARE FOR SYSTEMS ANALYSIS AND EVALUATION

Economy 2.0
MPF Cost 2.0
LCC Calculator
REPS Optimization

Courseware developed within the Systems Engineering Design Laboratory (SEDL)
Department of Industrial and Systems Engineering (ISE)

Virginia Polytechnic Institute and State University
ECONOMY 2.0 is an integrated software package for engineering economic analysis. It is composed of twelve modules. Major functions of the package include interest formula calculations, cash flow analysis, bond analysis, loan analysis, bases for comparison, forming mutually exclusive alternatives, replacement analysis, benefit-cost analysis, optimization analysis, after-tax analysis, and sensitivity analysis. The concepts and models behind the software are based on ENGINEERING ECONOMY, Eighth Edition, Prentice Hall, 1993, by Thuesen and Fabrycky.

ECONOMY 2.0 may be duplicated and distributed to students without restriction for educational purposes.

This software runs on IBM or IBM compatible personal computers using the DOS operating system. No computer background or prior experience is needed. If you have any questions, comments, or suggestions, please write: Systems Engineering Design Laboratory, Attention: ECONOMY 2.0, 146 Whittemore Hall, Virginia Tech, Blacksburg, Virginia, 24061. Instructors may call SEDL at (703) 231-6464 for immediate attention.

To start ECONOMY, type ECON at the A prompt. Example: A>ECON

The following screen will appear:

<table>
<thead>
<tr>
<th>MODULES OF ECONOMY 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interest Formula Calculations</td>
</tr>
<tr>
<td>2. Cash Flow Analysis</td>
</tr>
<tr>
<td>3. Bond Analysis</td>
</tr>
<tr>
<td>4. Loan Analysis</td>
</tr>
<tr>
<td>5. Bases for Comparisons</td>
</tr>
<tr>
<td>6. Mutually Exclusive Alternatives</td>
</tr>
<tr>
<td>7. Replacement Analysis</td>
</tr>
<tr>
<td>8. Benefit-Cost Analysis</td>
</tr>
<tr>
<td>9. Optimization Analysis (Bridge)</td>
</tr>
<tr>
<td>10. Optimization Analysis (Conductor)</td>
</tr>
<tr>
<td>11. After-Tax Analysis</td>
</tr>
<tr>
<td>12. Sensitivity Analysis</td>
</tr>
<tr>
<td>13. Quit</td>
</tr>
</tbody>
</table>

Enter choice:

Credits

ECONOMY originated with students enrolled in the honors sections of Engineering Economy in 1983 and 1984 under the guidance of Dr. W. J. Fabrycky, Department of Industrial and Systems Engineering, Virginia Polytechnic Institute and State University. Improvements have been contributed by Engineering Economy students since then.

Version 2.0 of ECONOMY was organized and edited by Dr. Chunming Duan and Brennan Bowen. Other contributors include Mona Behrend, Ron Branch, Michael Eldred, Jennifer Fraser, Kevin Hom, James Jennings, William Johnson, Matt Maier, and Ann Tien.
ECONOMY 2.0 USERS GUIDE

This guide to the ECONOMY software is written to parallel Thuesen and Fabrycky's ENGINEERING ECONOMY, Eighth Edition, Prentice Hall, 1993. The guide covers chapters in the book for which the ECONOMY modules are applicable. Within each chapter of this guide, the applicable modules are introduced and then a few problems from ENGINEERING ECONOMY are solved using ECONOMY 2.0 software.

As problems are worked using the software modules, the following key will be used: boxes will represent the computer screen. Of the characters on the computer screen, normal characters will represent program output and bold characters will represent user input. Statements in italics do not actually appear on the computer screen during software execution. These statements are provided to clarify and explain what appears on the screen.

An example:

Choose a function:

1. Word Processor (Since you wish to use ECONOMY 2.0 choose 4).
2. Spread Sheet
3. Games
4. Economy 2.0

Your Choice: 4

(Name of Software Module)

The ECONOMY software is provided on one 720 K, 3.5" diskette. To ready the software for use on 5.25" diskettes, separate the files as follows:

Disk One (283 K):

Formcalc.exe - Interest Formula Calculations
Cashflow.exe - Cash Flow Analysis
Bondcalc.exe - Bond Analysis
Loancalc.exe - Loan Analysis
Compare.exe - Bases for Comparison
MEA.exe - Mutually Exclusivne Alternatives
Brun.exe - Microsoft (R) QuickBasic Compiler Runtime Version 4.5

Disk Two (177 K):

Replace.exe - Replacement Analysis
Bencost.exe - Benefit-Cost Analysis
Bridgopt.exe - Optimization Analysis (Bridge)
Cnndopt.exe - Optimization Analysis (Conductor)
Aftertax.exe - After-tax Analysis
Sensitiv.exe - Sensitivity Analysis
Brun.exe - Microsoft (R) QuickBasic Compiler Runtime Version 4.5

Econ.exe and Helvb.fon cannot be used when dividing the ECONOMY modules onto two diskettes. To run a module, the user must enter the module filename at A>.
MPFCOST 2.0 COURSEWARE

MPFCOST assists in the estimation of item cost and in resolving the Manufacturer or Purchase decision. The manufacturing progress function may be determined from two or more data points and item cost derived based on direct labor hourly cost, material cost, and the overhead rate. Item cost sensitivity changes in a number of input factors may then be studied. Finally, the Manufacturer or Purchase options may be explored under various assumptions.

To start MPFCOST, type MPF at the A prompt. Example: A>MPF

MPFCOST 2.0 functions are as follows:

1. MPF determination from empirical data

The user can determine the manufacturing progress function parameters from empirical data. MPFCOST then performs linear regression in the log-log field to determine the slope parameter and extrapolates the direct labor hours for the first unit. These values are retained in the program for use with other menu options.

2. Find direct labor hours

The user can determine the direct labor hours for Unit N, cumulative direct labor hours including Unit N, and the cumulative average direct labor hours per Unit N. These calculations can be performed based on parameters values derived from empirical data or other parameters as defined by the user.

3. Determine item cost and sensitivity

This function allows the user to determine item cost and perform a sensitivity analysis on item cost over the following parameters: production amount, production rate, direct labor hours for first unit, slope parameter, direct labor cost, direct material cost, overhead rate, or interest rate.

4. Compare Manufacturer and Purchase options

This function allows the user to compare the make versus buy option by calculating the break-even point between make and buy. This break-even point is then compared to the quantity needed to determine whether to make or buy.

5. Exit program
SECTION 1 - THE LCCC PROGRAM

The Life-Cycle Cost Calculator program, LCCC, has been developed to allow the user to build a cost breakdown structure, enter cost data into the structure and modify both the structure and data. The model can be displayed in a summary or detailed format and graphics displays are provided. All or part of the model can be printed in summary or detail mode and the entire model can be saved to disk. Two versions of the program are provided - one, designed for use on faster machines, recalculates the model each time a number is changed. The second version only performs the recalculation when functional modes are changed.

1.1 EQUIPMENT REQUIREMENTS

LCCC is a complex, mathematics intensive program. The performance of the system is directly related to the computer system it is being run on.

The minimum equipment required to run LCCC is an IBM PC compatible computer with 512K of memory and one 360K disk drive. A monochromatic monitor is acceptable. Graphics capability is desirable but not required.

To achieve optimum results, especially with respect to recalculation times and display capabilities, a "286" class IBM compatible computer with colour display and a hard disk is required. The program will automatically use the highest video resolution available. A math co-processor will speed general execution, especially recalculation of the cost model.

Any text printer can be used with the program. Page dimensions can be specified by the user at run time.

1.2 PROGRAM FUNCTIONALITY

1.2.1 COST MODEL

The heart of the program is the cost model. The components of the each cost category structure are shown in Table I. At this time, the maximum number of cost periods is limited to forty and the number of categories to fifty. Name fields can hold 20 charcters, including blanks and numeric fields are limited to 12 digits. Categories are classed as one of three types:

1. Project - symbol "P", is reserved for the highest level category, representing the total project cost stream;
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
<td>Char 20</td>
<td>The parent category name.</td>
</tr>
<tr>
<td>Category</td>
<td>Char 20</td>
<td>The name of this category.</td>
</tr>
<tr>
<td>Type</td>
<td>Char 1</td>
<td>The type of category. Either P - Project, C - Cost or R - Revenue.</td>
</tr>
<tr>
<td>Amount</td>
<td>Floating Point Number</td>
<td>Array of current values for each cost period. The zero index value holds the sum of the other elements.</td>
</tr>
<tr>
<td>Discount</td>
<td>Floating Point Number</td>
<td>Array of discounted values for each cost period. The zero index value contains the sum of the other elements.</td>
</tr>
</tbody>
</table>
2. Cost - symbol "C", these categories are the normal incurred costs; and

3. Revenues - symbol "R", are categories representing incoming funds.

Revenue categories have been included to account for offsets to the total life cycle cost from revenues or sales. For example, the salvage value of equipment can be included in the model as a separate cost item. By using revenue categories, especially in the presence of sales or rental income, the LCCC model can be used for a Profit-Loss calculator to assess the commercial viability of a project.

Revenues categories have a side effect on the life cycle cost figure that necessitated a special feature in the display layout of the program. It is possible for one category’s total cost to be greater than the total life cycle cost and therefore, to show more than 100% of the total percentage. This would lead to confusing results on the cost summary screen. Therefore, percentages are not calculated or displayed if revenues are included in the totals. A special function has been provided to mask the presence of revenue categories, leaving only the traditional cost data. When this option is active, the cost percentages are calculated and displayed. The percentages are calculated as required and are not stored as part of the model.

The program contains routines to allow the addition of new categories at the same level as the current one, or as sub-categories of the current category. The deletion of categories is also permitted. The current working level can be set. Access to these functions is described fully under the User Interface section.

1.2.2 DISCOUNTED COST CALCULATION

The discounted cost figure is calculated using the Interest and Inflation rates entered by the user. These rates are used to derive the Inflation Free Interest Rate as follows:

\[ i' = \frac{(1 + i)}{(1 + f)} - 1 \]

where

- \( i' \) = Inflation Free Interest Rate
- \( i \) = Interest Rate
- \( f \) = Inflation Rate
"Discounted Cost" has been used as a generic term due to the multiple connotations that can result from the combinations of Interest and Inflation Rates. For example, entering an actual dollar value and a zero Inflation rate yields \( i' = i \), leaving the discounted cost equal to the actual dollar equivalent cost. If the inflation rate is also entered, the inflation free interest rate results, yielding a discounted figure in constant (Real) dollars. The correct usage depends on the context of the problem. Regardless of the rate used, the discounted amount represents the annual equivalent cost.

1.3 USER INTERFACE

The LCCC program operates in two modes - the Cost Summary screen and the Cost Category screen. This division allows the user to examine the overall distribution of the cost breakdown structure, or to delve into the depths of any category, as desired. Annual data can be reviewed for any category, although modification is limited to the lowest levels.

The primary design goal in the user interface was to keep the interactions between the user and the program as simple as possible. Function keys are used to select between sets of related functions. Only active functions are displayed. This leads to different menu options being available based on the current state of the program. Table II lists the functions and their availability in the two program modes. A complete description of each of the functions is included as Annex B.

1.3.1 SCREEN DESIGN

The basic layout of the LCCC screen is shown in Figure 1. The top line, the Menu area, contains the primary functional groups available. The main screen, used to display the cost data, is the primary interaction area for the program. The Dialogue area is used to present error messages and data entry cues to the user.

Two menu types are used. Pop-down windows are used to display options under the major functional groups. The printer options are set through an overlaid window in the centre of the screen. In both cases, the windows are non-destructive, i.e. the text behind them is restored when the window is removed.

1.3.2 DATA ENTRY PHILOSOPHY

Data entry and option selection in LCCC is as simple and
<table>
<thead>
<tr>
<th>Functional Group</th>
<th>Function</th>
<th>Program Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cost Summary</td>
</tr>
<tr>
<td>File (F1)</td>
<td>Exit</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Load</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Reset</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Save</td>
<td>X</td>
</tr>
<tr>
<td>View (F2)</td>
<td>Category</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Hide Revenues</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Show Revenues</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Zoom In</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Zoom Out</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Zoom Top</td>
<td>X</td>
</tr>
<tr>
<td>Edit (F3)</td>
<td>Add Category</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Add Sub-Category</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Delete Category</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Edit Header Data</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Edit Inflation Rate</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Edit Interest Rate</td>
<td>X</td>
</tr>
<tr>
<td>Print (F4)</td>
<td>Category</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Settings</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>X</td>
</tr>
<tr>
<td>Functional Group</td>
<td>Function</td>
<td>Program Mode</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost Summary</td>
</tr>
<tr>
<td>Graph (F5)</td>
<td>Bar Chart</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Cumulative Chart</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Line Chart</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Pie Chart</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Plot All</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Plot Discounted</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Plot Real</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Stacked Bar Chart</td>
<td>X</td>
</tr>
</tbody>
</table>
consistent as possible. The program recognizes three types of keys: function keys, screen navigation keys and general data entry keys. The navigation keys, being context specific, are discussed in detail under the specific screen modes.

The primary functional groups are selected using the appropriate function key. If an inactive function key is pressed, nothing happens. The sub-function is selected by entering its corresponding letter from the pop-down menu. If a letter not in the menu is selected, an error message is displayed. No other action occurs. Entry can be aborted by pressing the Enter key or any function or navigation key.

Data entry is allowed only in specific areas of the program. If entry is not active, the cursor remains outside a valid data field and pressing a keyboard key, other than a function or active navigation key, has no effect. When data entry is allowed, the cursor is placed in the data area and the keystrokes are echoed to the screen. Two types of entry are possible. Data entry cues are presented in the Dialogue area. Responses to cues are entered following the cue and ended by the Enter key or a function key, although Enter is recommended. The other form is direct data entry, such as in entering cost data in the Cost Category screen. Note that if numeric data is required, characters can be entered but are converted to a zero value. No error message is presented and the resulting number will most likely be in error.

1.3.3 SUMMARY SCREEN

The Cost Category Summary screen, Figure 2, is displayed when the program is in the first functional mode. It is divided into the header data and the cost breakdown areas. The header data includes the screen title, the project name and the file name for this model, if one has been entered. The number of categories and the number of active cost periods are displayed. The latter represents the total life span of the system under study. The Interest and Inflation rates are displayed for easy reference and the current and total page numbers are presented. The number of categories and the total pages are for the entire model, not necessarily for the current level.

The structure of the cost breakdown is shown by the level of indentation of the category name. The type indicates whether this category is a cost or a revenue. The "P" is reserved for the top or project level category. Types "C" and "R" are user selectable. The cost data shows the total life cycle cost for the category.
<table>
<thead>
<tr>
<th>Project</th>
<th>ALTERNATIVE A</th>
<th>&lt;COST SUMMARY SCREEN&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>File Name</td>
<td>COMMA, DBF</td>
<td>Category: 33</td>
</tr>
<tr>
<td>Periods: 13</td>
<td>Interest Rate: 10.0%</td>
<td>Inflation Rate: 0.0%</td>
</tr>
<tr>
<td>P</td>
<td>REAL DOLLARS</td>
<td>DISCOUNTED</td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>1036457.00</td>
<td>6268349.00</td>
</tr>
<tr>
<td>Customer Costs</td>
<td>1243750.00</td>
<td>1566390.50</td>
</tr>
<tr>
<td>System Management</td>
<td>399663.00</td>
<td>329302.12</td>
</tr>
<tr>
<td>Production Planning</td>
<td>47680.00</td>
<td>1193561.27</td>
</tr>
<tr>
<td>Supplier Costs</td>
<td>1476207.00</td>
<td>1193561.27</td>
</tr>
<tr>
<td>Product Planning</td>
<td>53550.00</td>
<td>291307.31</td>
</tr>
<tr>
<td>Design</td>
<td>63590.00</td>
<td>54883.14</td>
</tr>
<tr>
<td>Docs</td>
<td>711048.00</td>
<td>576880.12</td>
</tr>
<tr>
<td></td>
<td>145275.00</td>
<td>118015.62</td>
</tr>
</tbody>
</table>

Figure 2 - Summary Screen Display
Ten rows of data are displayed per page. Since no data can be modified from this screen, the cursor is placed between the Type and Category Name fields. Table III contains descriptions of the active navigation keys. Scrolling is limited to within the active categories on the current page. The <Page Up> or <Page Down> keys must be used to change pages. The cursor returns to the current location on return to the Summary screen from most of the called functions.

1.3.4 CATEGORY SCREEN

To examine or modify the annual cost details of a specific category, the second operating mode - the Category Screen, is used. The screen layout is shown in Figure 3. The header data includes the category name and type as well as its parent category and the number of sub-categories. The total Real and Discounted costs along with the Interest and Inflation Rates are included in the header for convenience.

Two columns of 10 rows are displayed per page. The number of pages available is automatically determined by the maximum number of cost periods available. Two pages are currently allowing. The location of the cursor and the operation of the screen navigation keys is dependent on the number of sub-categories. The navigation keys are listed in Table IV.

Since the annual costs for a category are the sum of the sub-category costs for that period, modification of the data for any category not on the lowest level is not allowed. Any modifications would be overwritten by the calculated value on the next recalculation. Therefore, if a category has sub-categories, the cursor is placed in the upper left corner of the screen and the navigation keys are limited to the <Page Up> and <Page Down> keys. If the category has no sub-categories, the cursor is placed at the left edge of the current Real Cost field. The cursor returns to the current location when most of the available functions are called. It also returns to the current location if the same category is re-entered from the Summary screen.

When updates are allowed, the cursor can be moved to any period, including those beyond the current "Last Period", which normally marks the end of the system life-cycle. Since equipment life is often extended, the ability to lengthen the model life is useful. Entering a non-zero cost in a category beyond the current end automatically sets the Last Period to the new value.
<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;Home&gt;</code></td>
<td>The cursor is moved to the top category on the current page.</td>
</tr>
<tr>
<td><code>&lt;End&gt;</code></td>
<td>The cursor moves to the last category on the current page.</td>
</tr>
<tr>
<td><code>&lt;Up Arrow&gt;</code></td>
<td>The cursor moves up one category. If already at the top of the page, no action occurs.</td>
</tr>
<tr>
<td><code>&lt;Down Arrow&gt;</code></td>
<td>The cursor moves one category down unless it is already at the last active category on the page, at which point it remains in position.</td>
</tr>
<tr>
<td><code>&lt;Left Arrow&gt;</code></td>
<td>See <code>&lt;Up Arrow&gt;</code></td>
</tr>
<tr>
<td><code>&lt;Right Arrow&gt;</code></td>
<td>See <code>&lt;Down Arrow&gt;</code></td>
</tr>
<tr>
<td><code>&lt;Page Up&gt;</code></td>
<td>If the current page is not page 1, the previous page is displayed and the cursor is moved to the first category of the new page. If page 1 is currently being displayed, no action occurs.</td>
</tr>
<tr>
<td><code>&lt;Page Down&gt;</code></td>
<td>If there is another page available below the current one, the new page is displayed and the cursor placed beside the first category on the new page. If there are no more pages, no action occurs.</td>
</tr>
</tbody>
</table>
### Category Screen Display

**ALTERNATIVE A**

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>REAL DOLLARS</th>
<th>DISCOUNTED</th>
<th>PERIOD</th>
<th>REAL DOLLARS</th>
<th>DISCOUNTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>488136.00</td>
<td>443760.00</td>
<td>11</td>
<td>778507.18</td>
<td>272862.03</td>
</tr>
<tr>
<td>2</td>
<td>850221.00</td>
<td>702662.00</td>
<td>12</td>
<td>328442.75</td>
<td>104651.97</td>
</tr>
<tr>
<td>3</td>
<td>1920379.25</td>
<td>1442809.37</td>
<td>13</td>
<td>121816.81</td>
<td>35285.99</td>
</tr>
<tr>
<td>4</td>
<td>1370037.50</td>
<td>935754.06</td>
<td>14</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>1556161.00</td>
<td>966253.56</td>
<td>15</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>483391.75</td>
<td>272862.03</td>
<td>16</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>531730.81</td>
<td>272861.96</td>
<td>17</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>8</td>
<td>584903.87</td>
<td>272861.96</td>
<td>18</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>9</td>
<td>643394.25</td>
<td>272861.96</td>
<td>19</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>707733.68</td>
<td>272861.96</td>
<td>20</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Sub-Categories:** 4  
**Next Higher:** ALTERNATIVE A  
**Life Cycle Cost:** 10364857.00  
**Interest Rate:** 10.0%  
**Inflation Rate:** 0.0%  
**Discounted Cost:** 6268349.00
<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;Home&gt;</code></td>
<td>If data entry is allowed, the cursor is placed in the first entry of the left column on the current page. If entry is not allowed, there is no effect.</td>
</tr>
<tr>
<td><code>&lt;End&gt;</code></td>
<td>The cursor moves to the last category in the right column of the current page if data entry is allowed. If entry is inactive, there is no effect.</td>
</tr>
<tr>
<td><code>&lt;Up Arrow&gt;</code></td>
<td>The cursor moves up one category in the current column. If it is at the top of the right column, it moves to the bottom of the left column. If it is at the top of the left column, no action occurs.</td>
</tr>
<tr>
<td><code>&lt;Down Arrow&gt;</code></td>
<td>The cursor moves one category down unless it is already at the last active category on the right column, at which point it remains in position. If it is at the bottom of the left column it is moved to the top of the right.</td>
</tr>
<tr>
<td><code>&lt;Left Arrow&gt;</code></td>
<td>If the cursor is in the right column, it is moved to the same row in the left. If it is in the left, no action occurs.</td>
</tr>
<tr>
<td><code>&lt;Right Arrow&gt;</code></td>
<td>If the cursor is in the left column, it is moved to the corresponding row in the right. If already in the right, the cursor remains in position.</td>
</tr>
<tr>
<td><code>&lt;Page Up&gt;</code></td>
<td>If the current page is not page 1, the previous page is displayed and the cursor is moved to the first category of the left column on the new page. If page 1 is currently displayed, no action occurs.</td>
</tr>
<tr>
<td><code>&lt;Page Down&gt;</code></td>
<td>If another page is not available below the current one, the new page is displayed and the cursor placed beside the first category in the left column of the new page. If there are no more pages, no action occurs.</td>
</tr>
</tbody>
</table>
SECTION 2 - USING LCCC

2.1 STARTING THE PROGRAM

The first step in using the LCCC program is to select the version suited to the hardware suite. The LCCC.EXE file provides immediate recalculation when a cost value is changed. If this is too slow on your computer, use the LCCPC.EXE file whenever the LCCC command is referred to below.

To start the LCCC program, set the current directory to the directory containing the data files (file extension "DBF"), using the DOS "CD" command. This is required as the LCCC program does not support data path names. Start the program by entering the command "\XXX\LCCC" where XXX is replaced by the disk directory containing the LCCC.EXE file. The program will load, presenting the default Cost Summary screen.

2.2 EXITING FROM THE PROGRAM

To exit from the program use the following key sequence from either the Cost Summary or the Cost Category screen: "<F1>E". A prompt will appear asking if the current model should be saved. Either Y or N must be entered. A "Y" will result in another prompt for the file name. In either case, the program will then clear the screen and return to DOS.

2.3 ACCESSING AN EXISTING CBS

To load or save a CBS file on disk, in LCCC format, use the FILE functions. The LOAD function (<F1>L) will bring in a file, after ensuring that the currently loaded model has been saved, if required. The SAVE function (<F1>S) can be accessed from either screen to save the current model to the specified file at any time. The RESET MODEL function (<F1>R) can be used to discard the current model with or without saving it.

2.4 BUILDING AND MODIFYING A CBS

One advantage of the LCCC structure is the ability to add, delete or modify cost categories interactively as the CBS increases in detail and size through the life of the project.

2.4.1 ADDING A CATEGORY

Adding a new category will insert the new line below the current cursor position, giving the new category the same
Next-Higher as the category at the cursor position. In Figure 2, the cursor is beside the Customer Cost category. Adding a category at this point would insert a new category between the Production Planning and Supplier Cost categories, with R&D as its next-higher category.

To add a new category to the cost breakdown structure, go to the Cost Summary Screen and position the cursor beside the category that the new one is to follow. It is important to be sure that it has the same Next-Higher category (is at the same indentation level on the screen) as that desired for the new category. Select the ADD CATEGORY command (F3>A) and enter the new category name, followed by the type. While entering the entire word "Cost" or "Revenue" is allowed, only the first letter is required. If nothing is entered, the Type will default to "Cost".

The cursor will remain beside the old category. If cost data is to be entered, move the cursor to the new category and proceed as in Section B.3.4.

2.4.2 ADDING A SUB CATEGORY

To add more detail to the CBS, it is necessary to break the categories down into their sub-components. This is done by adding sub-categories to the LCDC data structure. Once one sub-category exists for a category, others can be added following the existing one by using the ADD CATEGORY function (Section B.3.1). To add one to the top of the list, or to add the first one to a category, position the cursor on the category and activate the ADD SUB_CATEGORY function (F3>S). Enter the new name and type in response to the cues. To enter cost data, position the cursor beside the new category and proceed as in Section B.3.4.

2.4.3 DELETING A CATEGORY

To delete a category, place the cursor beside it and press F3>D, the DELETE CATEGORY function. The target category and all of its sub-categories will be removed.

2.4.4 MODIFYING COST DATA

Cost data can only be modified for categories with no sub-categories. To modify the data within such a category, place the cursor beside it and enter the Cost Category screen (F2>C). The cursor can then be placed beside the data to be modified and the new number entered. Use the Enter key to end the entry. If an error is made, use the delete key to back up
to it and re-enter the data. Using an arrow key will terminate the entry, accepting the incorrect data. If a letter is entered by accident, the result will be set to zero. Re-enter the proper data.

2.5 ANALYZING CBS DATA

The analysis of the data can be accomplished by examining the numeric data as presented, or by using the graphics interface to extract the desired information pictorially. LCCC will automatically determine the best graphics mode available, presenting a message if there are problems with either the graphics adaptor or the data to be plotted. Each of the graphics functions is described below. The best way to determine which presentation is best for a particular analysis task is through experimentation.

The CBS data can be sent to a printer using the Print functions. Do not attempt to use these functions if no printer is attached to the computer. The program and DOS action in this case is unpredictable, probably resulting in the termination of the program without the current model being saved.

In the Summary mode, the graphics and print routines act on the category showing in page 1, position 1, known as the current top level category. Use the VIEW functions to change this category.

2.6 FUNCTION DEFINITIONS

This section contains an outline of each of the functions in the LCCC program.

2.6.1 FILE FUNCTIONS

The File functions, activated by the F1 key, allow control of the external data models and the clearing of the current model. The Exit function is also located under this function.

2.6.1.1 Exit (<F1><E>)

The Exit function terminates the program. The user is asked if the current model should be saved. If the response is Yes, the file name is requested, with the current name as a default. The file is saved and the program terminated. If the response is No, the program terminates immediately and all data is lost.
This function is available in both modes.

2.6.1.2 Load (F1>L)

This function is used to load an existing model into the program. The user is asked if the current model is to be saved. If so, the Save function is activated. The user is then asked to enter the name of the new file. If the file name is too long, it is truncated to the first eight characters. If no extension is provided, LCCC appends the default extension of "_.DBF". The file is then opened. If the open is not successful or if the file is not in the correct format for LCCC, an error message is displayed and the load is aborted.

If the file is successfully loaded, the first page of the new model is displayed, including the Interest and Inflation rates, if they were included. If these rates were not stored as part of the file, they are set to zero and the discounted amounts default to the same values as the real dollars. The Show Revenues toggle is also set, hiding the cost percentages.

This function is available only in the Summary mode.

2.6.1.3 Reset (F1>R)

The Reset function clears the current model data including the cost matrix, the Interest and Inflation rates and the file name. The user is asked if the current model should be saved before clearing.

This function is available only in the Summary mode.

2.6.1.4 Save (F1>S)

The Save function takes the current data model and saves it to a dBase III compatible file. The user is asked for the file name to be used, with the current name as a default. The name is trimmed to eight characters and, if no extension is provided, the default of "_.DBF" is appended. The cost model is then saved to the file, including the Interest and Inflation rates.

This function is available in both modes.
2.6.2 VIEW FUNCTIONS

The View functions are used to change the presentation of the data, either between the summary and detail category modes or by changing the level of the current category. The display of revenue categories can also be toggled on and off.

2.6.2.1 Category (<F2><C>)

This function switches the display from the Summary screen to the Category screen. The category at the current cursor location is displayed. If this category was the last one displayed, the cursor will return to its previous location. If this a different category, the cursor goes to the default position.

This option is available only in the Summary mode.

2.6.2.2 Hide Revenues (<F2><H>)

The display of revenue categories can create difficulties with the generation of cost percentages. They also mask the value of the costs figures for categories of which they are a sub-category. Therefore, this function is provided to turn off the display of Revenue categories. Once activated, the screen is refreshed, including the percentage data. The total number of categories figure is not changed. The cursor is set to the first category on page 1.

This function can be used to turn on the cost percentage display for models that do not include revenues.

This option is available only in the Summary mode.

2.6.2.3 Show Revenues (<F2><R>)

If Revenue categories have been hidden or if the cost percentage data is not desired, this option redisplay the model with the Revenues included and no percentages. The cursor is set to the first category on page 1.

This function is available in the Summary Mode only.

2.6.2.4 Summary (<F2><S>)

The Summary function returns the display from the Category to the Summary mode. The model is recalculated and the cursor remains beside the current category.
This function is available in the Category mode only.

2.6.2.5 Zoom In (<F2><I>)

This function is used to set the category at the current
cursor location to the top level category. The screen is
redisplayed showing the new top level category and its sub-
categories. This allows detailed examination of a portion of
the model. If percentages are displayed, they are now in
relation to the new top level category.

This function must be used to change the level for
printout and graphics functions, which start from the current
top level.

This function is available in the Summary mode only.

2.6.2.6 Zoom Out (<F2><O>)

This function is used to back out one category
indentation level. The current category is set to the parent
of the present top level category and the display refreshed.
The cursor is set to the first category on page 1. If the
current top level is the Project category, no action occurs.

This function is available in the Summary mode only.

2.6.2.7 Zoom Top (<F2><T>)

This option provides a shortcut to the Project level
category when the display has been set to any lower level.
The current category is set to the Project category and the
screen refreshed. The cursor is set to the Project category
at line 1 of page 1.

This function is available in the Summary mode only.

2.6.3 EDIT FUNCTIONS

This series of functions is provided to allow changes to
the structure of the data model. Categories can be added or
removed and the category name and type can be edited. The
Interest and Inflation rates can also be changed.

2.6.3.1 Add Category (<F3><A>)

A category is added to the model at the same level as the
current category using this function. The data model is spread immediately following the last sub-category of the category the cursor is next to and the new entry inserted. The parent is set the same as that of the current category. The user is cued for the category name and type. If the entered name is longer than twenty characters, it is truncated to the first twenty. A null entry results in an error message. Blanks and mixed case are allowed within names. Category names can be repeated and are treated as separate entities, allowing the model to contain repeated patterns of cost categories.

This function is available in the Summary mode only.

2.6.3.2 Add Sub-Category (<F3><S>)

This function is used to add a category with the current one as its parent. The model is spread by one and the new category added immediately after its parent. The user is cued for the name and type as for the Add Category function.

This function is available in the Summary mode only.

2.6.3.3 Delete Category (<F3><D>)

This function removes a category and all of its sub-categories from the data model. The screen is redisplayed from the first page, with the cursor returning to the first line.

This function is available in the Summary mode only.

2.6.3.4 Edit Header Data (<F3><H>)

This function allows the user to change the name and/or type of a category. The user is cued to enter the name, which is truncated to twenty characters if more than that many are entered. The type must be "C" for Cost or "R" for Revenue. If the Project category is being edited, the type defaults to "P".

This function is available in the Category mode only.

2.6.3.5 Edit Inflation Rate (<F3><E>)

The Inflation rate for the current model can be edited using this function. The user is cued for the new rate, in percent. The value must be between -99.9 and 99.9. Values
outside this range result in an error message and a repeat of the input prompt.

This function is available in both modes.

2.6.3.6 Edit Interest Rate (<F3><I>)

The Interest rate for the current model can be edited using this function. The user is cued for the new rate, in percent. The value must be between -99.9 and 99.9. Values outside this range result in an error message and a repeat of the input prompt.

This function is available in both modes.

2.6.4 PRINT FUNCTIONS

A set of functions are available to allow the printout of the individual categories as well as the full Summary screen.

2.6.4.1 Category (<F4><C>)

This function prints the currently displayed category. The data is printed in two columns, as shown in Figure 4. The number of items per page will vary with the page length and the number of header lines entered (see Settings). The printout is centred laterally on the page.

This function is available in the Category mode only.

2.6.4.2 Settings (<F4><P>)

This option is used to modify the current printer settings. A special window is displayed in the centre of the screen containing the available options, as shown in Figure 5. The Settings window uses its own set of navigation and function keys. Their use is outlined in Table V.

The number of lines per page and the number of characters per line can be adjusted. If the entered value is less than the minimum required (12 lines, 80 characters), the value is set to the minimum. There are no maximum values, although entering values beyond the capabilities of the system printer will produce unpredictable results.

Up to three lines of header data can be entered. These lines will be centred at the top of the header on all subsequent reports.
The values are not permanently saved and must be entered each time the program is run.

This option is available in both modes.

2.6.4.3 Summary (<F4><S>)

This option prints the Summary screen data as it is currently displayed. The data is centred on the page. The actual number of category records per page will vary with the number of header lines entered (see Settings). A sample printout is shown in Figure 6.

This function is available in the Summary mode only.

2.6.5 GRAPH FUNCTIONS

The ability to display the cost data graphically is essential for the efficient analysis and presentation of the cost data. A variety of graphics displays are available. If possible, they are displayed in colour. Note that no cue is displayed telling the user how to get back to the text screens. This has been done to allow a "clean" presentation of the graphic, suitable for use in a technical presentation. To return to the text screen, press any key.

2.6.5.1 Bar Chart (<F5><B>)

In the Summary mode, a horizontal bar chart of the first level sub-category amounts is displayed, shown in Figure 7. If both real and discounted costs are being displayed, the real is displayed first. Pressing any key brings up the discounted plot. A second keystroke returns the user to the text screen.

In Category mode, the vertical bar chart shown in Figure 8 is displayed, representing the annual costs for the current category. Both costs can be displayed simultaneously.

2.6.5.2 Cumulative Chart (<F5><C>)

This chart, shown in Figure 9, shows the cumulative cost profile for the current category. Both real and discounted data can be shown on the same plot.

This function is available in the Category mode only.
Sample Title Line 1

<<<COST CATEGORY>>>  
ALTERNATIVE A
PROJECT
Interest Rate: 10.0%  
Inflation Rate: 0.0%  
Discounted Cost: 6268349.00

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>REAL DOLLARS</th>
<th>DISCOUNTED</th>
<th>PERIOD</th>
<th>REAL DOLLARS</th>
<th>DISCOUNTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>488136.00</td>
<td>443760.00</td>
<td>9</td>
<td>643394.25</td>
<td>272861.96</td>
</tr>
<tr>
<td>2</td>
<td>850221.00</td>
<td>702662.00</td>
<td>10</td>
<td>707733.68</td>
<td>272861.96</td>
</tr>
<tr>
<td>3</td>
<td>1920379.25</td>
<td>1442809.37</td>
<td>11</td>
<td>778507.18</td>
<td>272862.03</td>
</tr>
<tr>
<td>4</td>
<td>1370037.50</td>
<td>935754.06</td>
<td>12</td>
<td>328442.75</td>
<td>104651.97</td>
</tr>
<tr>
<td>5</td>
<td>1556161.00</td>
<td>966253.56</td>
<td>13</td>
<td>121816.81</td>
<td>35285.99</td>
</tr>
<tr>
<td>6</td>
<td>483391.75</td>
<td>272862.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>531730.81</td>
<td>272861.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>584903.87</td>
<td>272861.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4 - Sample Cost Category Printout

(Note: Printout page length shortened to show column wrapping)
**Figure 5 - Printer Settings Screen Layout**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CATE</th>
<th>Project: AL</th>
<th>File Name: CO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **LINES PER PAGE:** 60
- **CHARACTERS PER LINE:** 80
- **TITLE LINE 1:**
  - 268349.00
  - 566390.50
- **TITLE LINE 2:**
  - 372829.41
  - 329302.12
  - 43527.27
- **TITLE LINE 3:**
  - 193561.00
  - 291307.31
  - 54883.14
  - 576880.12
  - 118015.62

**Printer Settings:**
- **LINES PER PAGE:** 60
- **CHARACTERS PER LINE:** 80
- **TITLE LINE 1:**
  - 268349.00
  - 566390.50
- **TITLE LINE 2:**
  - 372829.41
  - 329302.12
  - 43527.27
- **TITLE LINE 3:**
  - 193561.00
  - 291307.31
  - 54883.14
  - 576880.12
  - 118015.62

**Page:** 1 of 4
**Date:** 0.0%
<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;F1&gt;</td>
<td>Exit from the function, returning to the calling screen.</td>
</tr>
<tr>
<td>&lt;F2&gt;</td>
<td>Set the current field to its default value.</td>
</tr>
<tr>
<td>&lt;Home&gt;</td>
<td>Move the cursor to the Lines per Page field.</td>
</tr>
<tr>
<td>&lt;End&gt;</td>
<td>Move the Cursor to the User Title 3 field</td>
</tr>
<tr>
<td>&lt;Up Arrow&gt;</td>
<td>Move up one field, unless at the Lines Per Page, where no action is taken.</td>
</tr>
<tr>
<td>&lt;Down Arrow&gt;</td>
<td>Move down one field unless at the User Title 3 field, where no action is taken.</td>
</tr>
<tr>
<td>&lt;Left Arrow&gt;</td>
<td>see &lt;Up Arrow&gt;</td>
</tr>
<tr>
<td>&lt;Right Arrow&gt;</td>
<td>see &lt;Down Arrow&gt;</td>
</tr>
<tr>
<td>&lt;Page Up&gt;</td>
<td>no action</td>
</tr>
<tr>
<td>&lt;Page Down&gt;</td>
<td>no action</td>
</tr>
</tbody>
</table>
LCCC Sample Summary Screen Printout

<<COST SUMMARY>>

Project: ALTERNATIVE A
File Name: COMMA.DBF
Categories: 33  Interest Rate: 10.0\%  Page
Periods: 13  Inflation Rate: 0.0\%  1

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CATEGORY</th>
<th>REAL DOLLARS</th>
<th>%</th>
<th>DISCOUNTED</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>ALTERNATIVE A</td>
<td>10364857.00</td>
<td>6268349.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>R&amp;D</td>
<td>1923750.00</td>
<td>1566390.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Customer Costs</td>
<td>447543.00</td>
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<td>System Management</td>
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<td>Production Planning</td>
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<td>Supplier Costs</td>
<td>1476207.00</td>
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<td></td>
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<tr>
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<td>System Test &amp; Eval</td>
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<tr>
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<tr>
<td>C</td>
<td>Customer Costs</td>
<td>337491.00</td>
<td>219534.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>System/Product Mgmt</td>
<td>337491.00</td>
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<tr>
<td>C</td>
<td>Supplier Costs</td>
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<td>2191912.25</td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>I.E. &amp; Op Analysis</td>
<td>210000.00</td>
<td>147326.01</td>
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<td></td>
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<tr>
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<td>2052000.00</td>
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<td></td>
<td></td>
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<tr>
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<td>190909.07</td>
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<td>Technical Data</td>
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<td>126545.45</td>
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<td></td>
</tr>
</tbody>
</table>

Figure 6 - Summary Printout
Figure 7 - Cost Summary Bar Chart
Figure 8 - Category Mode Bar Chart
2.6.5.3 Line Chart (<F5><L>)

The annual cost profiles for the current category are displayed as shown in Figure 10. Both real and discounted data can be shown on the same plot.

This function is available in the Category mode only.

2.6.5.4 Pie Chart (<F5><P>)

The Pie chart shown in Figure 11 is displayed, showing the percentage contributions of the sub-categories of the top level category. The cost figures are shown. If both cost types are being plotted, the first display is for real dollars. Any keystroke will display the discounted pie chart.

This function is available in the Summary mode only.

2.6.5.5 Plot All (<F5><A>), Plot Discounted (<F5><D>), Plot Real (<F5><R>)

These functions set the graphics mode to display the both real, the discounted data, or both. They are available in both modes.

2.6.5.6 Stacked Bar Chart (<F5><S>)

This function displays the annual contributions of the sub-categories of the current category in a stacked bar format as shown in Figure 12. Real and discounted data are shown on consecutive plots.

This function is available in the Summary mode only.
Figure 9 - Category Mode Cumulative Cost Chart
Figure 10 - Category Mode Line Chart
Figure 11 - Summary Mode Pie Chart
Figure 12 - Summary Mode Stacked Bar Chart
WHAT IS REPS-OPT?

REPS-OPT is an integrated menu-driven computer package for optimizing the design of repairable equipment population systems. Developed in C, this package assists the user to identify a best design which meets design requirements at a minimum life-cycle cost.

SYSTEM REQUIREMENTS

The REPS-OPT package is developed for operation on the IBM PC/AT and compatibles. It requires 640k of RAM and an EGA (or VGA) color monitor. REPS-OPT supports MS-DOS 2.1 or later versions. A hard disk is not required to run this package.

FILE ORGANIZATION OF REPS-OPT

The REPS-OPT package contains ten files:

- **READ.ME**: A text file explaining how to use REPS-OPT
- **REPS.EXE**: Executable file for REPS-OPT
- **HELVB.FON**: A file containing font helv
- **BASE.IND**: An input file storing the default setting for design-independent parameters
- **BASE.DEP**: An input file storing the base design
- **BASE.OUT**: An output file storing the base design's optimum setting and outputs
- **ALT_1.DEP**: An input file storing Candidate system 1
- **ALT_1.OUT**: An output file storing the optimum setting and outputs of Candidate system 1
- **ALT_2.DEP**: An input file storing Candidate system 2
- **ALT_2.OUT**: An output file storing the optimum setting and outputs of Candidate system 2
Among these ten files, only REPS.EXE and HELVB.FON are essential to the operation of REPS-OPT.

HOW TO INSTALL REPS-OPT?

No special procedures need to be followed to install the REPS-OPT on your computer. REPS-OPT can be run directly either from a floppy disk or from a hard disk. To run REPS-OPT from a floppy disk, you just insert the disk which contains the files of REPS-OPT into an appropriate disk drive. To speed the operation of REPS, you may create a subdirectory on your hard disk and copy the files of REPS-OPT to that directory.

HOW TO START AND EXIT REPS-OPT?

To start REPS-OPT, select the appropriate drive and subdirectory (if any) as the default. Then type `REPS` and press <Enter> key. The banner screen of REPS-OPT will be shown as below:

---

**REPS - OPT**

A Software Package for Optimizing the Design of Repairable Equipment Population Systems

Systems Engineering Design Laboratory
Department of Industrial and Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
---
To continue, press any key. Then this main menu will be shown:

REPS-OPT FUNCTIONS

1. Introduction to REPS-OPT
2. Enter and Modify Input Parameters
3. Optimize Current Design
4. Review and Evaluate Candidate Designs
5. Quit

Enter choice =>

Five functions are provided on this menu. To select a function, type the number corresponding that function and press <Enter> key. To exit REPS-OPT, select Function 5 (Quit) and press <Enter> key. At any part of the program, you may return to this main menu and select Option 5 to exit.

FUNCTION 1: INTRODUCTION TO REPS-OPT

On the main menu ("REPS-OPT FUNCTIONS"), Function 1 allows you to get familiar with the concepts, terminology, and program structure of REPS-OPT. If you are new to this package, you are encouraged to investigate this function.

If you select Function 1, the following screen will be shown:
INTRODUCTION TO REPS-OPT

1. Concepts of the REPS Model
2. Program Structure
3. Return to Main Menu

Enter choice =>

Three options are provided on this menu. Option 1 gives a brief introduction of the concepts and terminology of the original REPS model. Option 2 presents an overview of the program structure of REPS-OPT. To return to the main menu, select Option 3.

FUNCTION 2: ENTER AND MODIFY INPUT PARAMETERS

This function allows you to prepare inputs for design optimization. Before starting Function 3 (Optimize Current Design), all inputs must be prepared by loading Function 2. After selecting this function, the following screen is shown:

INPUT PREPARATION

1. Design-Independent Parameters
2. Design-Dependent Parameters
3. Return to Main Menu

Enter choice =>

Three options are given on this menu. To return to the main menu, select Option 3.
1. Design-Independent Parameters

This option allows you to input design-independent parameters. The following menu is displayed after you selected the option:

```
INPUT DESIGN-INDEPENDENT PARAMETERS

1. Enter Inputs from Keyboard
2. Load Inputs from a File
3. Load Default Setting
4. Return to Previous Menu

Enter choice =>
```

1) Enter inputs from keyboard

To enter inputs from keyboard, select Option 1 from this menu. Then a data input screen is displayed:

```
INPUT DESIGN-INDEPENDENT PARAMETERS

Demand:

Interest Rate (%):

Shortage Penalty Cost ($/unit/year):

Repair Channel Cost ($/channel/year):
```

<table>
<thead>
<tr>
<th>&lt;Up Arrow&gt;</th>
<th>Next field</th>
<th>&lt;Down Arrow&gt;</th>
<th>Previous field</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;Left Arrow&gt;</td>
<td>Cursor left</td>
<td>&lt;Right Arrow&gt;</td>
<td>Cursor right</td>
</tr>
<tr>
<td>&lt;Del&gt;</td>
<td>Delete a letter</td>
<td>&lt;F10&gt;</td>
<td>Finish editing</td>
</tr>
</tbody>
</table>
There are four input fields on the input screen. Enter your inputs into appropriate fields. To move within a field, use ← and → keys. To delete a character, move the cursor to that character and press <Del> key. To move between fields, use ↑, ↓, <PgUp>, or <PgDn> keys. <Enter> and <Backspace> keys are not activated. After completing data inputs, press <F10> key.

After <F10> key is pressed, the "SAVE INPUTS" screen is displayed:

```
SAVE INPUTS

1. Save the inputs into a new file
2. Save the inputs into the current file
3. Do not save

Enter choice =>
```

Since you are entering new inputs, select Option 1. Then you are asked to give a file name to store the inputs you just entered:

```
Enter the new file name:

Existing Input Files:
BASE.IND
```
To avoid overwriting your existing files, a list of input files for design-independent parameters stored in your disk is displayed in the lower window of the screen. To distinguish from other types of data files, give the file name extension ".ind", which denotes design-independent parameters.

2) Load inputs from a file

If you want to load inputs from an existing input file, select Option 2 from the "INPUT DESIGN-INDEPENDENT PARAMETERS" menu. Then you are asked to give the input file name. A list of existing input files is displayed on the screen for your selection (similar to the last screen shown above). If the input file you give exists, the inputs will be loaded from the file and be displayed on the screen. An example of the screen layout is given below:

```
DESIGN-INDEPENDENT PARAMETERS

Demand (units) : 15
Interest Rate (%): 10.00
Shortage Penalty Cost ($/unit/year) : 73000
Repair Channel Cost ($/channel/year): 45000

Input File: base.ind
To use the inputs directly, press 'U'
To modify the inputs, press 'M'
```

If you want to use the inputs as shown on the screen for design optimization, enter character U or u. To modify the inputs, enter character M or m. If M or m is pressed, you move to the input edit screen. The edit screen is similar to that for "Enter Inputs from Keyboard":

7
Demand: 15

Interest Rate (%): 10.000

Shortage Penalty Cost ($/unit/year): 73000.00

Repair Channel Cost ($/channel/year): 45000.00

When you finish editing, press <F10> key. Then the "SAVE INPUTS" screen is displayed:

SAVE INPUTS

1. Save the inputs into a new file
2. Save the inputs into the current file
3. Do not save

Enter choice =>

To save the inputs you just modified into a new file, select Option 1. To save the modified inputs into the same file from which the old inputs are loaded, select Option 2. If you do not want to save the modifications, select Option 3.
3) Load default setting

The default setting for design-independent parameters is saved in "BASE.IND". Selecting this option will load "BASE.IND" for optimization.

2. Design-Dependent Parameters

The organization of input screens for design-dependent parameters is the same as that for design-independent parameters. If you are already familiar with the process of preparing inputs for design-independent parameters, you may skip this part of the User's Guide and read "FUNCTION 3: OPTIMIZE CURRENT DESIGN".

As with inputting design-independent parameters, you are provided with four options on this screen to input design-dependent parameters:

```
INPUT DESIGN-DEPENDENT PARAMETERS

1. Enter Inputs from Keyboard
2. Load Inputs from a File
3. Load Default Setting
4. Return to Previous Menu

Enter choice =>
```

1) Enter inputs from keyboard

To enter inputs from keyboard, select Option 1 from this menu. Then a data input screen is displayed for entering design-dependent parameters:
There are 16 input fields on the screen. Enter your inputs into appropriate fields. To move within a field, use ← and → keys. To delete a character, move the cursor to that character and press <Del> key. To move between fields, use ↑, ↓, <PgUp>, or <PgDn> keys. <Enter> and <Backspace> keys are not activated. After completing data inputs, press <F10> key. <F2> and <F3> keys are for loading reliability and maintainability prediction routines. They are not activated in this version and will be available in future versions of REPS-OPT.

If <F10> is pressed, the "SAVE INPUTS" screen is displayed:

Since you are entering new inputs, select Option 1. Then you are asked to give a file name to store the inputs you just entered:
Enter the new file name:

NOTE: The new file name should have file extension '.dep'
Existing Input Files:
BASE.DEP    ALT_1.DEP    ALT_2.DEP

To avoid overwriting your existing files, a list of existing input files for design-independent parameters is displayed in the lower window of the screen. To distinguish from other types of data files, give the file name extension " .dep ", which denotes design-dependent parameters.

2) Load inputs from a file

If you want to load inputs from an existing input file, select Option 2 from the "INPUT DESIGN-DEPENDENT PARAMETERS" menu. Then you are asked to give the file name for the inputs. A list of existing input files is displayed on the screen for your selection (similar to the last screen given above). If the file you give exists, the inputs from the file will be loaded and displayed on the screen. An example is given below:

<table>
<thead>
<tr>
<th>DESIGN-DEPENDENT PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Life                : 6</td>
</tr>
<tr>
<td>Acquisition Cost ($)       : 52000</td>
</tr>
<tr>
<td>Salvage Value ($)          : 7000</td>
</tr>
<tr>
<td>Operating Cost ($/year)    : 1750</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age Cohorts</th>
<th>MTBF</th>
<th>Age Cohorts</th>
<th>MTTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>0.2000</td>
<td>0 - 1</td>
<td>0.0300</td>
</tr>
<tr>
<td>1 - 2</td>
<td>0.2400</td>
<td>1 - 2</td>
<td>0.0400</td>
</tr>
<tr>
<td>2 - 3</td>
<td>0.2900</td>
<td>2 - 3</td>
<td>0.0500</td>
</tr>
<tr>
<td>3 - 4</td>
<td>0.2900</td>
<td>3 - 4</td>
<td>0.0500</td>
</tr>
<tr>
<td>4 - 5</td>
<td>0.2600</td>
<td>4 - 5</td>
<td>0.0600</td>
</tr>
<tr>
<td>5 - 6</td>
<td>0.2200</td>
<td>5 - 6</td>
<td>0.0700</td>
</tr>
</tbody>
</table>

Input File: base.dep
To use the inputs directly, press 'U'
To modify the inputs, press 'M'
If you want to use the inputs as shown on the screen for design optimization, enter character \textit{U} or \textit{u}. To modify the inputs, type character \textit{M} or \textit{m}. If \textit{M} or \textit{m} is pressed, you move to the input edit screen. The edit screen is similar to that for "Enter Inputs from Keyboard":

\begin{center}
\begin{tabular}{ | c | c |}
\hline
\textbf{Design Life: 6} & \textbf{Salvage Value ($\$$): 7000.000} \\
\textbf{Acquisition Cost ($\$$): 52000.00} & \textbf{Operating Cost ($\$$/year): 1750.000} \\
\hline
\textbf{MTBF:} & \textbf{MTTR:} \\
0 - 1 & 0 - 1 \\
1 - 2 & 1 - 2 \\
2 - 3 & 2 - 3 \\
3 - 4 & 3 - 4 \\
4 - 5 & 4 - 5 \\
5 - 6 & 5 - 6 \\
\hline
\end{tabular}
\end{center}

\begin{itemize}
\item <Up Arrow> Next field
\item <Down Arrow> Previous field
\item <F2> Predict MTBF
\item <F3> Predict MTTR
\item <Left Arrow> Cursor left
\item <Right Arrow> Cursor right
\item <Del> Delete a letter
\item <F10> Finish editing
\end{itemize}

When you finish editing, press <F10> key. Then the "SAVE INPUTS" screen is displayed:

\begin{center}
\textbf{SAVE INPUTS}
\end{center}

1. Save the inputs into a new file
2. Save the inputs into the current file
3. Do not save

Enter choice =>

12
To save the inputs you just modified into a new file, select Option 1. To save the modified inputs into the same file from which the old inputs are loaded, select Option 2. If you do not want to save the modifications, select Option 3.

3) Load default setting

This function allows you to load the base design stored on the disk. The input file is "BASE.DEP".

**FUNCTION 3: OPTIMIZE CURRENT DESIGN**

This function allows you to optimize the current design based on the inputs prepared by using Function 2. REPS-OPT conducts a complete search to identify the best combination of population size, number of repair channels, and replacement age which minimizes the system's annual equivalent life-cycle cost.

The following screen is displayed after selecting Function 3:

```
OPTIMIZE CURRENT DESIGN

1. Start Optimization Routine
2. Change Input Files
3. Return to Main Menu

Enter choice =>

Input Files Selected --
Design-independent parameters: base.ind
Design-dependent parameters: base.dep
```
1. Start Optimization Routine

The input files selected for conducting optimization are given in the lower window of the screen. Before starting the optimization routine, make sure the input files are right files. If any file is not what you want, select Option 2 to change the file.

Depending upon the size of the problem and the speed of your computer, REPS-OPT takes from several seconds to several minutes to find the best solution. When a best solution is obtained, the outputs are displayed on an output summary screen. The outputs are also saved in a file which has the same file name as the input file for design-dependent parameters and but has a file extension ".out".

2. Change Input Files

If you would like to change any of the input files, select Option 2. Then you move to the "INPUT PREPARATION" screen. After appropriate files are loaded, selection Function 3 again from the main menu to start optimization.

FUNCTION 4: REVIEW AND EVALUATE CANDIDATE DESIGNS

This function allows you to display the outputs for the current design and compare any existing design with the base design.

REVIEW AND EVALUATE CANDIDATE DESIGNS

1. Display Characteristics of Current Design
2. Compare a Design Alternative with Base Design
3. Return to Main Menu

Enter choice =>

14
1. Display Characteristics of Current Design

If a design alternative has been selected and optimized, the characteristics of the design can be reviewed by selecting Option 1 from the above screen. The characteristics include the input values of the design-dependent parameters, the best settings of the decision variables, and the resulting values of cost and performance measures for the design alternative.

If an optimization process has not been conducted at this run, no current design exists. This function allows you to review any existing design alternatives which you optimized before. This screen is displayed for you to select an existing design for review:

No optimization has bee conducted yet.

Do you want to review an existing design alternative (Y/N)? >

If you would like to review an existing design, type Y or y. Then you will be asked to give the name of the design alternative you want to review:

Enter the name of the design alternative:

NOTE: The name of a design alternative is the file name of the design's design-dependent parameters without file extension.

Existing Design Alternatives:

BASE ALT_1 ALT_2
You may compare any optimized design alternative stored on your disk with the base design. After you entered the name of a design alternative to be compared, a "Design Evaluation" screen is displayed. The characteristics of the new design is shown on the left side window. The characteristics of the base design is shown on the right side window.

HOW TO PRINT INPUTS AND OUTPUTS?

If you would like to print any inputs or outputs from REPS-OPT, follow the procedures as follows:

1. Turn on your printer.
2. Press <Print Screen> key when the screen you'd like to print is displayed.

If you are using a laser printer to print the data, you may have to press the <Form FEED> key on your printer to release the output sent to the printer.

REFERENCES

If you would like to know more about the REPS model, two references are recommended:
