

BLOCPLAN (Single Story) for Windows

Introduction

BLOCPLAN is a facility layout system that has been developed at the Industrial Engineering Department of the University of Houston for PC personal computer systems.

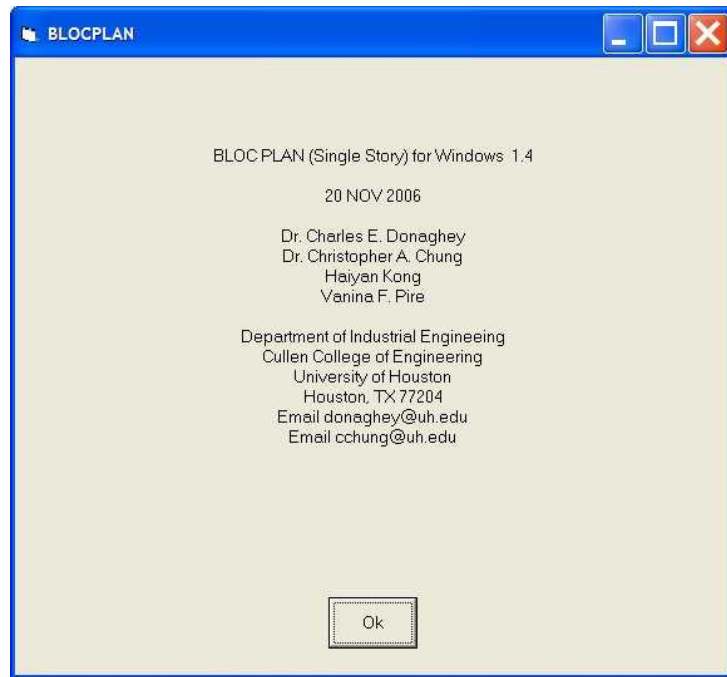


Figure 1. – Credits Screen for BLOCPLAN (Single Story) for Windows

The program generates and evaluates block type layouts in response to user supplied data. It is used only for single story layouts. For multi-story or multi-facility analysis, BLOCPLAN (Multi-Story) should be utilized.

BLOCPLAN (Single Story) uses a "banding" procedure to develop layouts. This permits a large range of possible layouts for a problem. For a nine department problem, the number of possible layouts is close to 20 million, and for a 15 department layout there are more than 2.6×10^{13} possibilities. Each department will also be rectangular in shape. The structure that holds the departments will also be rectangular in shape, and the user may select the length/width ratio of the structure. There are several scoring procedures that may be used to evaluate a layout. The manual explains how the current version is used. BLOCPLAN-WIN is the name of the current Windows version of BLOCPLAN.

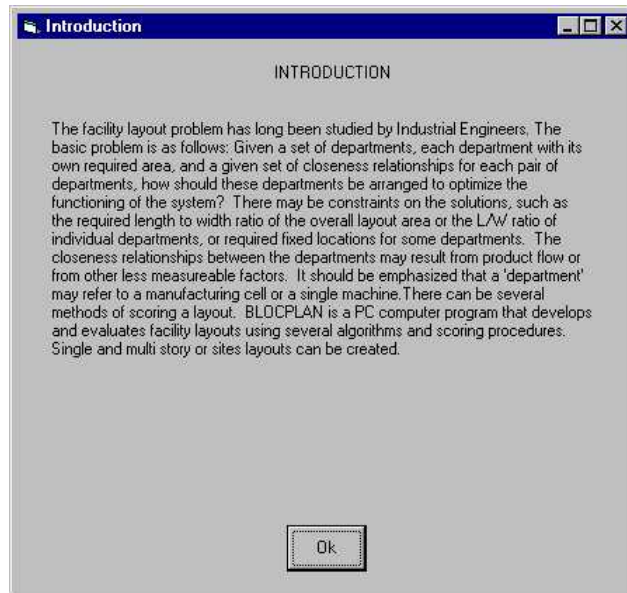


Figure 2. – Introduction Screen

BLOCPLAN Main Menu

The menu of choices in the Main Menu is shown in Figure 3.

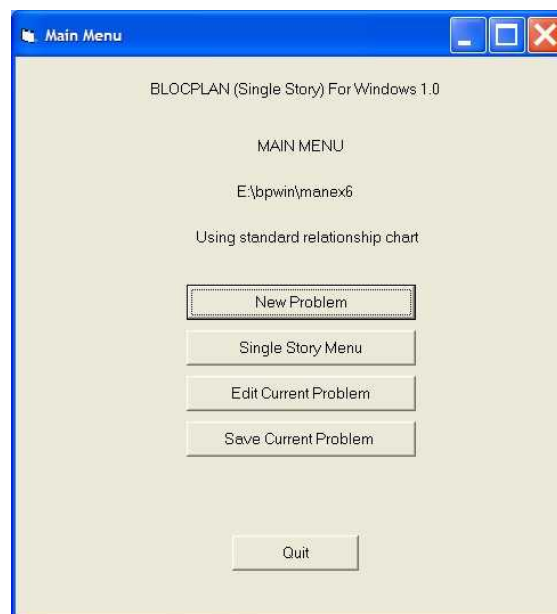


Figure 3. – BLOCPLAN Main Menu selections.

There are four menu options available to the user. The user clicks on the selection choice to cause execution of the proper option. The user may return to this Main Menu a number of times when working on a layout. It allows him/her to introduce a new problem, to examine single story layouts, modify data on the current problem, or to save the data on the current problem. The user can also exit from BLOCPLAN with the quit button. After a selection is made from the Main Menu, the user will be presented with new menus and information that pertain to the selection that has been made.

New Problem

If the user wants to introduce a new problem to BLOCPLAN he/she uses the “New Problem” option from the Main Menu shown in Figure 3. The BLOCPLAN system will respond with the message illustrated in Figure 4.

The system will first ask if a new problem is to be entered or if an existing problem is to be entered.

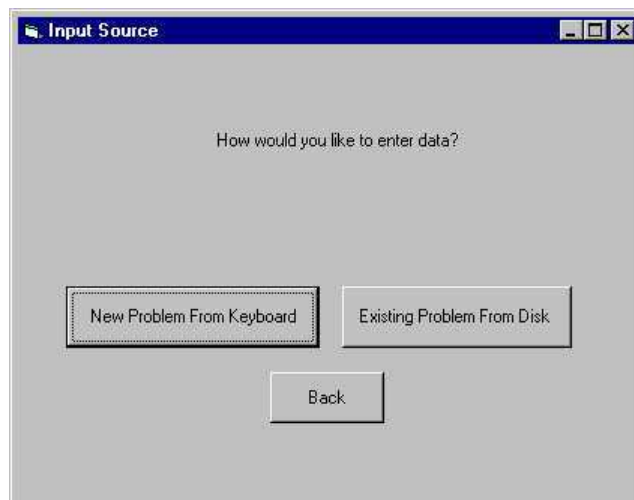


Figure 4. – Problem Source Screen

The user will click on his/her choice. If an existing problem choice is made, a list of the saved problems will be shown, and the user will click on the problem name, and the data concerning the saved problem will then be entered.

For a new problem, the screen shown in Figure 5 will first be displayed. The user would then type in the name of each department (8 characters maximum) in the layout, and the area of each of

them. BLOCPLAN can handle a maximum of 18 departments. When all departments and their areas have been entered, the user would click on the OK button.

The screenshot shows the BLOCPLAN software window. It features a table with three columns: 'Number', 'Department', and 'Area'. The 'Number' column contains integers from 1 to 18. The 'Department' and 'Area' columns are empty text boxes for data entry. To the left of the table, there are two radio buttons labeled 'New problem' and 'Enter or modify problem data.'. Below the table, there are three input fields: 'Average Area', 'Std. Dev. Area', and 'Total Area'. At the bottom of the window are three buttons: 'Ok', 'Print', and 'Back'.

Number	Department	Area
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		

Average Area:

Std. Dev. Area:

Total Area:

Ok Print Back

Figure 5. – Department and Area Information Screen

Figure 6 shows this display for an example problem. The total area for all the departments, the average department area, and the standard deviation of the department areas are calculated by the system and displayed

The data in Figure 6 was taken from "Facilities Planning" by Tompkins and White, 1984. The user may change any data in the list of departments by simply changing the data on the screen. the cursor is placed on the screen in the proper position and the data entered.

Number	Department	Area
1	REC'ING	12000
2	MILLING	8000
3	PRESS	6000
4	SCR. MCH	12000
5	ASSEMBLY	8000
6	PLATING	12000
7	SHIPPING	12000
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		

Average Area: 10000.0
Std. Dev. Area: 2390.5
Total Area: 70000

Continue Print Back

Figure 6. – Example Problem Data

Relationship Data

BLOCPLAN uses the relationship codes originally described by Muther in "Systematic Layout Planning", (Muther 1973, CBIPublishing, Boston, Mass). Figure 7 shows the screen display after the user has furnished the codes for each of the departmental relationships. This chart is called a Relationship Chart. The bottom of the screen gives a legend of acceptable codes and their definitions. An "A" indicates that it is absolutely essential that the two departments having this code be adjacent. An "E" indicates that it is essential etc. The "X" code indicates that it is undesirable. BLOCPLAN uses adjacencies for one type of layout analysis.

Figure 8 gives the numeric worth of each of these codes. The user can change any of these values

RELFORM

RELATIONSHIP CHART

		2	3	4	5	6	7
1	RECVING	A	O	I	O	U	U
2	MILLING		U	E	I	I	U
3	PRESS			U	U	O	U
4	SCR. MCH				I	U	U
5	ASSEMBLY					A	I
6	PLATING						E
7	SHIPPING						

Enter or change code A = Absolutely Essential I = Important U = Unimportant
 E = Essential O = Ordinary X = Undesireable

Continue Print

Figure 7. – Relationship Chart

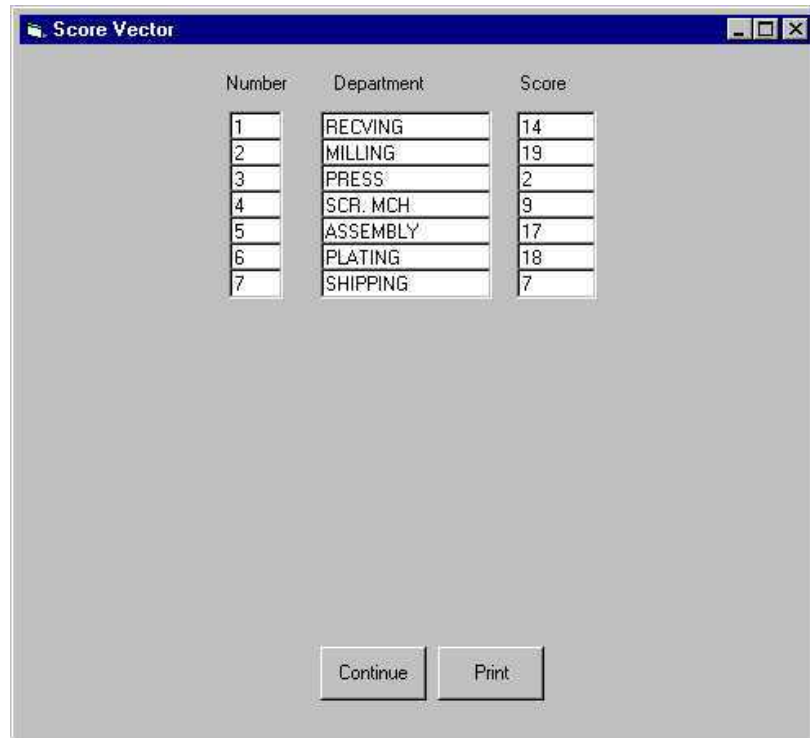
Score Vector

	Code	Score
Absolutely Essential	A	10
Essential	E	5
Important	I	2
Ordinary Importance	O	1
Unimportant	U	0
Undesireable	X	-10

Continue Restore Defaults Print

Figure 8. – Numeric Values For Relationship Codes

The numeric worth of each department is found by summing all of the numeric codes associated with the department. For example, from Figure 13, the PRESS department has two “O”s, and four “U”s associated it. The BLOCPAN numeric worth of these associations would be 2. (2 X 1) + (4 X 0). These scores for all departments in the example are shown in Figure 9.



The screenshot shows a window titled "Score Vector" with a table containing the following data:

Number	Department	Score
1	RECVING	14
2	MILLING	19
3	PRESS	2
4	SCR. MCH.	9
5	ASSEMBLY	17
6	PLATING	18
7	SHIPPING	7

At the bottom of the window are two buttons: "Continue" and "Print".

Figure 9. – Numeric worth of each department

Length/Width Ratio

The ratio of the length to the width of the facility that will contain the departments can be selected by the user. Figure 10 shows the display that is presented that permits this selection. There are five "selections" that are given. Selections 1,2,3, and 4 are standard L/W ratios. Selection 1 is 1.35/1, selection 2 is 2/1, selection 3 is 1/1, and selection 4 is 1/2. The user can choose any of these by clicking on the desired selection. If the user chooses selection 5, he/she will be asked for the desired L/W ratio. The user inputs the desired values of the L/W ratio of the facility that will contain the departments. Once the desired ratio has been selected, BLOCPAN will calculate the length and the width of the facility outline so that it will have the required area to contain the departments.

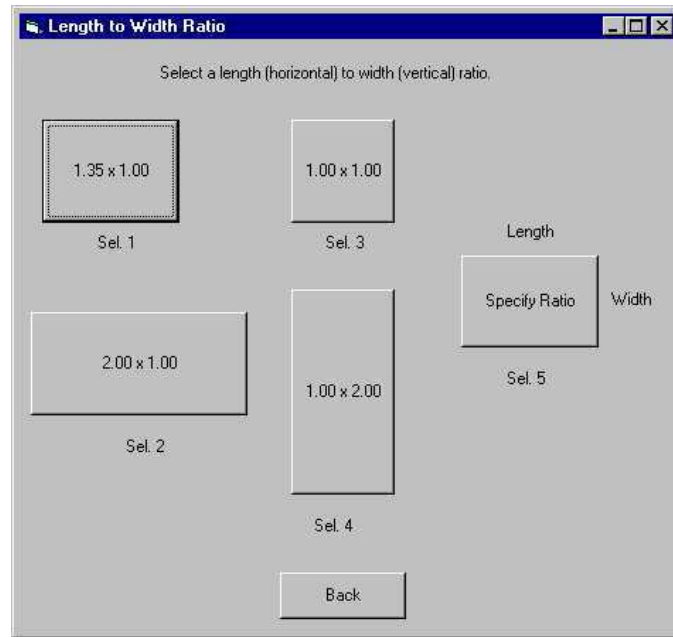


Figure 10. – Screen presented during selection of Length/Width Ratio for layout.

Material Handling Information

BLOCPLAN also allows the inclusion of Material Handling information in the layout analysis. This information is furnished by listing moves per time period between departments into a From/To Matrix. Figure 11 shows the format for giving material handling information.

		2	3	4	5	6	7
1	RECVING	150	75	200			
2	MILLING			400		150	
3	PRESS			75			
4	SCR. MCH				200	75	
5	ASSEMBLY						200
6	PLATING						225
7	SHIPPING						

Figure 11. – Screen Display for Entering Material Handling Information

Single Story Options Menu

When all departments are on the same level he/she uses selection the “Single Story Menu” from the Main Menu. After this selection is made the Single Story Layout Menu will be displayed. This menu is shown in Figure 12.

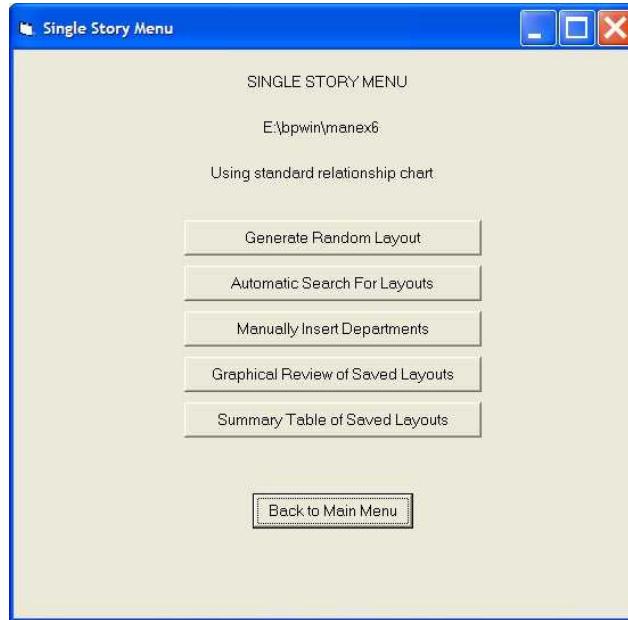


Figure 12. – Single Story Layout Menu.

Single Story Option – Generate Random Layout

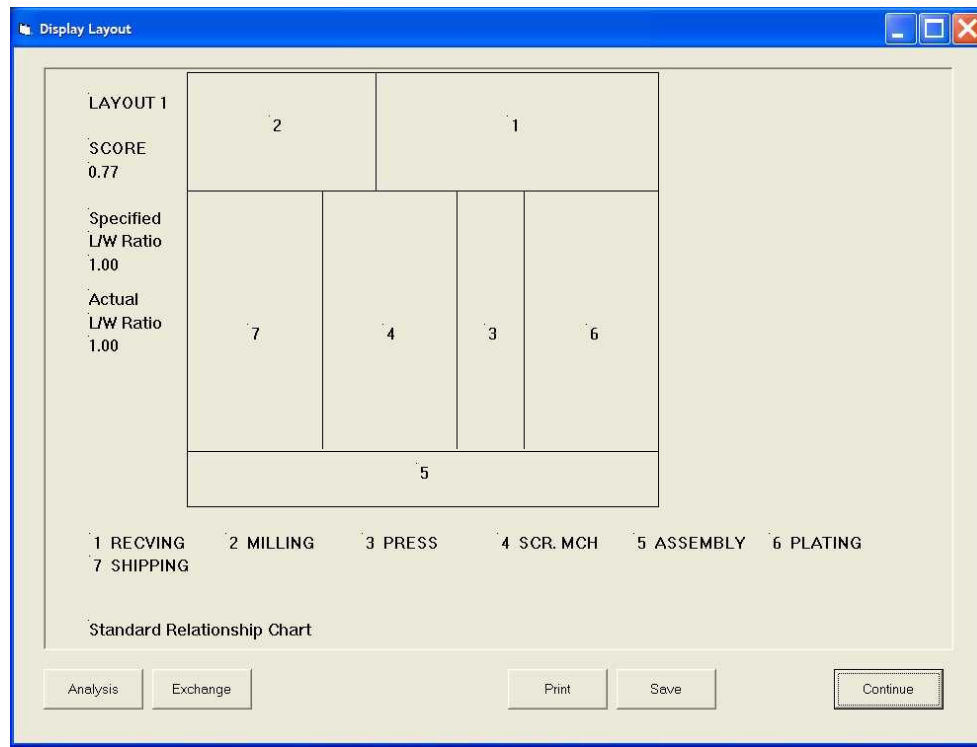


Figure 13 – Randomly Generated Layout

This layout uses the departments and the data that has previously been described. The score that is given, (.77) uses the adjacency scoring procedure that will be described later.

Single Story Menu - Automatic Search

The Automatic Search option that is available in BLOCPLAN - WIN greatly simplifies the layout task. The procedures that an experienced BLOCPLAN user used in obtaining a "good" layout were studied and these procedures have been incorporated into BLOCPLAN - WIN. When this option is selected, the first prompt that the system will give asks for the number of layouts desired. The user responds with a number between 1 and 20. The layouts that result from the automatic search procedure will be stored in memory in the common Saved Layout Area. The user has the option to manually locate some departments before the automatic search begins. The screen display for manually locating is shown in Figure 11, and the user either manually locates some department(s), or indicates that no departments are to be fixed. The system starts with an initial random "seed" layout, and operates on this layout until it is not able to improve it. This final layout is saved. Another seed layout is created and the process is continued until the number of desired layouts have been created. A table showing the information on the saved layouts is then displayed. The display of Figure 14 shows this table for an example problem. Five layouts have been saved, and the Adjacency Score, the Normalized and Un-Normalized Rel-Dist Score, and the total Product Movement are shown for each of them. The rankings of each of these scores are also shown. Layout #2 has the highest adjacency score of .98, and Layout #4 has the best Rel-Dist score of .87 and the lowest Product Movement of 234534 load feet.

The screenshot shows a software window titled "Layout Table". Inside the window is a table with four main columns: "LAYOUT", "ADJ. SCOR", "REL-DIST SCORES", and "PROD. MOVE.". The table contains five rows of data, each representing a different layout configuration. Below the table are three buttons labeled "Continue", "Delete", and "Print".

LAYOUT	ADJ. SCOR	REL-DIST SCORES	PROD. MOVE.
1	0.91 - 2	0.75 - 3 6191.49 - 3	278025.58 - 4
2	0.98 - 1	0.67 - 5 6669.18 - 4	247708.47 - 3
3	0.86 - 4	0.68 - 4 6719.74 - 5	289780.64 - 5
4	0.88 - 3	0.87 - 1 4934.13 - 1	234534.42 - 1
5	0.86 - 4	0.86 - 2 5675.29 - 2	247539.17 - 2

Continue
Delete
Print

Figure 14. – Resulting table of layouts after the Automatic Search Procedure was used. Five layouts were requested.

Single Story Menu - Manually Insert Departments

The user can manually position departments in the layout by using this option. When it is evoked the screen display of Figure 16 appears.

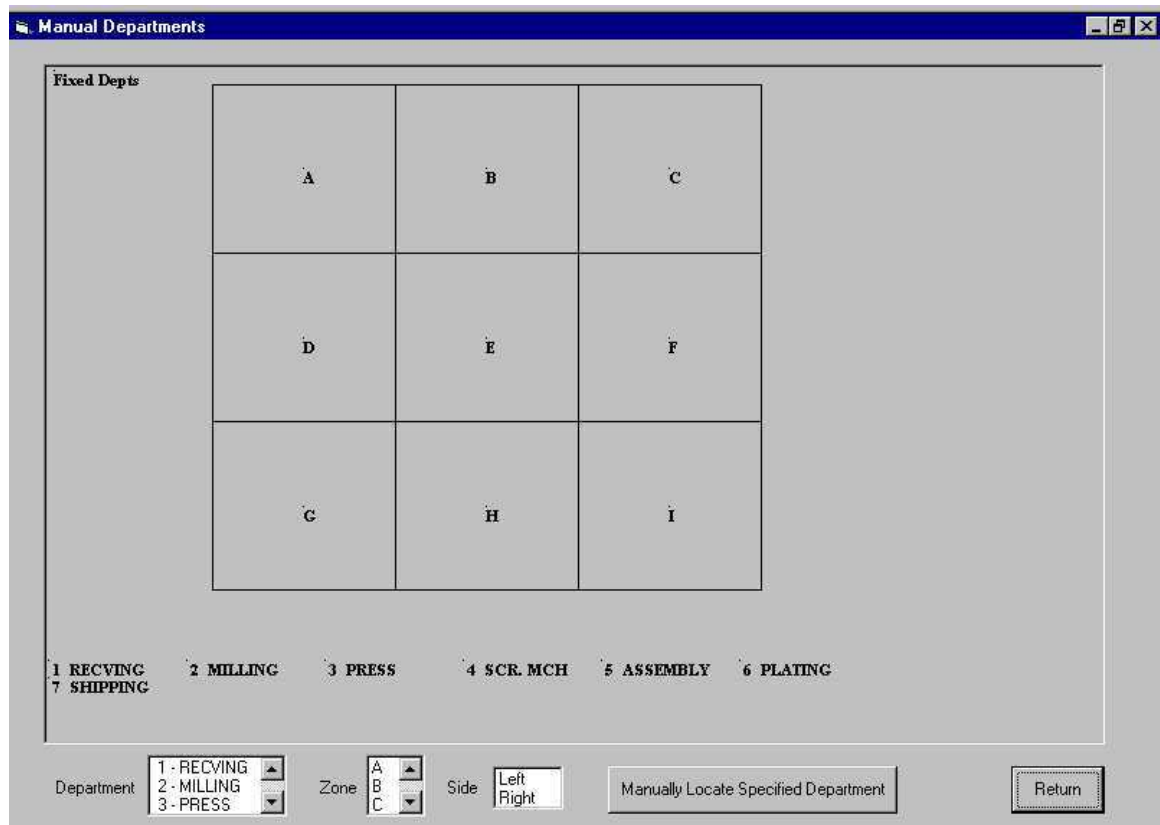


Figure 15– Screen display for manually locating departments. There are nine zones, and each zone may be divided into its left and right side. Department legend is on bottom of screen.

BLOCPLAN provides nine zones for locating departments. These zones are designated A through I, and they are arranged in three tiers of three zones each, as can be seen in Figure 15. Each zone can be further divided into its left side or its right side. The layout outline for manual insertion is drawn according to the current L/W ratio. The display in Figure 16 is for a L/W ratio of 1/1. Suppose the user wants to place Dept.1 (RECVING) in the upper left hand side of the layout, and Dept 7 (SHIPPING) next to it on the right. He/she would click on the RECVING choice in the Department scroll at the bottom of the screen, Zone A for the zone choice, and specify that it is to be on the left side of the zone. He would then click on the “Manually Locate Specified Department” option. He/she would do the same thing for RECVING, placing it in Zone A on the right side. After placing these two

departments he would use the “Return” option. These two departments would be placed in those two locations for the rest of the analysis.

Figure 12 shows an example layout with these two departments placed in their specified locations. The L/W ratio for this layout was set at 1/1.

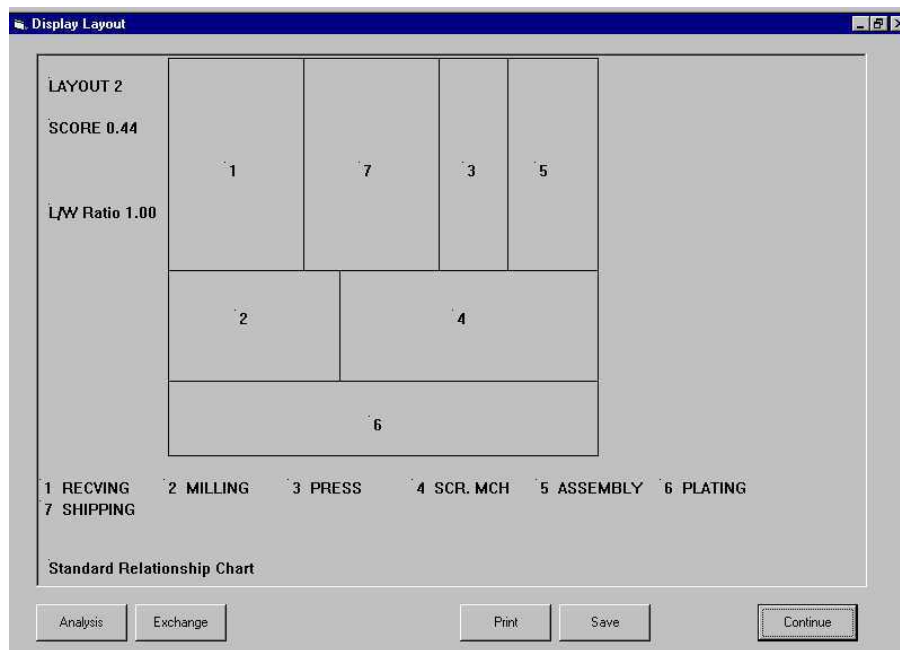


Figure 12. – Screen display after departments 1 and 7 have been manually located.

Adjacency Scoring

The layout display shown in Figure 12 is the format that BLOCPLAN uses to display a single story layout that it has created. It has a layout score of .44 assigned to it. BLOCPLAN uses an adjacency criterion to develop this score. The departments that share a boundary in the layout are examined and the numeric value of each of their relationship codes are added. The total value of all the normalized adjacency score for the layout of Figure 12 is $19/43 = .44$ (rounded to two places). A 1.0 would be the highest possible adjacency score.

Saving Layouts

Figure 12 also shows the options that are available to a user when a layout is created. These options are: "Save" to Save a layout, "Analysis" to have a layout Analysis performed, "Exchange" to Exchange departments in the layout, the “Print” option to get a hard copy of the layout being displayed.. BLOCPLAN is capable of saving 20 layouts in the Saved Layout area in memory. When the user uses the Save option, the layout currently on the screen will be stored. If there are currently 20 layouts

(41.78, 192.76). The centroid for department 4 is (185.20, 83.15.). Therefore, the distance between these departments, assuming rectilinear travel, is $|41.78 - 185.20| + |192.76 - 83.15| = 253.03$ feet.

The relationship matrix (Figure 3) shows that departments 1 and 4 have an "I" relationship code, which has been assigned an equivalent score of 2. Therefore, the product of the distance and the relationship score for these two departments is $253.03 \times 2 = 506.06$. These values are calculated and summed for each pair of departments in the layout. This sum is shown in Figure 20 at the bottom of the screen, and is 7984.00. The better layouts should have a lower Rel-Dist score. BLOCPAN normalizes this score.

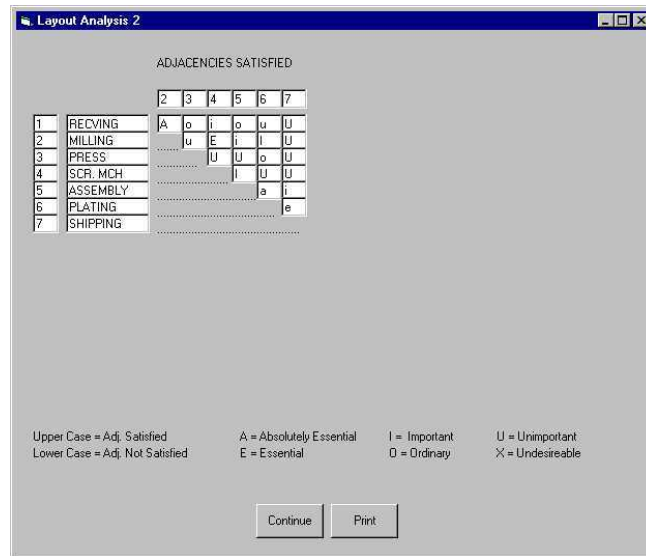


Figure 14. – Adjacencies That Have Been Satisfied For Layout Of Figure 12.

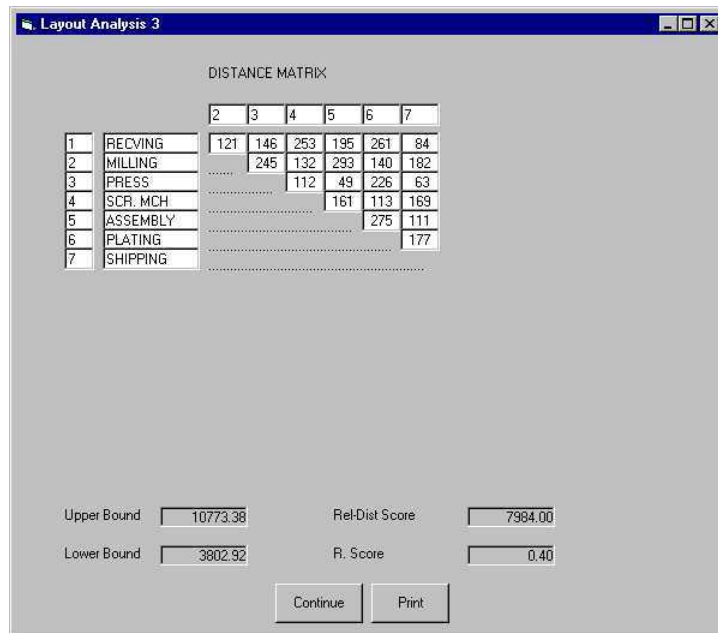


Figure 15. – Screen Display Giving Distances Between Departments for Current Layout

BLOCPLAN will create a vector of these 21 distance values from the lowest to the highest. This vector D would be:

$$D = d_1, d_2, \dots, d_{21}$$

A vector of the 21 values numeric values of the relationship chart for the problem is also developed. This vector S would also go from the lowest to the highest.

$$S = s_1, s_2, \dots, s_{21}$$

A lower bound for the Rel-Dist score for the layout would be:

$$\text{Lower Bound} = d_{21}s_1 + d_{20}s_2 + \dots + d_1s_{21}$$

The highest value in the D vector is multiplied by the lowest value in the S vector, the next highest D value by the next lowest S value, etc.. An upper bound for Rel-Dist score can be found by:

$$\text{Upper Bound} = d_1s_1 + d_2s_2 + \dots + d_{21}s_{21}$$

It should be noted that these bounds may not be obtainable for a given layout, and they will vary for each layout for a given set of departments. The lower and upper bounds for the Rel-Dist score for the layout is shown on the bottom of the display in Figure 20. The actual distances are used in the D vector instead of the entries in the distance matrix. The entries in the distance matrix have been divided by 10 and integerized to control the size of the matrix for the display. The normalized score for this criterion is also shown in Figure 20. It is labeled R-SCORE. It is calculated by:

$$\text{R-Score} = 1 - (\text{Rel-Dist Score} - \text{Lower Bound}) / (\text{Upper Bound} - \text{Lower Bound})$$

For the example, the value is $1 - (7984.00 - 3802.92) / (10773.38 - 3802.92)$ or 0.40. An R-SCORE of 1.0 would be a perfect layout, and a value of zero would be the worst possible.

The last display that results from the Analysis option is shown in Figure 21. This is the product flow screen. If there has been no product information given for a problem, this display will not be generated.

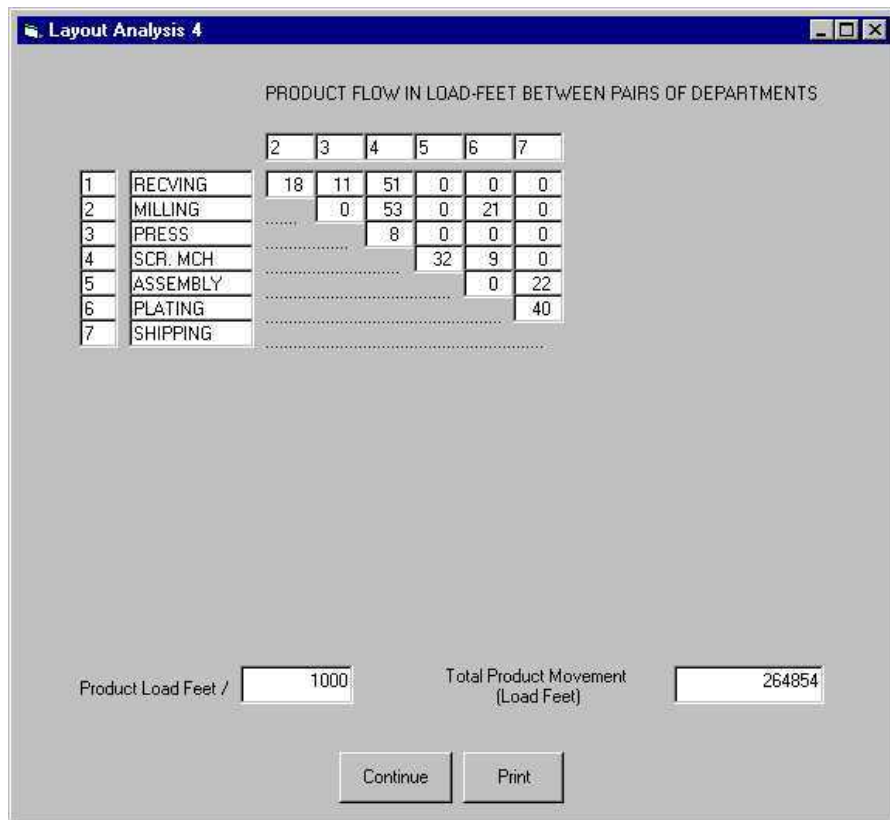


Figure 16. – Screen display giving product flow information. This is still another display that results from a layout analysis. It is suppressed if no product data has been supplied.

The matrix in Figure 16 shows the product of the unit loads and the distance between them for each pair of departments. The value has been divided by 1000 and rounded to the closest integer to control the size of the matrix. The divisor in this normalization is problem dependent. At the bottom of the screen the total unit load-distance value for the problem is shown. In this example the value is 264853.63 unit load feet. The two departments having the greatest contribution to this total are departments 2 and 4, which have approximately 53,000 unit load feet of product flow between them. This display will stay on the screen until the user depresses the continue button. The layout that has just been analyzed with a Layout Analysis will then be returned to the screen, with the display of Figure 17.

Exchanging Departments

When a layout is displayed the user the exchange button appears at the bottom of the screen. This allows the user to switch the locations of any two departments in the layout. When the exchanged button is pressed, the screen in figure 18 appears. In figure 18, the departments 7 and 1 have been entered for exchange. The exchange is executed by pressing the Make Change button. The layout is then updated with the change, and the resulting layout of Figure 23 would be displayed. This process is repeated for each set of departments to be exchanged. The total number of changes is the combinations of departments taken two at a time. For example for seven departments the formula for the combinations is:

$$= 7! / (5! 2!) = 21 \text{ combinations}$$

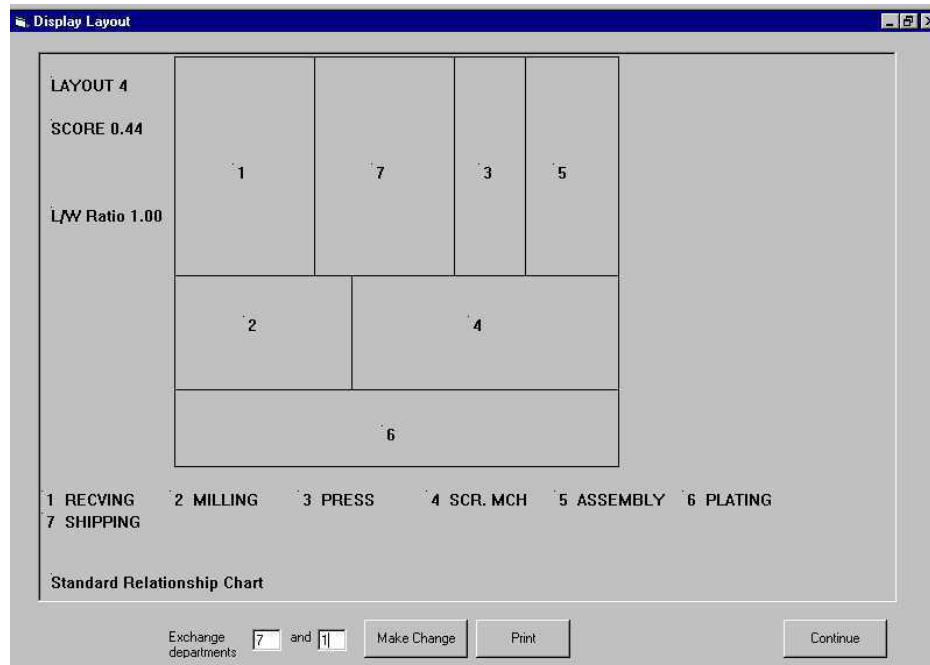


Figure 17. –Exchanging Departments

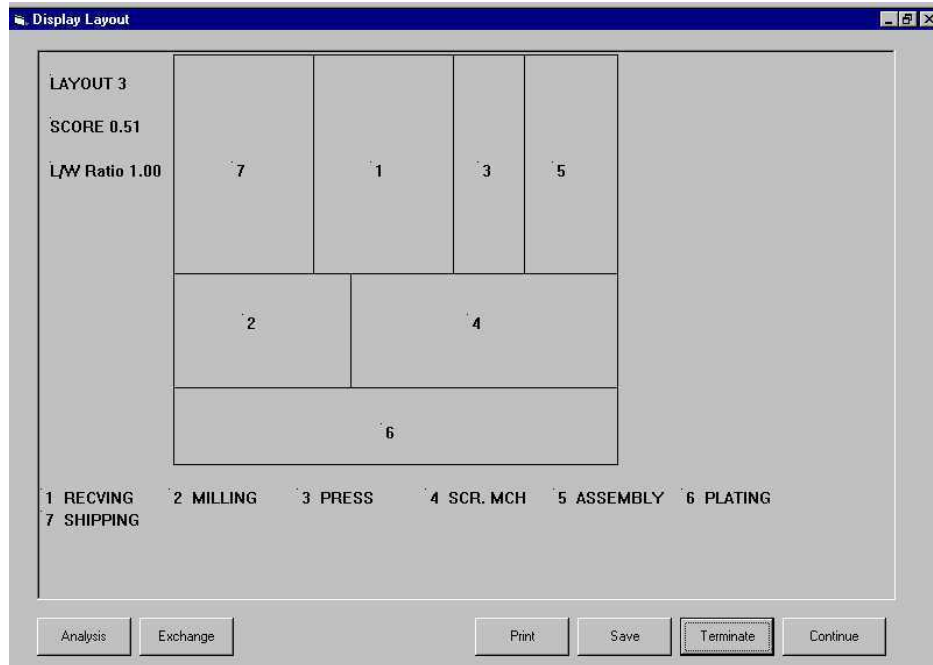


Figure 18. – Layout when Departments 1 and 7 have been exchanged.

The system will make the necessary adjustments in the positioning of the other departments so that the exchange can take place. The layout will be scored and the user has the same options available that were given with a new layout.

Single Story Menu - Graphical Review of Saved Layouts

Layouts that have previously been saved can be reviewed by using menu selection 5. When this selection is made the screen will be cleared and the message:

STARTING POINT FOR REVIEW?

The user would give the number of the first layout from Figure 24 that he/she would like to review. The specified layout will be displayed, and the user can have a layout analysis performed (option “A”), departments can be Exchanged (option “E”), or he/she can terminate the remainder of the reviews with the option “T”).

Main Menu - Edit Current Problem Option

When the user selects Edit Current Problem, it indicates that he/she wishes to change the data that pertains to the current problem. The Edit/Adjust Data Menu will then be presented that contains the options that are available. Figure 19 shows this menu. A user may examine and/or change the department areas, the relationship information, the length to width ratio of the layout area, and the material handling information. He/she can also ask for a relationship chart that is based solely on material handling information, and he/she can restore the original relationship chart when needed

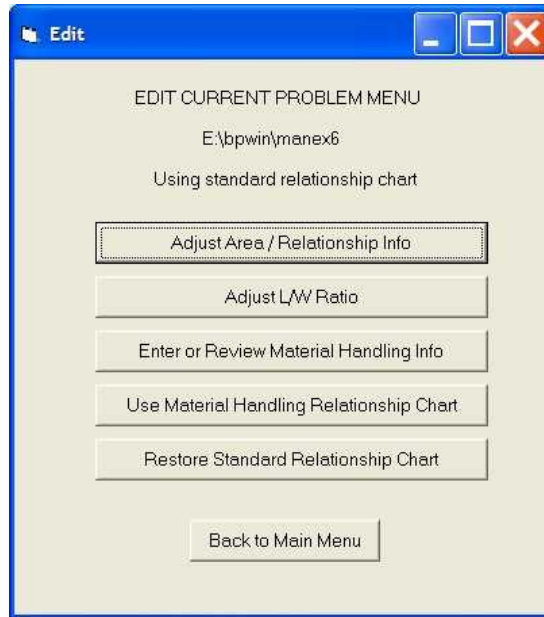


Figure 19. – Edit /Adjust Data Menu

Adjust Area/Relationship Data (Edit/Adjust Data Menu Selection

Selection 1 from the Edit/Adjust Data Menu allows the user to change the area and/or the relationship information currently in effect. After this option is selected, the display previously shown in Figures 6 appears, and the user is allowed to change any of the department areas. This is followed by the screen displays previously illustrated in Figures 7, 8, and 9 allowing for changes in the relationship data and the score vectors. The user is then returned to the Main Menu previously illustrated in Figure 3. It should be noted that all layouts that have been previously saved may now be reviewed under this new set of area and/or relationship parameters.

Adjust Length/Width Ratio (Edit/Adjust Data Menu Selection

A new L/W ratio may be established by selecting the second button from the Edit/Adjust Data Menu. When this choice is made, the display of Figure 10 is brought to the screen, and the user selects the desired L/W ratio. All layouts currently saved can then be reviewed with the new ratio. After the new ratio is selected the system will return to the Edit/Adjust Data Menu.

Review Material Handling Information (Edit/Adjust Data Menu Selection)

The material handling information can be reviewed and changed, if desired, by using the third button from the Edit/Adjust Data Menu. After the selection is entered, the screen display of Figure 11 appears, and the user can inspect and/or modify any of the data. If there is currently no material handling information in the problem, it can be added with this selection. In this case, the screen display would have material handling data, and the user would use the "C" option to indicate a change is required.

Use Material Handling Relationship Chart (Edit/Adjust Data Menu Selection)

This selection will cause BLOCPLAN to develop an alternate REL chart that is based entirely on material handling. The example problem had material handling information that is summarized in Figure 11. Figure 11 shows the greatest amount of product flow is between departments 2 and 4 (400 unit loads). BLOCPLAN will divide this maximum flow figure by 5.0 to develop product flow values for REL codes A through U. $400/5 = 80$. Thus, any product flow between 321 and 400 will be assigned an "A" code. A product flow from 241 to 320 will be assigned an "E", from 161 to 240 an "I", 81 to 160 an "O", and zero to 80 a "U" code. When Edit/Adjust Menu selection 4 is made, BLOCPLAN will make these calculations and assignments depending upon the current material handling information that has been given. It will then display the resulting REL chart. Figure 14 shows the REL chart that resulted for the example problem with the material handling information that is summarized in Figures 9 and 10. This REL chart is now the one that BLOCPLAN will use for its scoring calculations. Any layout scores or tables that are developed will use this REL chart. The user may alter any of the REL codes that are in effect by using menu selection 1 in the Edit/Adjust Data Menu. (Adjust REL Info). If the material handling information is changed by using selection 4 in the Edit/Adjust Data Menu, the user will have to then call on this selection again (selection 4) to cause the REL chart to reflect these changes. A message on the screen will indicate if the material handling information is used to develop layouts.

RELFORM

MATERIAL HANDLING RELATIONSHIP CHART

		2	3	4	5	6	7
1	RECVING	0	U	I	U	U	U
2	MILLING		U	A	U	0	U
3	PRESS			U	U	U	U
4	SCR. MCH				I	U	U
5	ASSEMBLY					U	I
6	PLATING						I
7	SHIPPING						

Enter or change code A = Absolutely Essential I = Important U = Unimportant
 E = Essential 0 = Ordinary X = Undesireable

Continue Print

Figure 14. – Material Handling Relationship Chart

Restore Relationship Chart (Edit/Adjust Data Menu Selection)

The REL chart that the user entered when creating the problem, along with any modifications that have been made to it, may be recalled from memory to replace a Material-Handling REL chart, by using this menu selection. The chart is recalled from disk and displayed on the screen. It will then be the chart that is used for scoring any layouts. The Relationship Chart that was used will be displayed for any tables or layouts created. This REL chart is based entirely on the material handling information that is summarized in Figure 11. The user may make any changes desired.

Return to Main Menu (Edit/Adjust Data Menu Selection)

When this selection is made, the user transfers from the Edit/Adjust Data Menu and the Menu shown in Figure 3 is placed on the screen.

Main Menu - Save Problem Data

In order to save a problem in memory so that it will be available at a later time the BLOCPLAN user will select the “Save Current Problem” option in the Main Menu. The screen that will appear after this selection is made is used to specify the layout name.

The user types the file name that is to be assigned to the problem. Any layouts or partitions that exist with the problem will be stored in memory with the problem, and will be available when the problem is again loaded. As mentioned earlier in this manual, there are two problem files. These are named MANEX6 (Manual Example), and EX12 a problem with 12 departments.

Main Menu - Quit

An exit from BLOCPLAN is made when the “QUIT” option is selected.

References:

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