This is to certify that the

thesis entitled

DEVELOPMENT OF A COMPUTER AIDED
CUSHION DESIGN SOFTWARE

presented by

Ruogong Liu

has been accepted towards fulfillment
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Julian Lee

Major professor

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DEVELOPMENT OF A COMPUTER AIDED CUSHION DESIGN SOFTWARE

By

Ruogong Liu

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ABSTRACT

DEVELOPMENT OF A COMPUTER AIDED
CUSHION DESIGN SOFTWARE

By

Ruogong Liu

Exponential and polynomial models were found to describe the relationship of dynamic stress with energy density in cushion materials. These models were used for regression analysis of eight cushion materials.

A computer program was written according to the two models. The program was coded in Qbasic and named as CUDE. The regression results were stored in a special file called CUDE.DAT as cushion data. CUDE contains three basic functions, Computer Design, User Design and Generate Cushion Data. Computer Design gives the cushion thickness and bearing area for the eight cushion materials in One Face Design and Six Face Design. One or All of the design variables, such as cushion thickness, bearing area and cushion material, can be chosen in the User Design. Generate Cushion Data will help packaging engineers to develop new cushion curves. In testing, CUDE provides the same results as the design using cushion curves.

Dedicated to my beloved Danping, Shen

and my dearest parents.

ACKNOWLEDGMENTS

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He also thanks Mr. Chuck Ailsworth for his help in testing the software and writing the thesis.

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a. b. c

G:

s:

h:

t.

y:

x:

LIST OF SYMBOLS

a, b, c, d:	Constants
G:	Deceleration
s:	Static Stress
h:	Drop Height
t:	Cushion Thickness
y:	Dynamic Stress
x:	Energy Density

CHAPTER I

INTRODUCTION

1.1 Cushioning

Cushion materials are primarily used to protect products against drops and to decrease the damage from shock and vibration in the distribution environments. A cushion material is any deformable material that can absorb the impact energy. The ideal cushion material should:

- Absorb all the impact energy in a drop and prevent the product from rebounding.
- Keep the G-level to the product as small as possible.
- Be thin to keep the overall package size as small as possible to save on the package cost and transportation cost.
- Be moldable, so that different product shapes can be easily to accommodated.
- Be durable, so the cushion material can stand up to repeated impacts and various environmental hazards such as temperature and humidity.
- Be manufactured with consistency in cushioning properties.

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- Be environmental friendly. Cushion materials should be biodegradable or recyclable to decrease the solid waste.

There are two different kinds of cushion materials. One is called loose-fill type. The cushion material is a small piece of solid materials, such as polystyrene "peanuts", shredded paper and popcorn. Another is called solid type. These materials are the structural foams made by different polymers such as polyethylene, polypropylene, polystyrene and urethane. All the foams are either closed-cell foam or open-cell foam. A closed-cell foam consists of individual bubbles of air or other gas, such as nitrogen and carbon dioxide, depending on the manufacturing process of the foam, trapped in a thin unbroken membrane of plastic. A closed-cell foam absorbs the impact energy by compress the air or gases trapped in the cell. The open-cell foam consists of a 3-D network linked with cells. Air is able to flow between cells and even out of the cushion materials. Open-cell foam absorbs the impact energy by moving the air through the cells and out of the cushion [1, 2, 3, 4].

The performance between the open and closed cell foams is different. Closed-cell foams are stiff, more durable and better suitable to cushion heavy products. Closed-cell foams also make better thermal insulators. Open-cell foams make better acoustic insulators. Cell size is determined by the density of the cushion materials. The density of foam can be adjusted for different cushion purposes. Usually, the more airs trapped in the cell, the bigger the cell size and the less dense of the cushion material is. Because density is more easily measured than the cell size, manufactures often give the density values along

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with the cushion performance data. The most useful foams are polyethylene, polypropylene, EPS or expended polystyrene and polyurethane foam. Except for polyurethane foam, all foams can be considered as closed-cell foams.

Another widely used cushion material is corrugated paper board. It is fairly energy absorbent, easy to work with, inexpensive, recyclable and biodegradable. However, it is not good for repeated impacts and its cushion properties are affected by environmental hazards, such as temperature and humidity.

Not all the properties of the ideal cushion are satisfied in one cushion material. From the packaging engineering stand point, the biggest concern is the energy absorption level or the G-level the product is cushioned to.

1.2 Cushion Design

The fragility of the product has to be known before the cushioning material can be selected. Different products have different fragility levels, depending on the product composition. Table 1 shows the approximate fragility of typical packaged articles. Table 1 only provides the approximate or typical values. For a proper design, the fragility of the product can be determined by test (ASTM D3331 and D3332) [5]. When the fragility of the product is known, the drop height that the product would be likely dropped from in distribution environments can be estimated from Table 1-2.

Table

Table

Table 1-1 Approximate Fragility of Typical Packaged Articles [6]

Extremely Fragile	
Aircraft altimeters, Winchester hard disc driver	15 - 25 G's
Very Delicate	
Medical diagnostic apparatus, X-ray equipment	24 - 40 G's
Delicate	
Computer display terminal and printer, electric Typewriter, cash register	40 - 60 G's
Moderately Delicate	
Stereos and television receivers, Floppy disc driver	60 -85 G's
Moderately Rugged	
Major appliances and furniture	85 - 115 G's
Rugged	
Table saw, sewing machines, machine tools	115 G's and up

Table 1-2 Typical Drop Heights [6]

Weight Range Gross Weight in Lbs	Type of Handling	Drop Height in Inches
0 ~ 10	1 person throwing	42
10 ~ 20	1 person carrying	36
20 ~ 50	1 person carrying	30
50 ~ 100	2 people carrying	24
100 ~ 250	Light equipment handling	18
250 +	Heavy equipment handling	12

Drop height varies with handing methods. For example, palletized products may typically receive drops from six inches. Notice that as the package becomes larger or heavier, the expected drop height decreases. Smaller packages are likely to experience higher drops in shipments. Investigators [7] recently studied the overnight air delivery system by shipping a 10 lbs package with outside dimensions 10" x 10" x 10", in which a Drop Height Recorder was packed in order to monitor the various dynamic impacts during the shipment. The study has shown that in the 100 one-way trips, and a total of 1678 drops were recorded. The drop heights were from 0.1 to 77.8 inches. 99.5 % of all drops recorded in the Federal Express and UPS shipments were below 27.5 inches. But 99.5 % of all drops measured in the UPS shipments occurred below 50 inches.

The exact drop height that the individual package may experience in the distribution environment may never be known but Table 1-2 can be used for a general reference in cushion design. For extremely fragile or expensive products, the designed drop height may be higher or indicated by the product manufactures.

After the fragility level of products and the expected drop height in the distribution environment have been selected, the next step for the cushion design is to determine the material to be used, its thickness and the cushioning area or bearing area.

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Cushion material manufactures usually offer the cushioning performance data in cushion curve forms for their product. Users can make cushion curves by following the standard procedures (ASTM D-1595) [5].

Cushion curves are generated by flat dropping block-shaped weights onto plank-shaped cushion samples from different heights and recording the peak deceleration G from an accelerometer attached to the weight. The cushion curves show the relationship of deceleration and static stress in different thickness and drop heights. Cushion designers consult the cushion curves to select the proper cushion material, its thickness and static stress. From the product weight, the bearing area or cushion area can be simply calculated by the following equation:

$$\text{Bearing Area} = \frac{\text{Product Weight}}{\text{Static Stress}} \qquad (1.1)$$

There are two different cases for the cushion design. The product needs the entire base support or does not need the entire support. The procedure for designing the cushion in each case is different.

For products that do not need support under the entire base:

- Find the fragility of the product by doing drop tests. The product may have different fragility for the different impact orientations and even different faces. Use the corresponding fragility for the next step.

- Find the expected drop height for the product based on its weight, referred Table 1-2.
- Select a cushioning material and use the 2-5 impact cushion curves for the selected drop height. Several cushioning materials may be selected at same time in order to choose the most economical one.
- Draw a horizontal line through the set of curves that intersects the G-axis at the fragility level that has been determined. Figure 1-2 illustrates the procedure for a product with 40 G fragility.

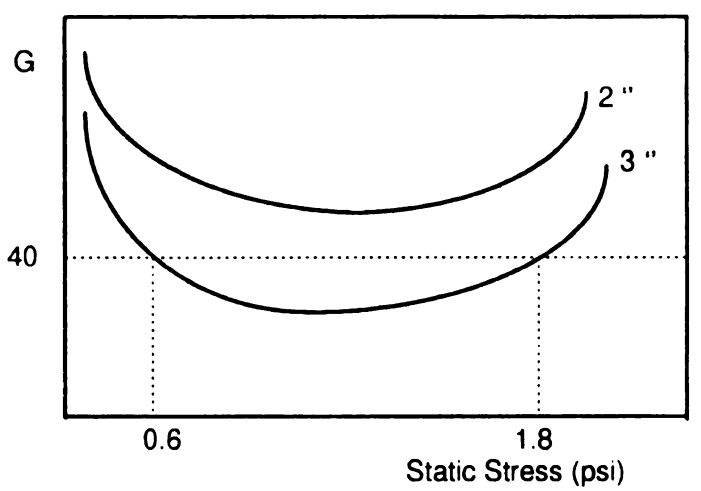

Figure 1-2 Cushion Design Procedure

- Only those curves that are below this line are useable for the specific product. This will ensure that the G-level obtained in the actual drop test is less than the G-level that damages the product.

- Select the thinnest cushion possible. In Figure 1-2, the thinnest cushion is 3 inches.
- Choose the largest static stress possible because this corresponds to the smallest cushion area or minimum cushion material needed. In Figure 1-2, the static stress range is from 0.6 psi to 1.8 psi. So 1.8 psi should be selected for calculating the cushioning area.

For the product that needs support under the entire base, the design procedure is different. For this case, the static stress, does not need to be selected from the cushion curve because the bearing area is equal to the base area of the product. The static stress can be calculated using the base area as bearing area. Then a vertical line that intersects the static stress axis at the known value on the cushion curves can be drawn. Only those curves that below the fragility level at this static stress line are useable. Select the thinnest cushion possible [1, 2, 3].

In order to compare the thickness and bearing area obtained above with different cushion materials, start over the whole procedure for the other materials.

To simplify the cushion design procedure for different materials, it is possible to use a computer to aid packaging engineers in the cushion design. Dow Chemical USA has developed a software called EthaCalc to ease and speed the package cushion design process [9]. This software does help

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packaging engineers to design cushion with ETHAFOAM brand foams [10]. For other brands of cushion materials, the computer software is still not available.

In this study, a computer software was written according to Dynamic Stress and Energy Density described in references [3, 4] to simplify the cushion design process for different cushion materials.

CHAPTER II

DYNAMIC STRESS, ENERGY DENSITY AND COMPUTER MODELING

2.1 Dynamic Stress and Energy Density

When a product drops on a cushion material from a certain height, the cushion material is compressed. The product receives a dynamic force according to Newton's law. Dynamic Stress can be defined:

$$\text{Dynamic Stress} = (\text{Peak G}) \times (\text{Static Stress}) = Gs \qquad (2.1)$$

"G" is the maximum deceleration that the dropped object received and "s" is the static stress. They can been read directly from the published cushion curves for the cushioning material. From the Equation (2.1), the dynamic stress applied on the cushion material will be equal to the maximum stress acted on the product during the drop. When the cushioning material is compressed to the maximum point, the potential energy is totally absorbed in the cushioning material. The

energy absorbed in unit volume is called Energy Density and it is defined by the following equation:

$$\begin{aligned} \text{Energy Density} &= (\text{Weigh x Drop Height}) / (\text{ Cushion Volume}) \\ &= (\text{Weight x Drop Height}) / (\text{Area x Thickness}) \\ &= (\text{Static Stress}) \times (\text{Drop Height}) / (\text{Thickness}) \\ &= sh / t \end{aligned} \qquad (2.2)$$

All the quantities, Deceleration (G), Static stress (s), Drop Height (h) and Cushion Thickness (t) are listed in the published cushion curves. The two new variables are only related to the material property. Air model [3] has the following relationship for the closed-cell cushion materials.

$$Gs = P\, e^{(E/P)} \qquad (2.3)$$

Where: Gs: Dynamic Stress

P: Normal Air Pressure, Constant

E: Energy Density

The constant P may change with different material because the gases trapped in the cell and the materials are different, but the air model indicates that all published cushion curves may be consolidated to one dynamic stress and energy density curve for one cushioning material.

2-2 Mathematical Models for Computer Programming

Two mathematical models were used in the consolidation of the cushion curves to one dynamic stress and energy density curve in programming. One is Exponential Model that is based on the following equation:

$$Gs = a\, e^{(b\, sh/t)} + c \qquad (2.4)$$

Where:

	G:	Deceleration, G's.
	s:	Static Stress, psi.
	h:	Drop Height, in.
	t:	Cushion Thickness, in.
	a, b, c:	Constants for a certain material.

When three of the four variables are known, the other one can be solved from the equation directly or numerically. For example, when the expected drop height (h), cushion thickness (t) and static stress (s) are known, the protect G level for the cushion material can be solved by rearranging the Equation (2.4) to the following equation:

$$G = [a\, e^{(b\, sh/t)} + c] / s \qquad (2.5)$$

Equation (2.5) was used in programming to generate the cushion curves for the thickness described in the original cushion curves or for a certain thickness. The later information is not contained in the published cushion curves but that will be very useful to design cushion in molded forms. When the expected drop height (h), the fragility level (G) are known, simulating to the cushion design, the cushion thickness (t) has the following simple relationship with static stress (s):

$$t = bsh / [\ln(Gs-c) - \ln(a)] \qquad (2.6)$$

Equation (2.6) was used in programming to solve the minimum thickness and the bearing area for a certain cushioning material. Using the similar approach, the bearing area can be obtained by solving the equation (2.4) for a known drop height (h), fragility level (G) and cushion thickness (t). A special subprogram was written for solving the bearing area because the static stress (s) could not be solved directly.

The relationship of dynamic stress with energy density described in the Equation (2.4) may not be suitable for some cushion materials. Another mathematical model used in programming is a 3rd order Polynomial Model.

$$Gs = a(sh/t)^3 + b(sh/t)^2 + c(sh/t) + d \qquad (2.7)$$

Where: G: Deceleration, G's.

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s: Static Stress, psi.

h: Drop Height, in.

t: Cushion Thickness, in.

a, b, c, d: Constants for a certain material.

Using similar methods as with the Exponential Model, we can rearrange the Equation (2.7) to obtain the following equation:

$$G = [a(sh/t)^3 + b(sh/t)^2 + c(sh/t) + d\,] / s \qquad (2.8)$$

Any thickness cushion curves for a particular material could be generated from the Equation (2.8). Other subprograms were written to solve static stress (s) and thickness (t) numerically [15, 16,17].

The two models, Equation (2.4) and Equation (2.7), could be used to simulate dynamic performances of cushion materials. They were used in the cushion design computer program.

Special codes were needed to control the computing flow between the two models, The parameter (d) was only in the Polynomial Model or d was considered to be equal to zero in the Exponential Model. Whether or not the parameter (d) was equal to zero was tested and used as a switch for the two models.

The constant a, b, c or d for both models were generated from statistic analysis. The correlation coefficient, R^2 , should be greater than 0.99 to ensure

the generated G in plus or minus 5 G's compared with the original G values in the published cushion curves.

2.3 Consolidation of Cushion Curves

The procedure for extraction of the Dynamic Stress vs. Energy Density curve from the published standard cushion curves was described in reference [4]. The first step is to consult the cushion curves. One single curve in particular drop height and thickness is sufficient but for the best results, more curves are preferable. Most published cushion curves cover drop heights from 12 inches to 48 inches in increments of step 6 inches. They also contain thickness from 1 inch to 6 inches and static stress from 0.2 psi to 3.0 psi. The next step is to randomly select points on the curves and tabulate the values for drop heights (h), cushion thickness (t), static stress (s) and peak deceleration (G). Then dynamic stress (Gs) and energy density (sh/t) can be calculated form them. Table 2-1 is one example for EPS foam from ARCO Chemical Company.

Table 2-1 DYLITE D195B, 1.25 PCF, 2-5 Impacts, Expandable Polystyrene

Drop Height in	Thickness in	Stress psi	G	sh/t (x)	Gs (y)
12	1.0	1.00	56.0	12.00	56.00
12	1.5	1.00	40.0	8.00	40.00
12	1.0	1.45	60.0	17.40	87.00
12	3.0	2.00	20.0	8.00	40.00
12	1.5	2.20	40.0	17.60	88.00
12	5.0	1.50	18.0	3.60	27.00
18	1.0	0.50	86.0	9.00	43.00
18	1.5	0.70	60.0	8.40	42.00
18	2.0	1.25	42.0	11.25	52.50
18	2.5	0.25	100.0	1.80	25.00
18	2.0	2.00	48.0	18.00	96.00
18	4.0	2.50	20.0	11.25	50.00
18	5.0	1.70	20.0	6.12	34.00
18	2.5	2.90	40.0	20.88	116.00
24	1.5	0.30	100.0	4.80	30.00
24	1.5	1.10	80.0	17.60	88.00
24	2.0	0.70	60.0	8.40	42.00
24	2.0	1.40	60.0	16.80	84.00
24	2.5	0.50	60.0	4.80	30.00
24	2.5	2.00	52.0	19.20	104.00
24	5.0	2.50	22.0	12.00	55.00
24	3.0	2.50	45.0	20.00	112.50
30	1.5	1.00	110.0	20.00	110.00
30	1.5	0.40	100.0	8.00	40.00
30	2.0	1.30	80.0	19.50	104.00
30	2.0	0.75	70.0	11.25	52.50
30	2.5	1.00	56.0	12.00	56.00

Table 2-1 (continued)

Drop Height in	Thickness in	Stress psi	G	sh/t (x)	Gs (y)
30	3.0	2.30	60.0	23.00	138.00
30	5.0	3.00	30.0	18.00	90.00
30	4.0	3.00	45.0	22.50	135.00
36	2.0	1.20	100.0	21.60	120.00
36	2.0	1.00	90.0	18.00	90.00
36	2.5	1.50	82.0	21.60	123.00
36	4.0	1.30	41.0	11.70	53.30
36	4.0	2.50	55.0	22.50	137.50
36	5.0	3.00	41.0	21.60	123.00
36	5.0	0.80	40.0	5.76	32.00
36	2.5	0.50	75.0	7.20	37.50
42	2.0	1.00	118.0	21.00	118.00
42	2.0	0.60	100.0	12.60	60.00
42	2.0	0.40	100.0	8.40	40.00
42	2.5	1.00	85.0	16.80	85.00
42	2.5	0.60	80.0	10.08	48.00
42	3.0	0.50	75.0	7.00	37.50
42	3.0	0.75	65.0	10.50	48.75
42	3.0	1.60	80.0	22.40	128.00
42	5.0	1.80	40.0	15.12	72.00
48	2.5	0.40	100.0	7.68	40.00
48	2.5	1.20	118.0	23.04	141.60
48	2.5	1.00	100.0	19.20	100.00
48	3.0	0.50	80.0	8.00	40.00
48	3.0	0.70	75.0	11.20	52.50
48	3.0	1.10	80.0	17.60	88.00
48	4.0	0.70	60.0	8.40	42.00
48	4.0	1.50	62.0	18.00	93.00
48	5.0	2.40	60.0	23.04	144.00
48	5.0	1.25	45.0	12.00	56.25

In Table 2.1, there are two columns for the dynamic stress (Gs) and energy density (sh/t). They were calculated by using of the Equation (2.1) and Equation (2.2). Once the table is completed, plot the dynamic stress vs. the energy density to see the trend of the curve and to fit the data to the Exponential Model or Polynomial Model. A spread sheet software with statistic function or statistic software can be used to perform these calculations and regression analysis. Figure 2-1 is the regression result for the EPS cushion. From Figure 2-1, the regression equation is:

$$y = 20.486\, e^{0.0835\, x} \qquad (2.9)$$

and

$$R^2 = 0.9985$$

Where: y: Dynamic Stress or Gs, psi

x: Energy Density or sh/t, in-lb./cu.in

At this point, the consolidation of the cushion curves to one dynamic stress and energy density curve is complete.

Eight cushion materials [9, 11, 12, 13] were consolidated using the same methodology. The dynamic stress and energy density curves are listed on Figure 2-2 to Figure 2-13. The regression results are listed in Table 2-2. The parameters of the regression equations in Table 2-2 were used as the cushion data for the cushion design program.

Table 2-2 Dynamic Stress (y) and Energy Density (x) Data for Popular Cushion Materials

Materials	Impact(s)	Regression Equation	R^2
0.7 PolyPlank	2 ~ 5	$y = -0.0023x^3 + 0.2142x^2 + 0.9868x + 7.2455$	0.9802
1.6 PolyPlank	2 ~ 5	$y = 0.0013x^3 + 0.0645x^2 + 2.1993x + 6.2958$	0.9964
2.2 PolyPlank	2 ~ 5	$y = 0.0032x^3 + 0.0108x^2 + 2.6049x + 5.6353$	0.9912
ARSAN 600	1st	$y = 17.19\ e^{(0.0596x)}$	0.9921
ARSAN 600	2 ~ 5	$y = 16.88\ e^{(0.0891x)}$	0.9969
ARPRO 3313	1st	$y = 12.70\ e^{(0.0805x)}$	0.9973
ARPRO 3313	2 ~ 5	$y = 12.83\ e^{(0.0947x)}$	0.9980
ARPRO 3319	1st	$y = 22.149\ e^{(0.0448x)}$	0.9974
ARPRO 3319	2 ~ 5	$y = 21.57e^{(0.0577x)}$	0.9984
ARCEL 512	1st	$y = 18.79e^{(0.0543x)}$	0.9991
ARCEL 512	2 ~ 5	$y = 18.643e^{(0.0786x)}$	0.9984
DYLITE D195B	1st	$y = 20.655e^{(0.0474x)}$	0.9986
DYLITE D195B	2 ~ 5	$y = 20.486e^{(0.0834x)}$	0.9985

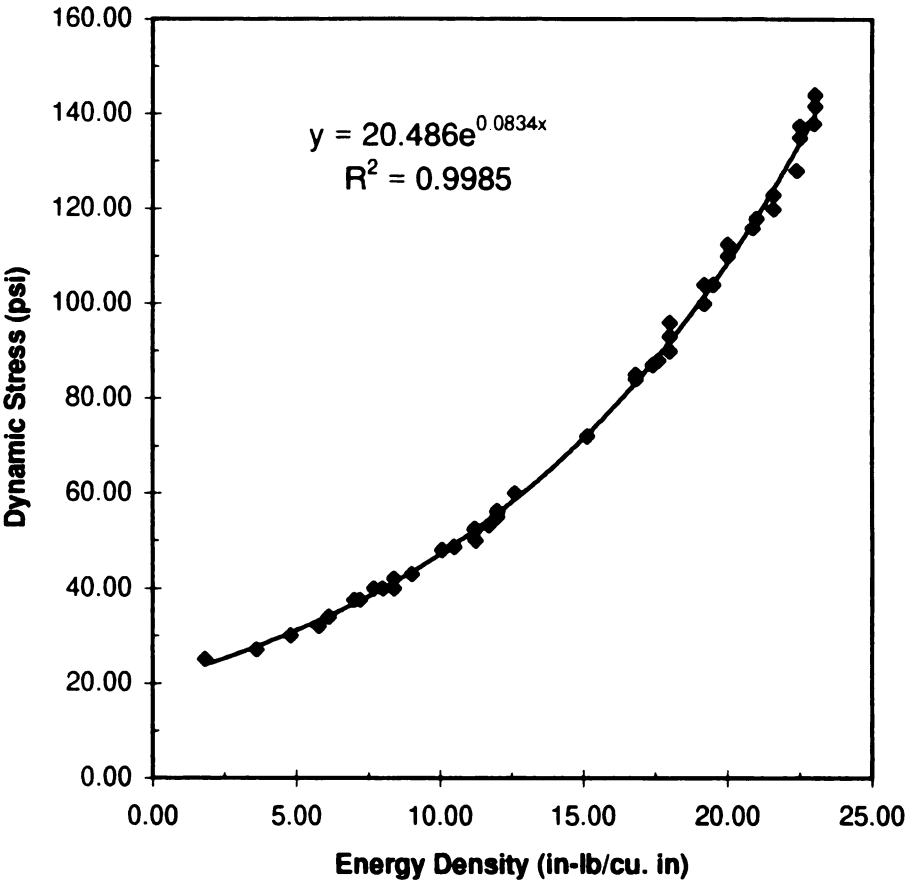

Figure 2-1 Dynamic Stress and Energy Density for DYLITE D195B, 2-5 Impacts

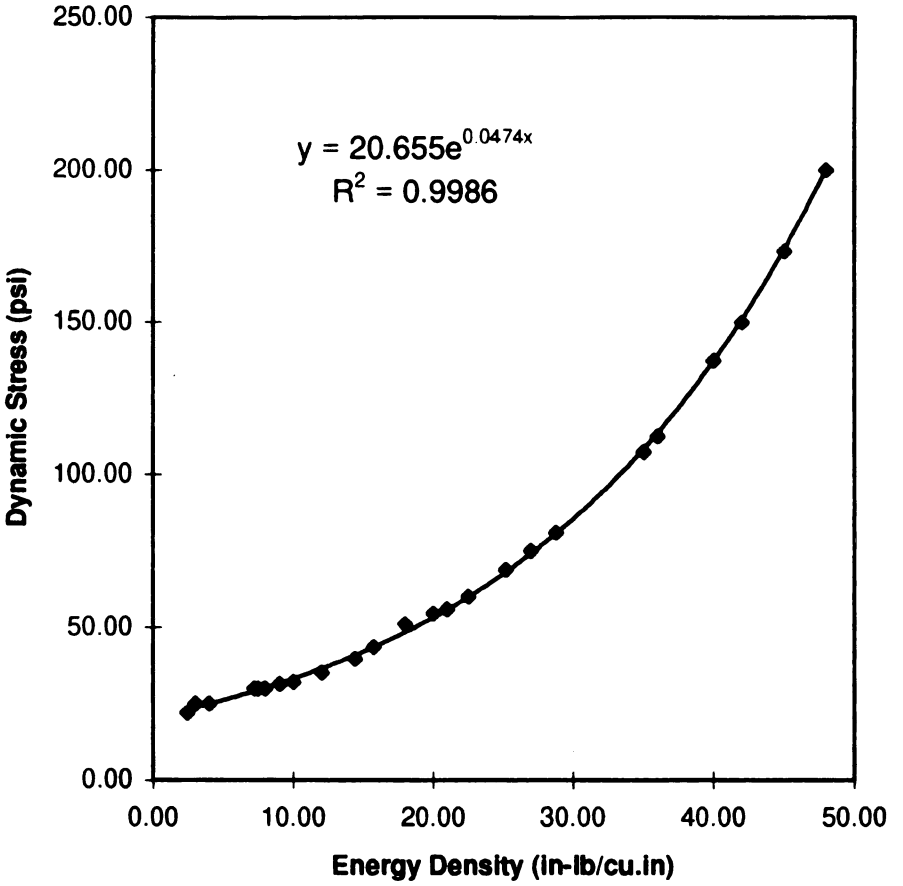

Figure 2-2 Dynamic Stress and Energy Density for DYLITE D195B, 1st Impact

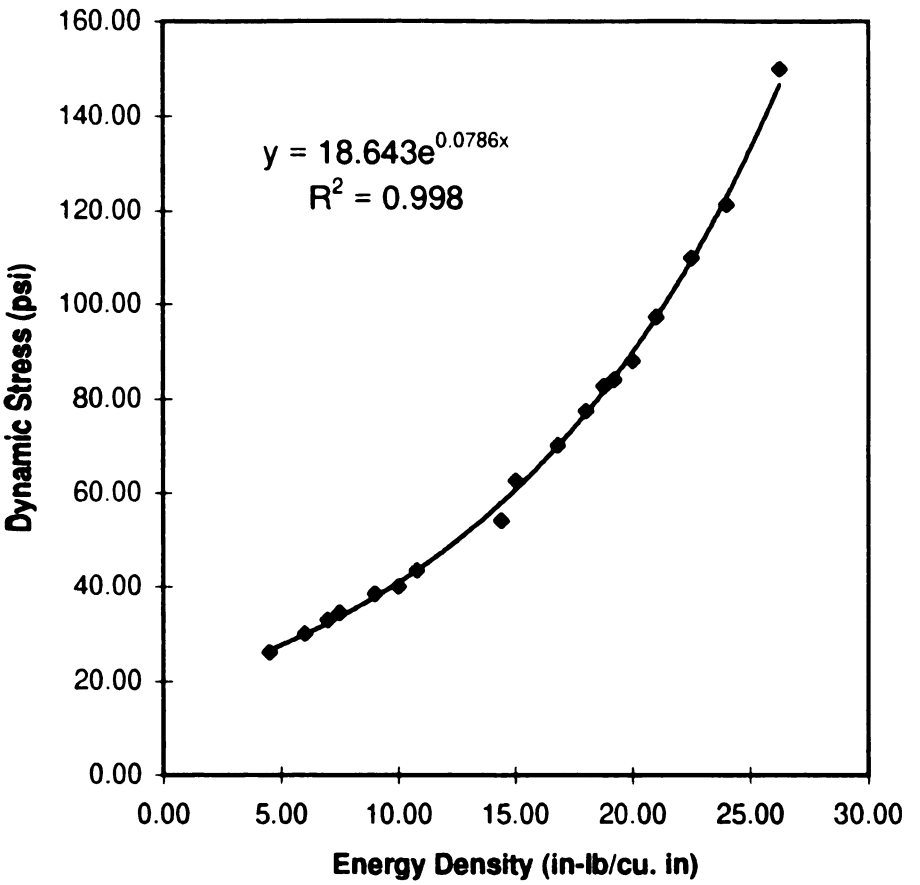

Figure 2-3 Dynamic Stress and Energy Density for ARCEL 512, 2-5 Impacts

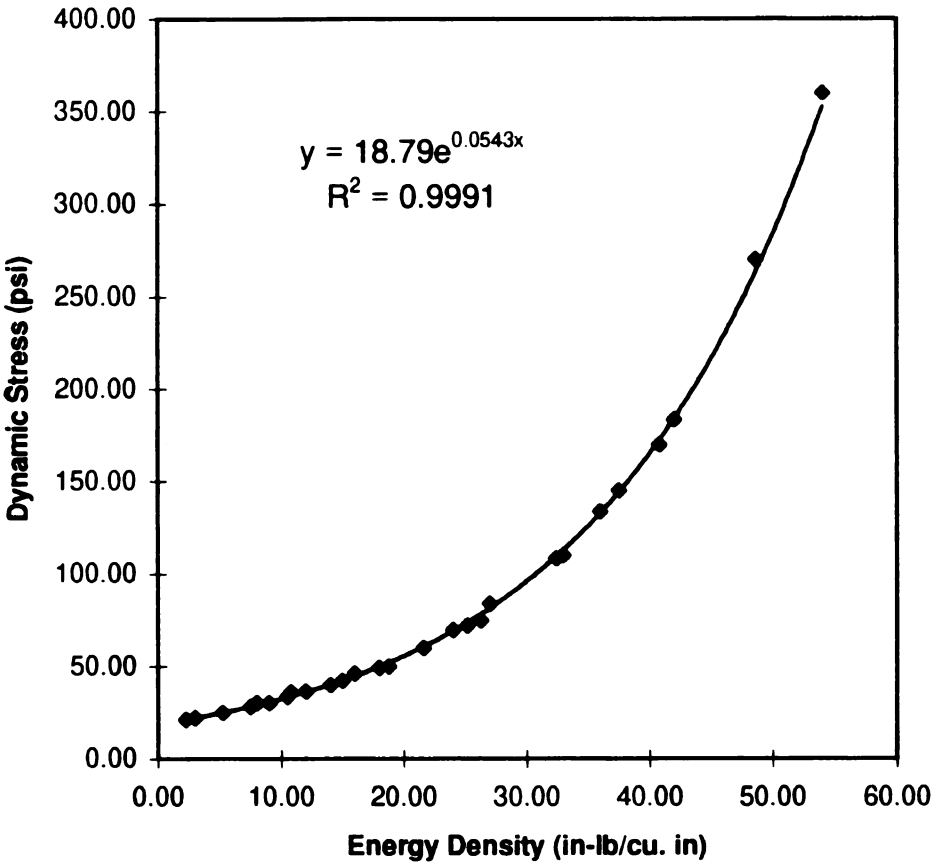

Figure 2-4 Dynamic Stress and Energy Density for ARCEL 512, 1st Impact

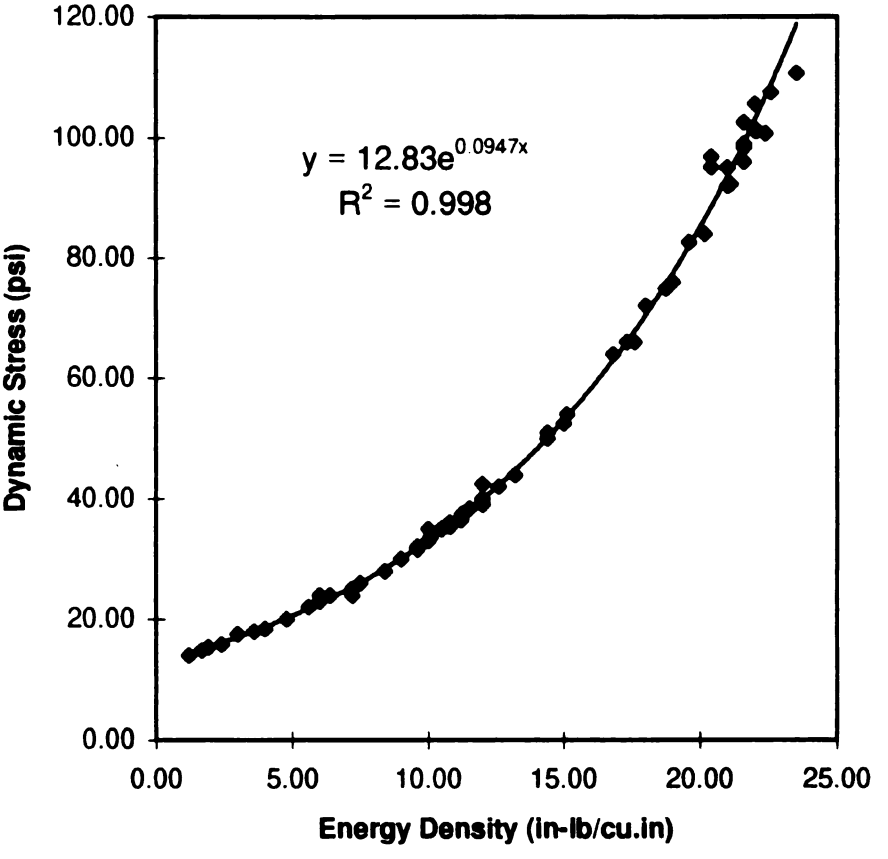

Figure 2-5 Dynamic Stress and Energy Density for ARPRO 3313, 2-5 Impacts

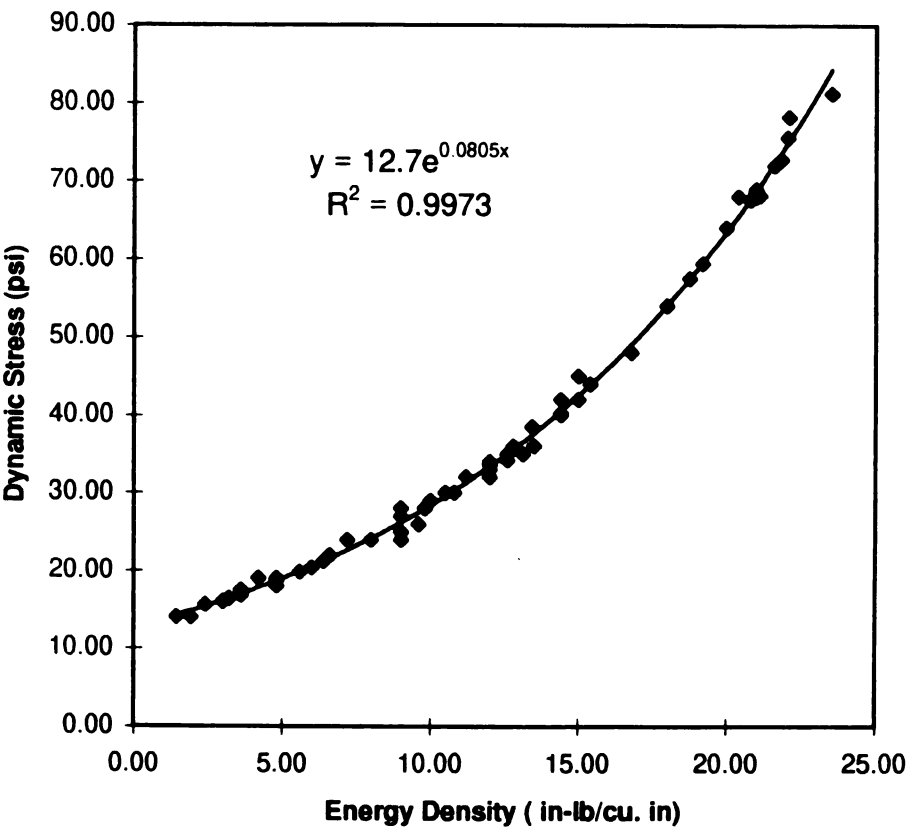

Figure 2-6 Dynamic Stress and Energy Density for ARPRO 3313, 1st Impact

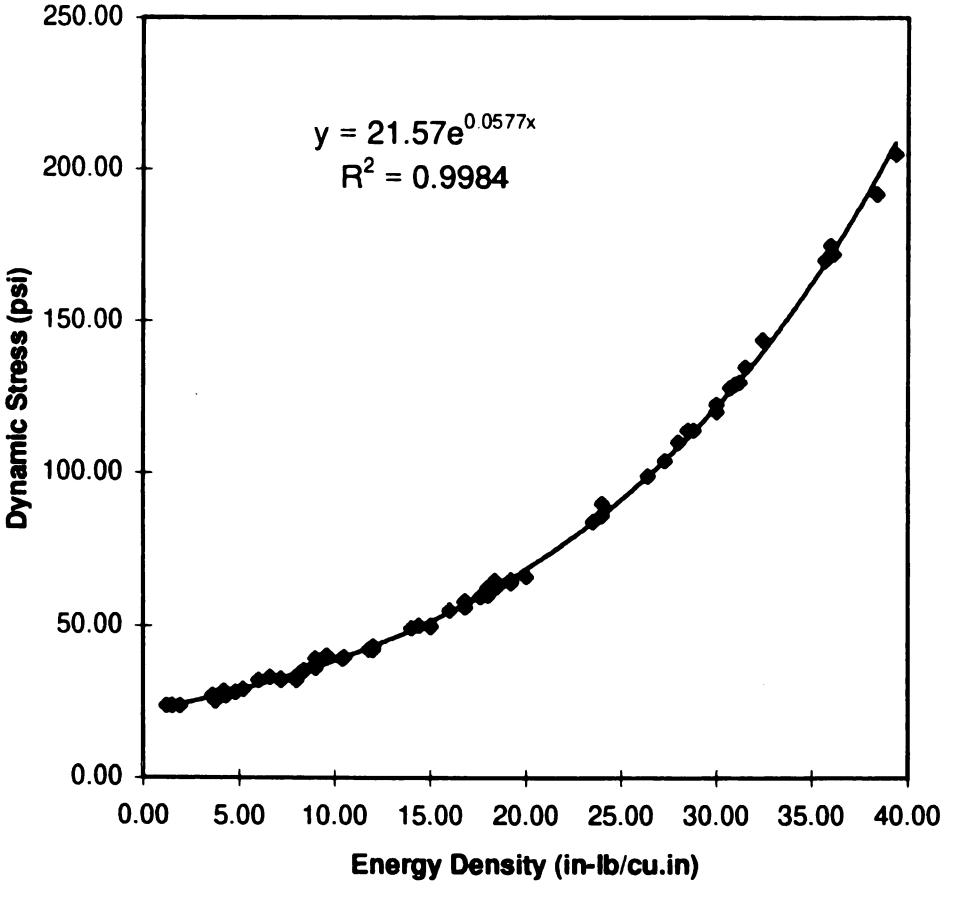

Figure 2-7 Dynamic Stress and Energy Density for ARPRO 3319, 2-5 Impacts

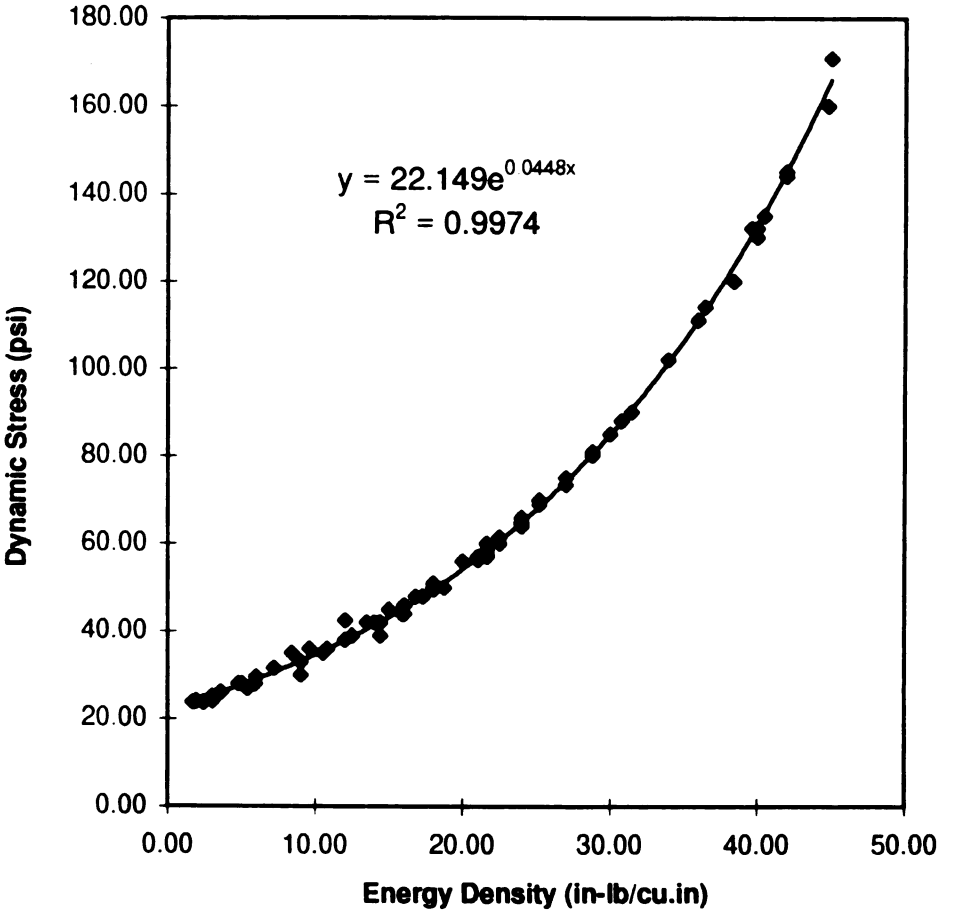

Figure 2-8 Dynamic Stress and Energy Density for ARPRO 3319, 1st Impact

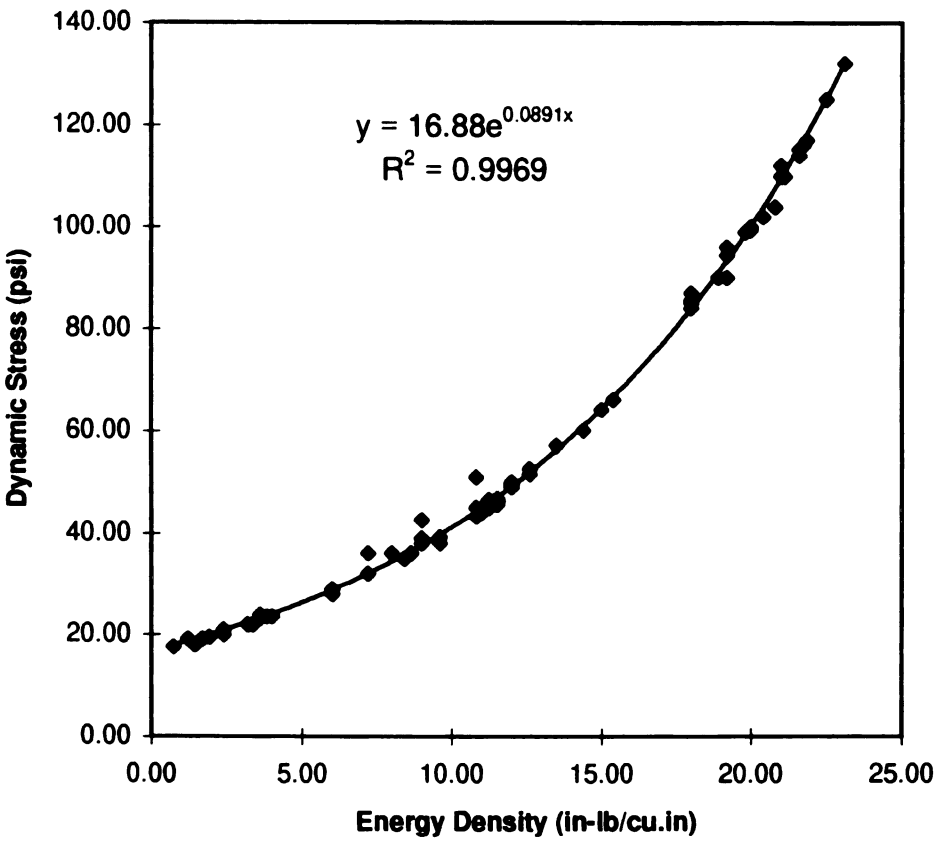

Figure 2-9 Dynamic Stress and Energy Density for ARSAN 600, 2-5 Impacts

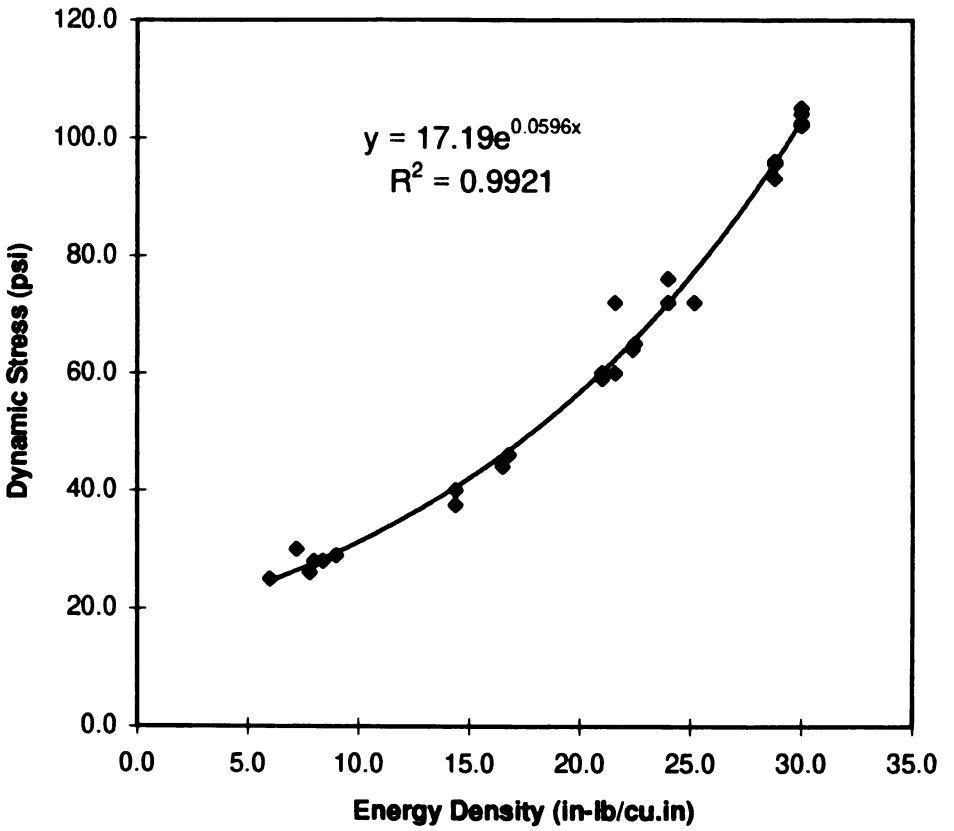

Figure 2-10 Dynamic Stress and Energy Density for ARSAN 600, 1st Impact

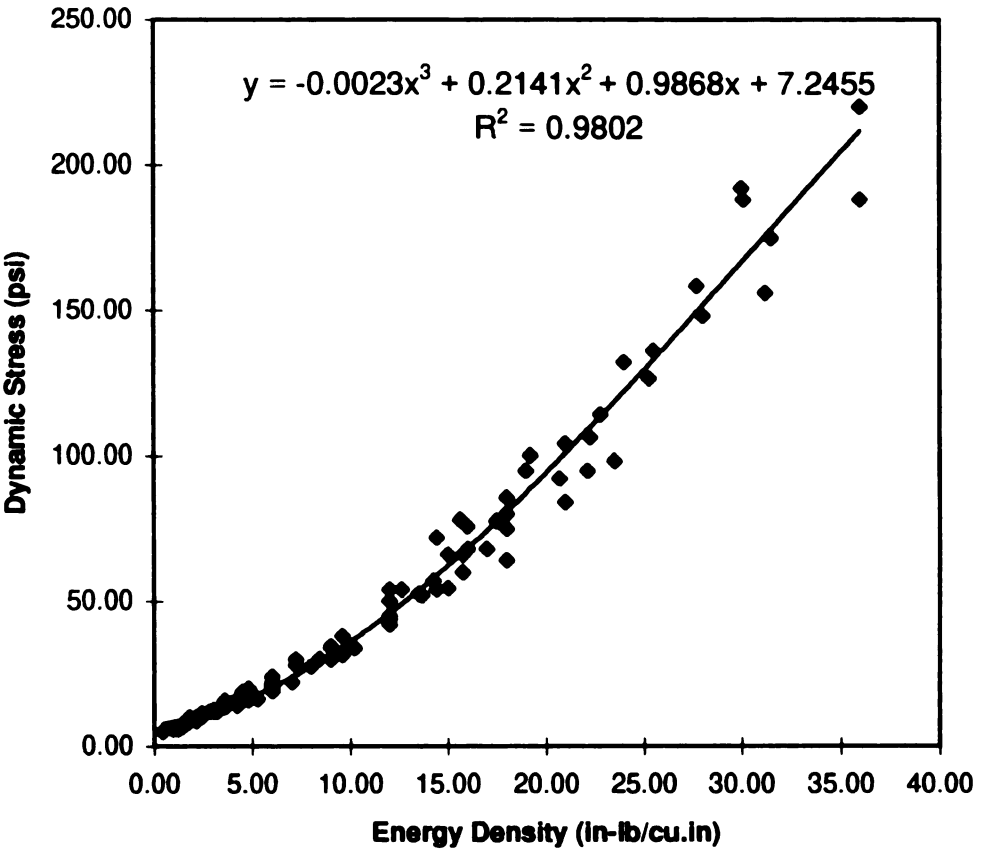

Figure 2-11 Dynamic Stress and Energy Density for 0.7 PolyPlank, 2-5 Impacts

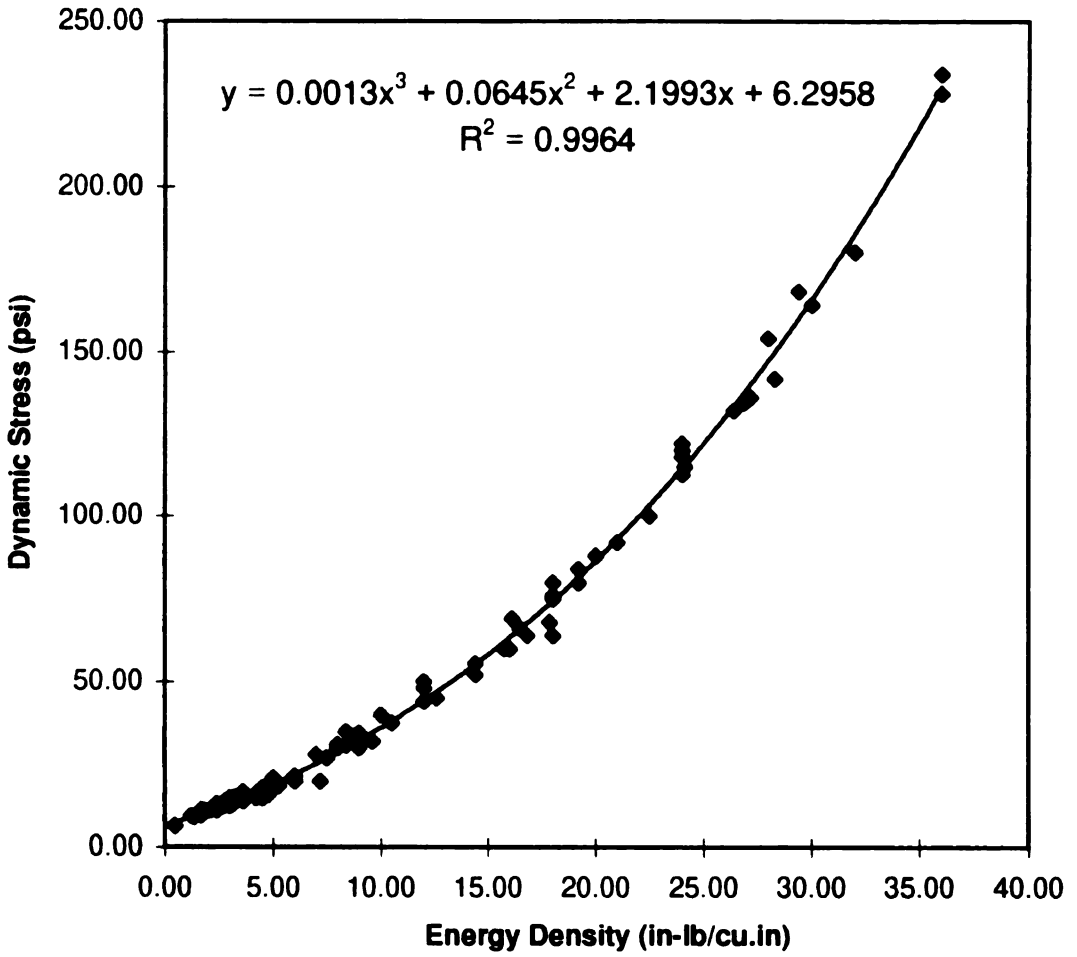

Figure 2-12 Dynamic Stress and Energy Density for 1.6 PolyPlank, 2-5 Impacts

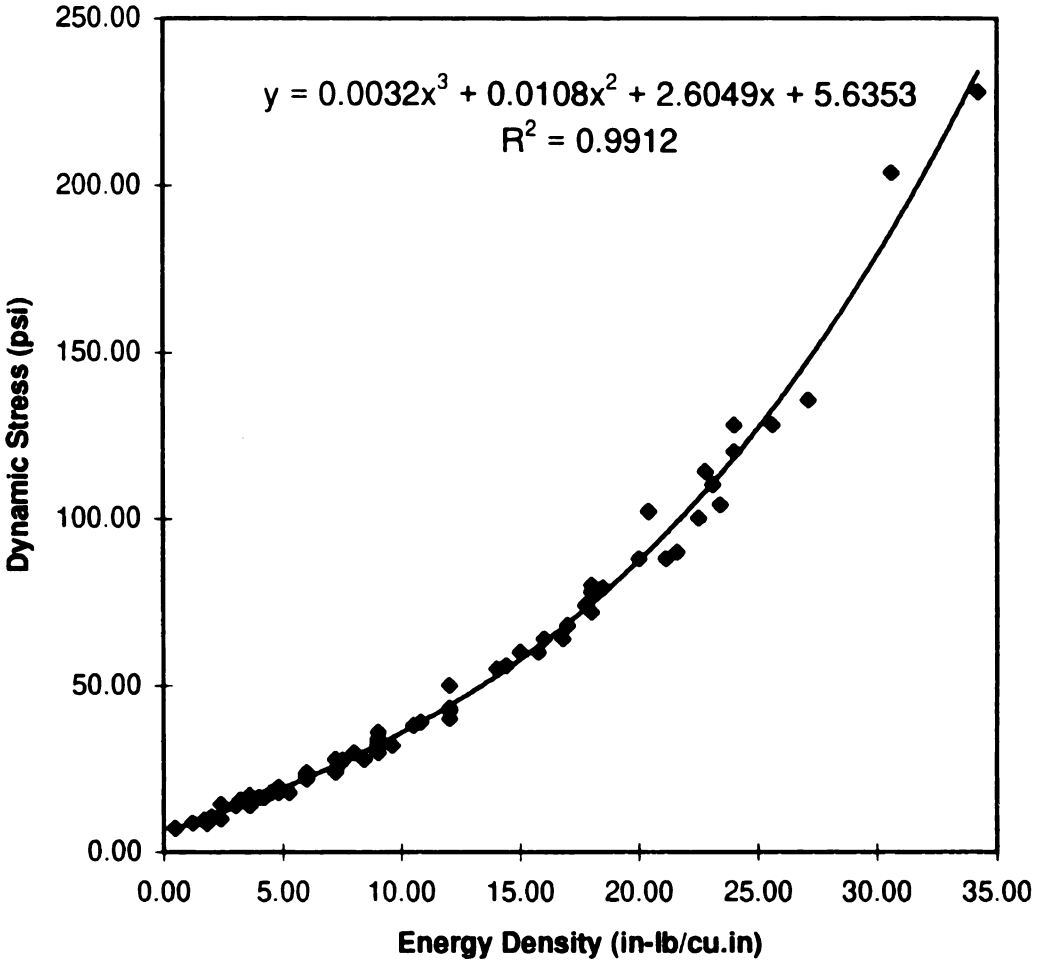

Figure 2-13 Dynamic Stress and Energy Density for 2.2 PolyPlank, 2-5 Impacts

CHAPTER III

COMPUTER PROGRAMMING

3.1 Structure of Program

The structure design method [14] was used in development of the cushion design software because the task was complex. One subprogram was written to solve one problem. When possible, the reusable subprograms were also written so they could be called from many places in the program. The main task of cushion design was broken into the computer design, user design, generating cushion curves. They could be broken down further into one specific function or task so the subprogram could easily handle it. Figure 3-1 shows the main structure of the cushion design program. The Cushion Design program performs four tasks, which are Computer Design, User Design, Generate Cushion Curves and Other Options. In Computer Design, user inputs the product fragility G level, expected drop height and package weight, and then computer gives the cushioning area and material thickness according to two criteria, the minimum volume and the minimum thickness. Figure 3-2 shows the structure in Computer Design.

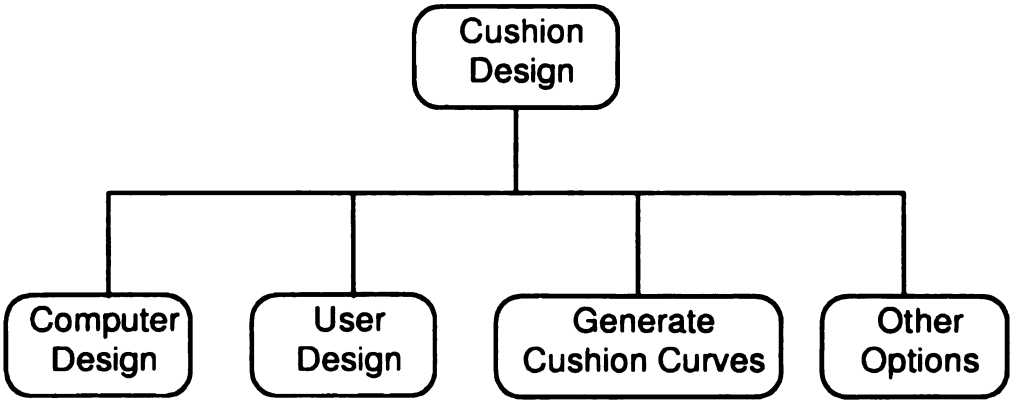

Figure 3-1 Main Structure of the Cushion Design

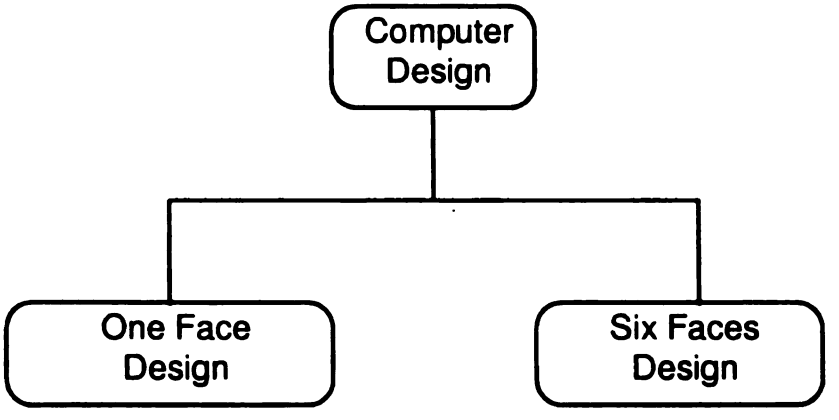

Figure 3-2 The Structure of Computer Design

In User Design, users predetermine the cushion thickness or cushioning area. The cushion design program calculates other variables. User Design can be broken into Material Design, in which cushion material is selected, Thickness Design, where the cushion thickness is fixed, Bearing Area Design, in which cushioning area is predetermined and All of These, where all cushion parameters can be chosen by users. Figure 3-3 shows the structure of it.

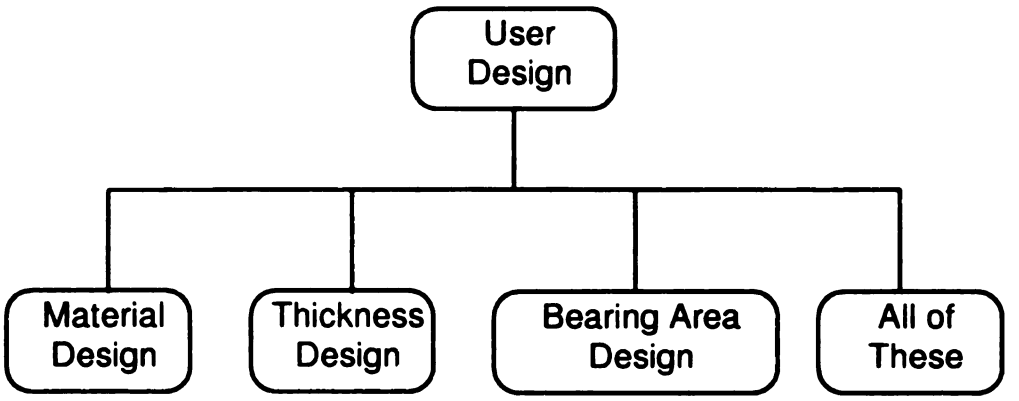

Figure 3-3 Structure of the User Design

Standard Cushion Curves and Special Cushion Curves can be generated from Generated Cushion Curves. There is another function in Generate Cushion Curves. It is Input Cushion Data, which are the regression results according the

two models discussed in the Chapter II. Figure 3-4 shows the general structure of Generate Cushion Curves.

The cushion design program was written according to these structures. In programming, the tasks might be decomposed further for code writing.

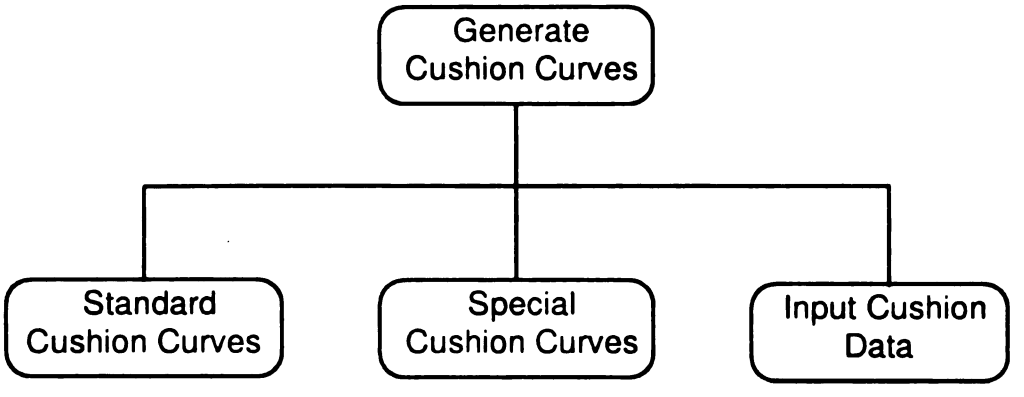

Figure 3-4 Structure of the Generated Cushion Curves

Because the cushion design program was tested on IBM PCs, Qbaisc was chosen to code the program. It is easy to transfer the code to Visual Basic for Windows or C/C++ to take the advantage of the window's graphic interface. In this version of the program, the menu interface with on-line-help was still used.

3.2 Data file

Cushion data are the parameters, a, b, c, and d, in the two models, cushion material name and density, first impact or 2-5 impacts and final stress or maximum stress on the cushion curves. They were written to a special file, which was named as CUDE.DAT for convenience. Table 3-1 shows the data file format used in the program. One advantage of using data file is easily to modify it. Because the data file is in ASCII format, any text editor program, such as DOS EDITOR, can be used to modify the data file. If the text editor is used, open CUDE.DAT referred the editor's operation menu. After add the new cushion data following the exact format, save it in the same name. That will help the packaging engineers to predict cushion curves for a new cushion material.

Table 3-1 shows the data in CUDE.DAT. The first three string values would be assigned to string arrays, Name$(), Impact$() and Density$(). The last column would be the final stress array fs(). The left four numerical values would be assigned to the numerical arrays, a(), b(), c() and d(). A special loop was written to read the data in the starting of the cushion design program and to count the total number of materials available in the program. Because the read loop can be written to test whether or not to reach the end of the data file, if adding new material, the total number of available cushion materials will change also. It is easy to expand the power of the cushion design program.

Table 3-1 Date File Format for the Cushion Design Program

0.7 PolyPlank	2-5	0.75	-0.0023	0.2142	0.9868	7.2455	2.0
1.6 PolyPlank	2-5	1.65	0.0013	0.0645	2.1993	6.2958	2.0
2.2 PolyPlank	2-5	2.2	0.0032	0.0108	2.6049	5.6353	2.0
ARSAN 600	1st	1.0	17.19	0.0596	0	0	3.0
ARSAN 600	2-5	1.0	16.88	0.0891	0	0	3.0
ARPRO 3313	1st	1.3	12.7	0.0805	0	0	3.0
ARPRO 3313	2-5	1.3	12.83	0.0947	0	0	3.0
ARPRO 3319	1st	1.9	22.149	0.0448	0	0	3.0
ARPRO 3319	2-5	1.9	21.57	0.0577	0	0	3.0
ARCEL 512	1st	2	18.79	0.0543	0	0	3.0
ARCEL 512	2-5	2	18.643	0.0786	0	0	3.0
DYLITE D195B	1st	1.25	20.655	0.0474	0	0	3.0
DYLITE D195B	2-5	1.25	20.606	0.0828	0	0	3.0

In Table 3-1, the numerical values on the seventh column are equal to zero for Exponential Model but not to zero for Polynomial Model. These numbers correspond to values of the numerical array d(), which were used as a flag to switch the computing flow between Exponential Model and polynomial Model.

3.3 Interface

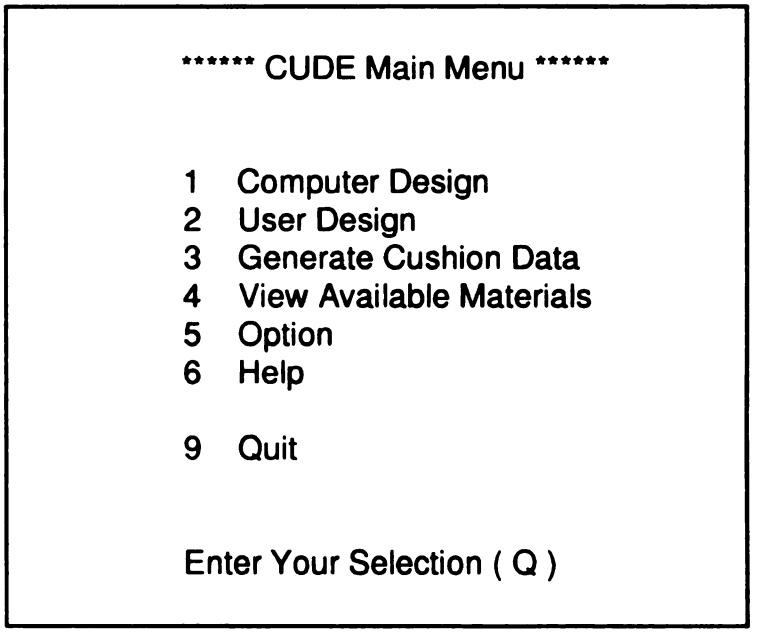

Figure 3-5 Main Menu of Cushion Design Program (CUDE).

Menu interface was used in the program. When the program starts, a cover page about the program name, developed date and other information is

displayed on the screen about 2 second. A main menu like Figure 3-5 appears on the screen. In the main menu, user can enter the number before the item or the first letter of the item. If user enters a number or letter beyond the selections, a beep will be heard and an error message will appear on the screen. The default selection for all menus is on the "Quit" selection.

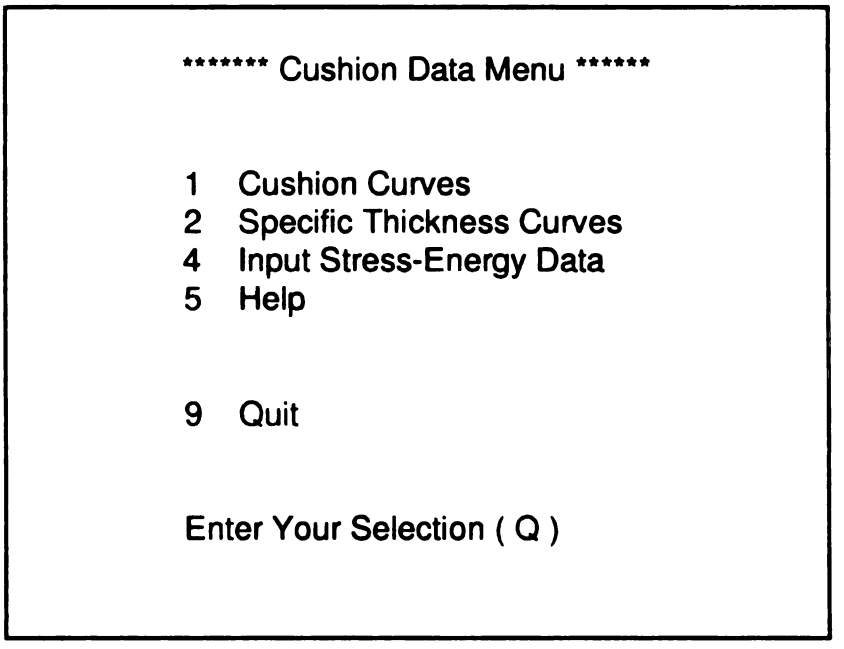

Figure 3-6 The Generate Cushion Data Submenu in CUDE

When the correct selection is entered, a submenu appears on the screen. All the submenus have the same features as the main menu. Figure 3-6 shows the submenu of Generate Cushion Data.

Some items on the maim menu may not have the submenu, such as the "Help" selection on the main menu. The direct result will show on the screen. Usually, the Data Input Screen follows the submenus.

F1 and F9 function keys are active in the program. F1 is for "Help" and F9 means to "Quit".

3.4 Input and Output

The only data that are input through the keyboard are the product weight, product dimensions, product fragility level and expected drop height. The cushion data has been stored in the file, CUDE.DAT, which is read into the program when it is loaded.

Data input subroutines handle the data input tasks. Data entered through keyboard are assigned to a temporary string variable. Whether or not the right number will be checked. A special subprogram converts the string to a number. If an unexpected data format or value is entered, the program will not process the wrong data until the correct format or value are input. That will force users to correct the mistake immediately and prevent the program from crashing or giving unexpected results. The data input subprogram accepts the letter "Q ", or "q" to exit from it.

Figure 3-7 gives a data input example for Six Face Design. In the example, the first and second data entries were in the accepted format and had

successfully been converted into numbers. In the third line, the computer asked to enter "Product Length" but a letter "L" was given. The cursor returned back.

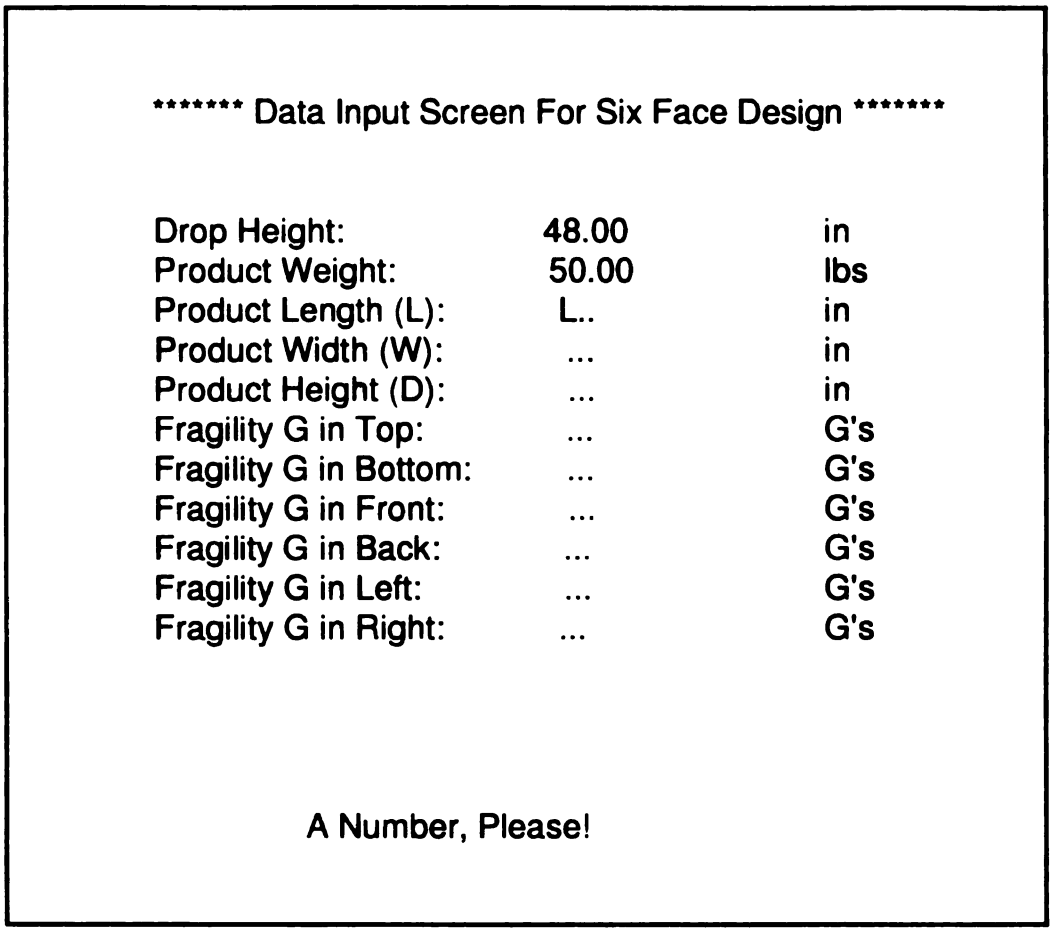

Figure 3-7 A Sample of Data Input for Six Faces Design

The message on the bottom of screen, "A Number, Please" was displayed with a beep to remind the user to correct the mistake. Computer halted and waited for entering the right data format or enter "Q", or "q" to abort the processing.

The default output device is the computer screen. After the cushion design results are displayed on the screen, choices to save file and to send the results to a printer are prompted. The file saved by the cushion design program is the ASCII text file so it can be inserted to a report.

CHAPTER IV

RESULTS AND ANALYSIS

All results in this chapter were obtained by running the cushion design program (CUDE). The source codes were listed in Appendix A. The program was coded in Qbasic, which came with MS-DOS 5.0 (or later). Any IBM PC with MS-DOS 5.0 (or later) can run this program. To run it, the four files, CUDE.BAS, CUDE.INI, CUDE.DAT and DETAIL.DAT, must be located in the same directory. In this directory, start the command line with "qbasic cude" or "qbasic /run cude" on DOS prompt. The later will run the CUDE program without displaying it.

4.1 User Design Material

An example of the results from User Design Material is shown in Figure 4-1. In Figure 4-1, the cushion material, ARCEL 512, was selected and the 2-5 impacts data was also indicated. The information the user input is printed in the beginning of the result table. All the computed results are listed in a tabular form. The first column is the protected G level.

CUDE Report: Minimum Cushion Thickness & Area

User Designed: ARCEL 512, 2-5 Impact(s)
Density = 2.0 pcf
Drop Height: 36 in
Weight: 30 lbs
Face Area:(24 x 36) = 864 sq. in

	Minimum Thickness		Minimum Volume	
G	Thickness	Area	Thickness	Area
g's	in	in2	in	in2
75.00	1.92	7.26	3.36	10.22
70.00	2.05	40.83	3.46	10.22
65.00	2.21	40.83	3.57	10.22
60.00	2.39	35.94	3.70	10.22
55.00	2.61	32.10	3.85	10.22
50.00	2.87	28.99	4.02	10.22
45.00	3.19	26.44	4.24	10.22
40.00	3.59	24.30	4.51	10.22
35.00	4.10	20.91	4.87	10.22
30.00	4.78	17.29	5.35	10.22
25.00	5.74	14.74	6.06	10.22
20.00	7.17	11.84	7.24	10.22
15.00	9.66	10.22	9.66	10.22
10.00	18.30	10.22	18.30	10.22
5.00	18.30	10.22	18.30	10.22

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Figure 4-1 A Sample Output Result of User Design Material from CUDE

The second column and third column are under the Minimum Thickness. The thickness and area were calculated by using of the minimum thickness as criterion. The last two columns are under the tittle of Minimum Volume. The area and thickness were calculated by use of minimum volume as the criterion.

4.2 User Design Thickness

Figure 4-2 shows an example of the output results from User Design Thickness. The result table lists all the available materials in CUDE and their corresponding cushioning area for the thickness designed by user. The last row in the result table is the best material according the minimum area or minimum volume. This best material may not be the most economical one. Because the cushioning areas for all the materials were given, the user could easily compare the current marketing price and choose the most suitable materials for his design. For example, if the cushioning material DYLITE 195B was used for the following design. To prevent 65 G-level in 24 inch drop, if 2 inch thickness was used for a 60 lb. product, the cushioning area would be around 145 in^2 for the first drop or about 34 in^2 for 2-5 drops. If we look the cushion curves [11] and draw a line at 65 G level. The 65 G line will cross the 2 inch thickness curve at around 0.4 psi. This is equal to a cushioning area around 150 in^2 for the first impact. If we do the same things for multiple impacts, we will find the static load is 1.75 psi. CUDE gave 1.745 psi (60 / 34.38 = 1.745 psi), the same results as the original cushion curves in this example.

CUDE Report: Bearing Area & Materials

User Designed Thickness: 2 in
Protected G: 65 G's
Drop Height: 24 in
Product Weight: 60 lbs

No.	Materials	Impacts	Area in2
1	0.7 PolyPlank	2-5	*****
2	1.6 PolyPlank	2-5	*****
3	2.2 PolyPlank	2-5	*****
4	ARSAN 600	1st	171.43
5	ARSAN 600	2-5	32.00
6	ARPRO 3313	1st	21.58
7	ARPRO 3313	2-5	28.44
8	ARPRO 3319	1st	34.83
9	ARPRO 3319	2-5	126.32
10	ARCEL 512	1st	157.89
11	ARCEL 512	2-5	27.52
12	DYLITE D195B	1st	144.58
13	DYLITE D195B	2-5	34.38

The Best Material & Bearing Area:

6	ARPRO 3313	1st	21.58

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Note: ***** means no solution or CUDE can not find it.

Figure 4-2 A Sample Output Result of User Design Thickness from CUDE

4.3 User Design Cushioning Area

An example from User Design Bearing Area is in Figure 4-3. All the input data are listed on the top of the report with computed static stress. There are four columns in the results. The first column shows the code number of the cushion material in this program. The second column lists the name of the available cushion materials. Because different performances of cushioning materials between the first drop and 2-5 drops, the impact(s) are listed in the third column also. The final column is the computed results, which are the minimum thickness for the cushion material listed on the same line. On the final row in the table, the best material, based on thickness, was recommended by CUDE. The user could compare the different thickness with the cushion material current marketing price and decide which was the most economical one.

The User Design Bearing Area function is best suited for a product that requires to cushion the entire base area.

CUDE Report: Thickness & G in Available Materials

User Designed Bearing Area:	100	sq. in
Static stress:	0.50	psi
Drop Height:	36	in
Protect G:	80	G's
Product Weight:	50	lbs

No.	Material	Impact(s)	Thickness in
1	0.7 PolyPlank	2-5	1.68
2	1.6 PolyPlank	2-5	1.66
3	2.2 PolyPlank	2-5	1.66
4	ARSAN 600	1st	1.27
5	ARSAN 600	2-5	1.86
6	ARPRO 3313	1st	1.26
7	ARPRO 3313	2-5	1.50
8	ARPRO 3319	1st	1.36
9	ARPRO 3319	2-5	1.68
10	ARCEL 512	1st	1.29
11	ARCEL 512	2-5	1.85
12	DYLITE D195B	1st	1.29
13	DYLITE D195B	2-5	2.25

The Best Material & Thickness For This Design:

6	ARPRO 3313	1st	1.26

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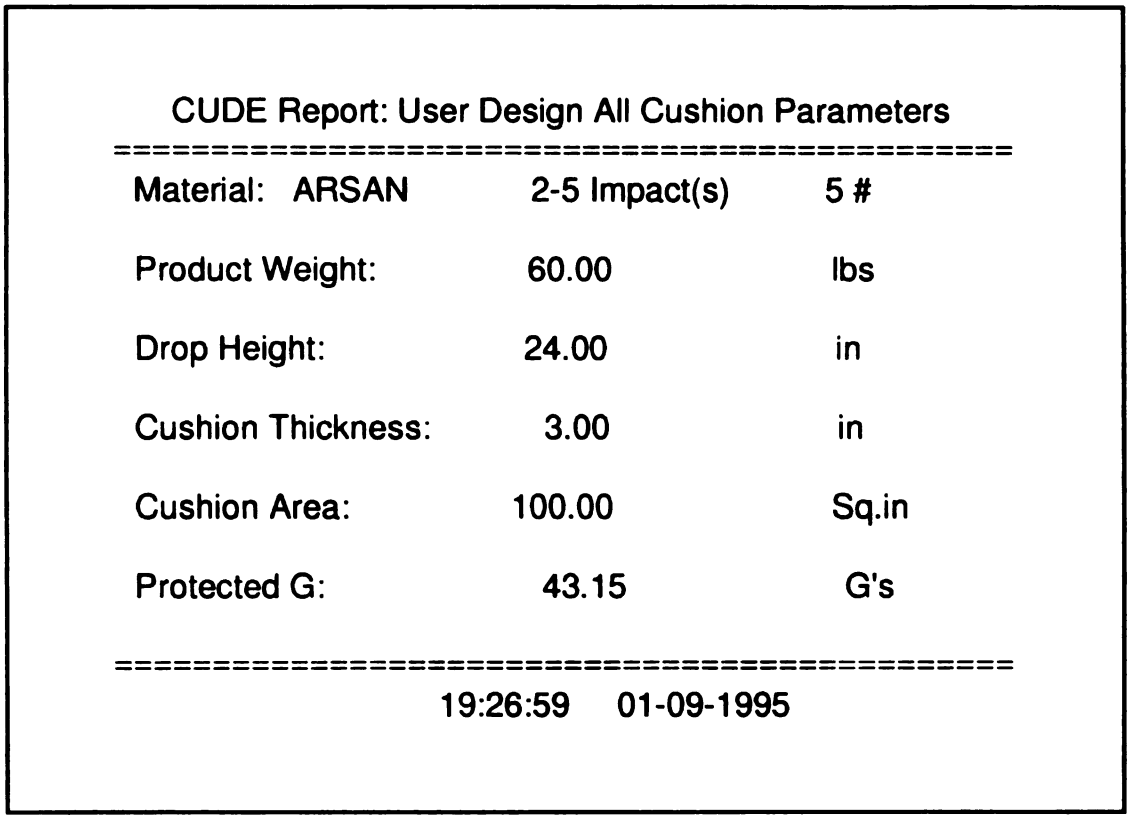
Figure 4-3 A Sample Output Result of User Design Area

4.4. User Design All Cushion Parameters

Figure 4-4 shows a sample output from User Design All Cushion Parameters. In this function, the user is free to select all the parameters.



CUDE Report: User Design All Cushion Parameters

Material: ARSAN	2-5 Impact(s)	5 #
Product Weight:	60.00	lbs
Drop Height:	24.00	in
Cushion Thickness:	3.00	in
Cushion Area:	100.00	Sq.in
Protected G:	43.15	G's

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Figure 4-4 A Sample Output Result of User Design All Cushion Parameters from CUDE

The Protected G level is shown on the last line. Users can input all possible combination for their product and find the best solution. This function

can be used to check the designed cushion to see what G level can be protected.

4.5 One Face Design Results

A sample of CUDE for One Face Design results is shown in Figure 4-5. The results show all the available cushion materials on the left, and the corresponding cushion thickness and bearing areas list on the right. The thickness listed under Minimum Thickness is the minimum thickness to be used for the cushion material. The thickness under the Minimum Volume is the fewest cushion materials to be used. Users can decide which set data will be used for their products. The final row is the recommendation of CUDE.

CUDE Report For One Face Design: Thickness & Materials

Protected G:	75	g's
Drop Height:	36	in
Product Weight:	25	lbs
Face Area; 24 x 36 :	864	in^2

No.	Material	Minimum Thickness Impact(s)	Thick. in	Area in2	Minimum Thick. in	Volume Area in2
1	0.7 PolyPlank	2-5	1.70	109.20	2.60	12.63
2	1.6 PolyPlank	2-5	1.80	76.00	2.50	12.96
3	2.2 PolyPlank	2-5	1.80	76.00	2.60	12.96
4	ARSAN 600	1st	1.34	39.75	2.49	8.39
5	ARSAN 600	2-5	1.96	39.75	3.70	8.39
6	ARPRO 3313	1st	1.33	52.20	3.01	8.39
7	ARPRO 3313	2-5	1.59	52.20	3.55	8.39
8	ARPRO 3319	1st	1.30	32.10	2.08	8.39
9	ARPRO 3319	2-5	1.62	32.10	2.65	8.39
10	ARCEL 512	1st	1.33	36.82	2.35	8.39
11	ARCEL 512	2-5	1.91	36.82	3.39	8.39
12	DYLITE D195B	1st	1.28	34.30	2.13	8.39
13	DYLITE D195B	2-5	2.23	34.30	3.73	8.39

The Best Cushion Material:

12	DYLITE D195B	1st	1.28	34.30	2.13	8.39

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Figure 4-5 A Sample Output Result of Computer One Face Design

4.6 Computer Six Face Design.

Six Face Design generates a set of reports by different faces. The corresponding cushion parameters are reported at the top of the result table so users can easily distinguish the results for a special face from the others. The result reports are numbered from CUDE Report 1 to CUDE Report 6. The CUDE Reporter 1 is for top face of the product and CUDE Reporter 2 is for the bottom face. Reports 3 and 4 are for the frond and back of the product. Report 5 and 6 are for the left and right face. Which face is top or bottom is depended on the data input by the user.

An example of Six Face results is shown in Figure 4-6 to Figure 4-11. The example uses 30 lbs as the product weight. The product size is 24 x 36 x 24 in^3 and different fragility is given for each face. CUDE recommended the DYLETE D195B as the best material to be used. The user could override the results by selection of other material, thickness and bearing area combination from the result tables.

CUDE Report 1 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Top, Area:	24 X 36 = 864	in2
Protected G in the Face:	70	G's
Drop Height:	36	in
Product Weight:	30	lbs
L X W X D: 24 x 36 x 24	= 20736	in

No.	Material	Impact(s)	Minimum Thickness Thick. in	Area in2	Minimum Volume Thick. in	Area in2
1	0.7 PolyPlank	2-5	1.80	89.63	2.80	15.51
2	1.6 PolyPlank	2-5	1.90	69.01	2.70	15.51
3	2.2 PolyPlank	2-5	1.90	69.01	2.80	15.51
4	ARSAN 600	1st	1.43	47.26	2.54	10.22
5	ARSAN 600	2-5	2.10	47.26	3.77	10.22
6	ARPRO 3313	1st	1.43	56.10	3.06	10.22
7	ARPRO 3313	2-5	1.70	56.10	3.61	10.22
8	ARPRO 3319	1st	1.39	35.94	2.13	10.22
9	ARPRO 3319	2-5	1.74	35.94	2.70	10.22
10	ARCEL 512	1st	1.43	40.83	2.40	10.22
11	ARCEL 512	2-5	2.05	40.83	3.46	10.22
12	DYLITE D195B	1st	1.37	35.94	2.18	10.22
13	DYLITE D195B	2-5	2.39	35.94	3.80	10.22

The Best Cushion Material:

12	DYLITE D195B	1st	1.37	35.94	2.18	10.22

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Figure 4-6 A Sample Output of Computer Six Face Design for Top Face

CUDE Report 2 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Bottom, Area: 24 X 36 = 864 in2
Protected G in the Face: 80 G's
Drop Height: 36 in
Product Weight: 30 lbs
L X W X D: 24 x 36 x 24 = 20736 in

No.	Material	Minimum Impact(s)	Thickness Thick. in	Area in2	Minimum Thick. in	Volume Area in2
1	0.7 PolyPlank	2-5	1.60	127.81	2.50	15.51
2	1.6 PolyPlank	2-5	1.70	89.63	2.50	15.51
3	2.2 PolyPlank	2-5	1.70	89.63	2.50	15.51
4	ARSAN 600	1st	1.26	47.26	2.41	10.22
5	ARSAN 600	2-5	1.84	56.10	3.58	10.22
6	ARPRO 3313	1st	1.25	69.01	2.92	10.22
7	ARPRO 3313	2-5	1.49	69.01	3.44	10.22
8	ARPRO 3319	1st	1.21	40.83	2.00	10.22
9	ARPRO 3319	2-5	1.52	40.83	2.55	10.22
10	ARCEL 512	1st	1.25	47.26	2.27	10.22
11	ARCEL 512	2-5	1.79	47.26	3.28	10.22
12	DYLITE D195B	1st	1.20	40.83	2.06	10.22
13	DYLITE D195B	2-5	2.09	40.83	3.60	10.22

The Best Cushion Material:

No.	Material	Minimum Impact(s)	Thickness Thick. in	Area in2	Minimum Thick. in	Volume Area in2
12	DYLITE D195B	1st	1.20	40.83	2.06	10.22

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Figure 4-7 A Sample Output of Computer Six Face Design for Bottom Face

CUDE Report 3 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Front, Area: 24 X 24 =	576	in2
Protected G in the Face:	75	G's
Drop Height:	36	in
Product Weight:	30	lbs
L X W X D: 24 x 36 x 24 =	20736	in

No.	Material	Impact(s)	Minimum Thickness Thick. in	Minimum Thickness Area in2	Minimum Volume Thick. in	Minimum Volume Area in2
1	0.7 PolyPlank	2-5	1.70	127.81	2.70	15.51
2	1.6 PolyPlank	2-5	1.80	89.63	2.60	15.51
3	2.2 PolyPlank	2-5	1.80	89.63	2.60	15.51
4	ARSAN 600	1st	1.34	47.26	2.47	10.22
5	ARSAN 600	2-5	1.96	47.26	3.67	10.22
6	ARPRO 3313	1st	1.34	69.01	2.98	10.22
7	ARPRO 3313	2-5	1.59	69.01	3.52	10.22
8	ARPRO 3319	1st	1.30	35.94	2.06	10.22
9	ARPRO 3319	2-5	1.63	40.83	2.62	10.22
10	ARCEL 512	1st	1.33	47.26	2.33	10.22
11	ARCEL 512	2-5	1.92	47.26	3.36	10.22
12	DYLITE D195B	1st	1.28	40.83	2.12	10.22
13	DYLITE D195B	2-5	2.23	40.83	3.69	10.22

The Best Cushion Material:

12	DYLITE D195B	1st	1.28	40.83	2.12	10.22

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Figure 4-8 A Sample Output of Computer Six Face Design for Front Face

CUDE Report 4 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Back, Area: 24 X 24 =	576	in2
Protected G in the Face:	60	G's
Drop Height:	36	in
Product Weight:	30	lbs
L X W X D: 24 x 36 x 24 =	20736	in

No.	Material	Impact(s)	Minimum Thickness Thick. in	Area in2	Minimum Volume Thick. in	Area in2
1	0.7 PolyPlank	2-5	2.20	89.63	3.20	15.51
2	1.6 PolyPlank	2-5	2.30	69.01	3.00	15.51
3	2.2 PolyPlank	2-5	2.30	56.10	3.00	15.51
4	ARSAN 600	1st	1.67	40.83	2.71	10.22
5	ARSAN 600	2-5	2.46	40.83	4.01	10.22
6	ARPRO 3313	1st	1.67	56.10	3.23	10.22
7	ARPRO 3313	2-5	1.99	47.26	3.82	10.22
8	ARPRO 3319	1st	1.62	28.99	2.28	10.22
9	ARPRO 3319	2-5	2.03	32.10	2.90	10.22
10	ARCEL 512	1st	1.66	35.94	2.56	10.22
11	ARCEL 512	2-5	2.39	35.94	3.70	10.22
12	DYLITE D195B	1st	1.60	32.10	2.34	10.22
13	DYLITE D195B	2-5	2.78	32.10	4.08	10.22

The Best Cushion Material:

12	DYLITE D195B	1st	1.60	32.10	2.34	10.22

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Figure 4-9 A Sample Output of Computer Six Face Design for Back Face

CUDE Report 5 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Left, Area: 36 X 24 =	864	in2
Protected G in the Face:	65	G's
Drop Height:	36	in
Product Weight:	30	lbs
L X W X D: 24 x 36 x 24 =	20736	in

No.	Material	Impact(s)	Minimum Thickness Thick. in	Area in2	Minimum Volume Thick. in	Area in2
1	0.7 PolyPlank	2-5	2.00	89.63	3.00	15.51
2	1.6 PolyPlank	2-5	2.10	69.01	2.80	15.51
3	2.2 PolyPlank	2-5	2.10	69.01	2.90	15.51
4	ARSAN 600	1st	1.54	40.83	2.62	10.22
5	ARSAN 600	2-5	2.27	40.83	3.88	10.22
6	ARPRO 3313	1st	1.54	56.10	3.14	10.22
7	ARPRO 3313	2-5	1.83	56.10	3.71	10.22
8	ARPRO 3319	1st	1.49	32.10	2.20	10.22
9	ARPRO 3319	2-5	1.87	32.10	2.80	10.22
10	ARCEL 512	1st	1.54	35.94	2.48	10.22
11	ARCEL 512	2-5	2.21	40.83	3.57	10.22
12	DYLITE D195B	1st	1.47	35.94	2.25	10.22
13	DYLITE D195B	2-5	2.57	35.94	3.93	10.22

The Best Cushion Material:

12	DYLITE D195B	1st	1.47	35.94	2.25	10.22

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Figure 4-10 A Sample Output of Computer Six Face Design for Left Face

CUDE Report 6 : Computer Designed Six Faces
Bearing Area & Minimum Thickness in Available Materials

Right, Area: 36 X 24 =	864	in2
Protected G in the Face:	85	G's
Drop Height:	36	in
Product Weight:	30	lbs
L X W X D: 24 x 36 x 24 =	20736	in

No.	Material	Impact(s)	Minimum Thickness Thick. in	Area in2	Minimum Volume Thick. in	Area in2
1	0.7 PolyPlank	2-5	1.50	127.81	2.40	15.51
2	1.6 PolyPlank	2-5	1.60	89.63	2.40	15.51
3	2.2 PolyPlank	2-5	1.60	89.63	2.50	15.51
4	ARSAN 600	1st	1.18	56.10	2.35	10.22
5	ARSAN 600	2-5	1.73	56.10	3.50	10.22
6	ARPRO 3313	1s	1.18	69.01	2.86	10.22
7	ARPRO 3313	2-5	1.40	69.01	3.37	10.22
8	ARPRO 3319	1st	1.14	40.83	1.95	10.22
9	ARPRO 3319	2-5	1.44	40.83	2.49	10.22
10	ARCEL 512	1st	1.18	47.26	2.22	10.22
11	ARCEL 512	2-5	1.69	47.26	3.20	10.22
12	DYLITE D195B	1st	1.13	47.26	2.01	10.22
13	DYLITE D195B	2-5	1.97	47.26	3.51	10.22

The Best Cushion Material:

12	DYLITE D195B	1st	1.13	47.26	2.01	10.22

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Figure 4-11 A Sample Output of Computer Six Face Design for Right Face

CHAPTER V

CONCLUSIONS

Conclusions

1. Exponential and polynomial models can be used to describe the relationships of dynamic stress with energy density. Eight cushion materials were analyzed using statistical methods for the dynamic stress and energy density equations. The parameters of regression equations can be used as cushion data when R^2 is greater than 0.99.

2 A computer program for cushion design can been written based on the exponential and polynomial models.

3 The testing version of the cushion design program was coded in Qbasic and named as CUDE. CUDE has three main functions, Computer Design, User Design and Generate Cushion Date. The sample running results show that the cushioning parameters designed by CUDE are the same as the results using the original cushion curves.

4. The cushion design process will be simplified and speeded up using the cushion design program as an aided tool. More cushion materials will be needed to increase the program power.

APPENDIX

APPENDIX

QBASIC SOURCE CODE FOR CUSHION DESIGN PROGRAM

```
'=======================================================
'                    *** Cushion Design V x.xx ***
'-------------------------------------------------------------------------------
'File Name:                 CUDEXX.BAS
'Author:                    Ruogong Liu
'Last Modified Date:        3/27/94
'=======================================================
'
' CUDEXX.BAS uses the Dynamic Stress & Energy Density Equations:
'
'          G*s = a*exp(b*s*h/t) + c
'
' and
'          G*s = a*(s*h/t)**3 + b*(s*h/t)**2 + c*(s*h/t) + d
'
' to process all data analysis.
'
' Where:
'       a, b, c, d:   Constant for certant material;
'       G:            Protected G, g's ( g = 386.4 in/s2 );
'       h:            Expected drop heigh ( in );
'       t:            Cushion thickness ( in );
'       s:            Static stress ( psi )
'
' G, t, or s can been solved directly or numerically.

DECLARE SUB Cover ()
DECLARE SUB Case.Else ()
DECLARE SUB Curves.Graphic (i!)
DECLARE SUB Curve.Spe.T (i!, t!)
DECLARE SUB DOS ()
DECLARE SUB Exit.Message ()
```

```
DECLARE SUB Help.P.File ()
DECLARE SUB Help.CUDE ()
DECLARE SUB Hit.any.key ()
DECLARE SUB Ini.Data ()
DECLARE SUB Info ()
DECLARE SUB Input.SE.Data ()
DECLARE SUB Input.D.Material ()
DECLARE SUB Input.D.Thickness ()
DECLARE SUB Input.D.Area ()
DECLARE SUB Input.D.All ()
DECLARE SUB Input.Std.Curve ()
DECLARE SUB Input.Spe.Curve ()
DECLARE SUB Input.1.Design ()
DECLARE SUB Input.6.Design ()
DECLARE SUB List.File ()
DECLARE SUB Menu.Generate.Data ()
DECLARE SUB Menu.User.Design ()
DECLARE SUB Menu.Compu.Design ()
DECLARE SUB Menu.Option ()
DECLARE SUB Menu.View.Data ()
DECLARE SUB Detail.Data ()
DECLARE SUB message (F, h)
DECLARE SUB Number.CK (R$, R!)
DECLARE SUB Pause ()
DECLARE SUB Screen.Color ()
DECLARE SUB Show.Color ()
DECLARE SUB Solve.1.Face (Out$, F!, h!, P!)
DECLARE SUB Solve.6.Faces (Out$, Face%, h!, P!)
DECLARE SUB Solve.6.Face.File (Out$, Face%, h!, P!)
DECLARE SUB User.D.Thickness (Out$, F!, h!, P!, t!)
DECLARE SUB User.D.Area (Out$, F!, h!, P!, Area!)
DECLARE SUB User.D.Material (Out$, F!, h!, P!, i!)
DECLARE FUNCTION User.D.All.exp! (W!, h!, t!, Area!, i!)
DECLARE FUNCTION User.D.All.pol! (W!, h!, t!, Area!, i!)
DECLARE SUB View.Data.File ()

DIM SHARED Name$(1 TO 100), Impact$(1 TO 100), Density$(1 TO 100)
DIM SHARED a(1 TO 100), b(1 TO 100), c(1 TO 100), d(1 TO 100), fs(1 TO
100), t(1 TO 100), G(1 TO 6)
DIM Mt(1 TO 100), MtA(1 TO 100), Mvt(1 TO 100), MvA(1 TO 100)

ON ERROR GOTO Handler     'Handle Error
KEY 1, "H" + CHR$(13)     'Enable F1 Function Key
KEY 9, "Q" + CHR$(13)     'Enable F9 Function Key
SCREEN 0: CLS             'Prepare Screen
```

```
CALL Cover              'Load Cover
CALL Info               'Load Information about CUDE
CALL Ini.Data           'Load Screen Setting & Cushion Data

ERCOV:                  'Label "ERCOV" for the Error Resume
DO                      'Main Menu
   CLS
   LOCATE 2, 20: PRINT "******* CUDE Main Menu *******"
   LOCATE 5, 20: PRINT "1   Computer Design"
   LOCATE 6, 20: PRINT "2   User Design"
   LOCATE 7, 20: PRINT "3   Generate Cushion Data "
   LOCATE 8, 20: PRINT "4   View Available Materials"
   LOCATE 9, 20: PRINT "5   Option"
   LOCATE 10, 20: PRINT "6   Help"

   LOCATE 12, 20: PRINT "9   Quit"
   LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
   LOCATE 15, 43: INPUT "", s$
   SELECT CASE UCASE$(s$)
   CASE "1", "C"
      CALL Menu.Compu.Design
   CASE "2", "U"
      CALL Menu.User.Design
   CASE "3", "G"
      CALL Menu.Generate.Data
   CASE "4", "V"
      CALL Menu.View.Data
   CASE "5", "O"
      CALL Menu.Option
   CASE "6", "H", "?"
      CALL Help.CUDE
   CASE "9", "Q", "E", ""
      CLS : CALL Exit.Message      'Prompt Exit
   CASE ELSE
      CALL Case.Else
   END SELECT
LOOP

Handler:
  SELECT CASE ERR
  CASE 76                       'Path not found
    BEEP: BEEP
    CLS : LOCATE 2, 1: PRINT SPC(15); "Path Not Found! "
    LOCATE 10, 15: INPUT "Type New File Name or Q to Quit >", R$
    IF UCASE$(R$) = "Q" THEN
```

```
      CLS : RESUME ERCOV
    ELSE
      File.Name$ = R$
      RESUME
    END IF
  CASE 71                    'Disk Not Ready
    BEEP: BEEP
    CLS : LOCATE 2, 1: PRINT SPC(15); "Disk Not Ready! "
    LOCATE 10, 15: INPUT "Type New File Name or Q to Quit >", R$
    IF UCASE$(R$) = "Q" THEN
      CLS : RESUME ERCOV
    ELSE
      File.Name$ = R$
      RESUME
    END IF
  CASE 53                    'File not found
    CLS : COLOR 7, 0: LOCATE 5, 15
    PRINT "CUDE.INI and/or CUDE.DAT Missed, Ending Program."
    PRINT SPC(10); "Type cls and ENTER, if Screen Blank, to recove DOS
Sreen."
    SLEEP: END
  CASE 25                    'Printer Error
    CLS : BEEP: BEEP: LOCATE 10, 20: PRINT "Is Your Printer On ?"
    LOCATE 12, 20: PRINT "Q to Quit or Other Key to Continue. ( C )"
    LOCATE 12, 58: INPUT "", R$
    IF UCASE$(R$) = "Q" THEN
      CLS : RESUME ERCOV
    ELSE
      RESUME
    END IF
  CASE 27                    'Out of Paper
    CLS : LOCATE 5, 15: PRINT "Printer out of Paper"
    LOCATE 7, 15: INPUT "When Ready Press R or Other Key to Quit.", R$
    IF UCASE$(R$) = "R" THEN
      RESUME
    ELSE
      CLS : RESUME ERCOV
    END IF
  CASE 35                    'Subprogram not defined
    RESUME ERCOV
  CASE ELSE
    CLS : LOCATE 8, 25
    PRINT "Unexpeced Error. Error code: "; ERR
    LOCATE 10, 25
    PRINT "Ending Program."
```

```
    END
  END SELECT
'This is the Bottom of Main Program

SUB Case.Else
SHARED TextC%, BackC%
          '***  Beep, Print Message
    BEEP: LOCATE 23, 15: COLOR 4, 7
    PRINT " Enter the Number or the First Letter, Please! "
    COLOR TextC%, BackC%
    SLEEP: CLS
END SUB

SUB Cover
        '   **  The Cover on the Starting

    COLOR 14, 1: CLS
    E = 14            'Leading Space
    d = 5             'Distance of Letter
    W = 9             'Width of printed letter
    ascii = 177       'Character ASCII Code
    LOCATE 3
    PRINT SPC(E); STRING$(W, ascii); SPC(d); STRING$(2, ascii); SPC(W - 3);
    PRINT STRING$(2, ascii); SPC(d); STRING$(W + 1, ascii); SPC(d);
STRING$(W, ascii)
    LOCATE 6
    PRINT SPC(E + 46); STRING$(W - 3, ascii)
    FOR i = 4 TO 8
       LOCATE i
       PRINT SPC(E); STRING$(2, ascii); SPC(d + W - 2); STRING$(2, ascii);
       PRINT SPC(d + 1); STRING$(2, ascii); SPC(d + 2); STRING$(2, ascii);
       PRINT SPC(d - 1); STRING$(2, ascii); SPC(d); STRING$(2, ascii)
    NEXT i
    LOCATE 9:
    PRINT SPC(E); STRING$(W, ascii); SPC(d); STRING$(W + 1, ascii);
    PRINT SPC(d); STRING$(W + 1, ascii); SPC(d); STRING$(W, ascii)

    LOCATE 12, 22: PRINT "A Computer Aided Cushion Design Program"
    LOCATE 14, 37: PRINT "V x.x"
    LOCATE 16, 33: PRINT "5/1994 - 5/1995"
    LOCATE 21, 35: PRINT "Developed by"
    LOCATE 22, 28: PRINT "Ruogong Liu for his thesis"
    LOCATE 23, 16: PRINT "at School of Packaging, Michigan State University"
    SLEEP (2)
END SUB
```

```
SUB Curve.Spe.T (i, t)
            '*** Plot Specifical Thickness Cushion Curves
  SHARED a(), b(), c(), fs(), Name$(), TextC%, BackC%
  SCREEN 12                         'VGA Screen 12

  Sp = 15                           'Major Mark  Distance in X
  Xo = 15                           'X=0 Position
  dh = 6
  No% = 1
  IF fs(i) <= 3 THEN
    nw = 1: ds = .005
  ELSEIF fs(i) <= 6 THEN
    nw = 2: ds = .01
  ELSEIF fs(i) <= 9 THEN
    nw = 3: ds = .01
  ELSE
    CLS : LOCATE 10, 5
    PRINT "Sorry, the final stress is out of my plotting range."
  END IF

  WINDOW (-120 * nw, -57)-(380 * nw, 143)      'Set X, Y Coordinates

  IF LEFT$(Name$(i), 2) = "AR" OR LEFT$(Name$(i), 2) = "DY" THEN
    sh = 12: fh = 48
  ELSEIF RIGHT$(Name$(i), 9) = "PolyPlank" THEN
    sh = 12: fh = 48
  ELSEIF RIGHT$(Name$(i), 7) = "Polylam" OR Name$(i) = "2.2 pcf Sealed Air"
THEN
    sh = 12: fh = 42
  ELSEIF Name$(i) = "4.0 pcf Sealed Air" OR Name$(i) = "6.0 pcf Sealed Air"
THEN
    sh = 6: fh = 42
  ELSE
    sh = 12: fh = 48
  END IF

  FOR h = sh TO fh STEP dh

    COLOR 7:  CLS
    LOCATE 2, 13
    PRINT "Fig."; No%; ": CUDE Generated Cushion Curve for ";
    PRINT Name$(i): LOCATE 3, 21: PRINT h; CHR$(34); " Drop, ";
    PRINT Impact$(i); " Impact(s), "; "Density = "; Density$(i); " pcf"
    LOCATE 11, 10: PRINT "G's"
```

```
LOCATE 23, Xo
PRINT "0.0"; SPC(Sp + 2);
PRINT USING "#.#"; 1! * nw;
PRINT SPC(Sp - 2);
PRINT USING "#.#"; 2! * nw;
PRINT SPC(Sp - 2);
PRINT USING "#.#"; 3! * nw
LOCATE 24, 35: PRINT "Static Stress, psi"

FOR R = 1 TO 6                    'Y Label
   LOCATE 3 * R + 1, 13
   PRINT USING "###.#"; (120 - 20 * (R - 1))
NEXT R

FOR y = 0 TO 120 STEP 10          'Y Grids
   FOR X = 0 TO 300 * nw STEP 10 * nw     'X Grids
      PSET (X, y)
   NEXT X
NEXT y

FOR MarkX% = 50 * nw TO 250 * nw STEP 50 * nw
   LINE (MarkX%, -1)-(MarkX%, 1)          'Mark X
NEXT MarkX%

FOR MarkY% = 20 TO 100 STEP 20
   LINE (-2, MarkY%)-(2, MarkY%)          'Mark Y
NEXT MarkY%

LINE (0, 0)-(0, 120): LINE (0, 120)-(300 * nw, 120)
LINE (0, 0)-(300 * nw, 0): LINE (300 * nw, 0)-(300 * nw, 120)

LOCATE 1, 8: PRINT CHR$(218)
LOCATE 1, 75: PRINT CHR$(191)
LOCATE 25, 8: PRINT CHR$(192)
LOCATE 25, 75: PRINT CHR$(217)
FOR c% = 9 TO 74
   LOCATE 1, c%: PRINT CHR$(196)
   LOCATE 25, c%: PRINT CHR$(196)
NEXT

FOR R% = 2 TO 24
   LOCATE R%, 8: PRINT CHR$(179)
   LOCATE R%, 75: PRINT CHR$(179)
NEXT
```

```
    COLOR 12
    FOR s = .2 TO fs(i) STEP ds
        IF d(i) = 0 THEN
            G = (a(i) * EXP(b(i) * h * s / t) + c(i)) / s
        ELSE
            G = (a(i) * (h * s / t) ^ 3 + b(i) * (h * s / t) ^ 2 + c(i) * h * s / t + d(i)) / s
        END IF

        IF G < 120 THEN           'Max G
              X = s: y = G
              PSET (X * 100, y)      'Draw Curve
              LOCATE 12, 69
              PRINT USING "##.##"; t;  'Print Thickness
              PRINT CHR$(34)         'Print "
        END IF
    NEXT s

    BEEP
    IF h <> fh THEN
        LOCATE 26, 28: COLOR 12
        PRINT "Press Q to Quit or Other Key for More!"
    ELSE
        LOCATE 26, 35
        PRINT "The Last One!"
    END IF
    SLEEP
    IF UCASE$(INKEY$) = "Q" THEN EXIT FOR
    No% = No% + 1
  NEXT h
  SCREEN 0: COLOR TextC%, BackC%: CLS
END SUB

SUB Curves.Graphic (i)
                '*** Plot Cushion Curves
  SHARED a(), b(), c(), fs(), Name$(), TextC%, BackC%
  SCREEN 12                        'VGA Screen 12

  Sp = 15                          'Major Mark  Distance in X
  Xo = 15                          'X=0 Position
  dh = 6
  No% = 1

  IF fs(i) <= 3 THEN
    nw = 1: ds = .005
  ELSEIF fs(i) <= 6 THEN
```

```
    nw = 2: ds = .01
  ELSEIF fs(i) <= 9 THEN
    nw = 3: ds = .01
  ELSE
    CLS : LOCATE 10, 5
    PRINT "Sorry, the final stress is out of my plotting range."
  END IF

  WINDOW (-120 * nw, -57)-(380 * nw, 143)       'Set X, Y Coordinates

  IF LEFT$(Name$(i), 2) = "AR" OR LEFT$(Name$(i), 2) = "DY" THEN
    sh = 12: fh = 48: dt = .5: ft = 5
  ELSEIF RIGHT$(Name$(i), 9) = "PolyPlank" THEN
    sh = 12: fh = 48: dt = 1: ft = 5
  ELSEIF RIGHT$(Name$(i), 7) = "Polylam" OR Name$(i) = "2.2 pcf Sealed Air"
THEN
    sh = 12: fh = 42: dt = 1: ft = 4
  ELSEIF Name$(i) = "4.0 pcf Sealed Air" OR Name$(i) = "6.0 pcf Sealed Air"
THEN
    sh = 6: fh = 42: dt = 1: ft = 4
  ELSE
    sh = 12: fh = 48: dt = 1: ft = 4
  END IF

  FOR h = sh TO fh STEP dh
    COLOR 7:  CLS
    LOCATE 2, 13
    PRINT "Fig."; No%; ": CUDE Generated Cushion Curve for ";
    PRINT Name$(i): LOCATE 3, 21: PRINT h; CHR$(34); " Drop, ";
    PRINT Impact$(i); " Impact(s), "; "Density = "; Density$(i); " pcf"
    LOCATE 11, 10: PRINT "G's"
    LOCATE 23, Xo
    PRINT "0.0"; SPC(Sp + 2);
    PRINT USING "#.#"; 1! * nw;
    PRINT SPC(Sp - 2);
    PRINT USING "#.#"; 2! * nw;
    PRINT SPC(Sp - 2);
    PRINT USING "#.#"; 3! * nw
    LOCATE 24, 35: PRINT "Static Stress, psi"

    FOR R = 1 TO 6                      'Y Label
      LOCATE 3 * R + 1, 13
      PRINT USING "###.#"; (120 - 20 * (R - 1))
    NEXT R
```

```
FOR y = 0 TO 120 STEP 10                'Y Grids
   FOR X = 0 TO 300 * nw STEP 10 * nw       'X Grids
      PSET (X, y)
   NEXT X
NEXT y

FOR MarkX% = 50 * nw TO 250 * nw STEP 50 * nw
   LINE (MarkX%, -1)-(MarkX%, 1)          'Mark X
NEXT MarkX%

FOR MarkY% = 20 TO 100 STEP 20
   LINE (-2, MarkY%)-(2, MarkY%)          'Mark Y
NEXT MarkY%

LINE (0, 0)-(0, 120): LINE (0, 120)-(300 * nw, 120)
LINE (0, 0)-(300 * nw, 0): LINE (300 * nw, 0)-(300 * nw, 120)

LOCATE 1, 8: PRINT CHR$(218)
LOCATE 1, 75: PRINT CHR$(191)
LOCATE 25, 8: PRINT CHR$(192)
LOCATE 25, 75: PRINT CHR$(217)
FOR c% = 9 TO 74
   LOCATE 1, c%: PRINT CHR$(196)
   LOCATE 25, c%: PRINT CHR$(196)
NEXT

FOR R% = 2 TO 24
   LOCATE R%, 8: PRINT CHR$(179)
   LOCATE R%, 75: PRINT CHR$(179)
NEXT

colr% = 1
FOR t = 1 TO ft STEP dt
   COLOR colr%
   colr% = colr% + 1                'Set Line Color
   IF t = 3.5 OR t = 4.5 THEN       'Filt Out 3.5 and 4.5"
   ELSE
      FOR s = .2 TO fs(i) STEP ds
       IF d(i) = 0 THEN
         G = (a(i) * EXP(b(i) * h * s / t) + c(i)) / s
       ELSE
         G = (a(i) * (h * s / t) ^ 3 + b(i) * (h * s / t) ^ 2 + c(i) * h * s / t + d(i)) / s
       END IF
         IF G < 120 THEN          'Max G
            X = s: y = G
```

```
                PSET (X * 100, y)       'Draw Curve
                LOCATE 10 + 2 * t, 69
                PRINT USING " #.#"; t;  'Print Thickness
                PRINT CHR$(34)          'Print "
              END IF
            NEXT s
          END IF
        NEXT t
        BEEP
        IF h <> fh THEN
            LOCATE 26, 28: COLOR 12
            PRINT "Press Q to Quit or Other Key for More!"
        ELSE
            LOCATE 26, 35
            PRINT "The Last One!"
        END IF
        SLEEP
        IF UCASE$(INKEY$) = "Q" THEN EXIT FOR
        No% = No% + 1
      NEXT h
      SCREEN 0: COLOR TextC%, BackC%: CLS
    END SUB

    SUB Detail.Data

          '   subprogram to list details about cuahion materials

    CLS
    SHELL "type detail.dat|more"
    CALL Hit.any.key
    CLS
        LOCATE 12, 20: PRINT "Print ?      ( N ) "
        LOCATE 12, 35: INPUT "", P$
        IF UCASE$(P$) <> "Y" THEN CLS : EXIT SUB
        LOCATE 13, 20: PRINT "Printing Port: 1. LPT1; 2. LPT2 ( 1 )"
        LOCATE 13, 54: INPUT "", R$
        IF UCASE$(R$) = "" OR R$ = "1" THEN
            SHELL "copy detail.dat lpt1"
        ELSEIF UCASE$(R$) = "LPT2" OR R$ = "2" THEN
            SHELL "copy detail.dat LPT2"
        ELSE
            CLS : EXIT SUB
        END IF
    CLS
    END SUB
```

```
SUB DOS
        '*** Transfer Control To DOS
   CLS : LOCATE 2: PRINT "Type EXIT to return to CUDE."
   SHELL: CLS
END SUB

SUB Exit.Message
        ' Message promts to quit program
   IF TextC% = BackC% THEN TextC% = 7: BackC% = 0: CLS
   LOCATE 12, 25: BEEP
   PRINT "Do You Really Want to Quit ? ( N )"
   LOCATE 12, 56: INPUT "", a$
   E$ = LEFT$(UCASE$(a$), 1)
   IF E$ = "Y" OR E$ = "Q" OR E$ = "E" THEN
      COLOR 7, 0: CLS : LOCATE 12, 25
      END
   END IF
   CLS
END SUB

SUB Help.CUDE
        '*** Help for CUDE
CLS : LOCATE 8, 1
PRINT SPC(10); "CUDE is  a computer aided cushion design software. It was"
PRINT SPC(8); "specially designed for packaging Engineering. The software is"
PRINT SPC(8); "still in development. More features will be added soon."
PRINT
PRINT SPC(10); "To use it, just follow the screen menu instuctions."
PRINT
PRINT SPC(10); "F1 = Help and F9 = Quit"
LOCATE 22, 20: PRINT "Press Q to Quit or ENTER to See More (   )"
LOCATE 22, 59: INPUT "", R$
IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
CALL Help.P.File
END SUB

SUB Help.P.File
        '*** Help File for Output Selection Screen
   CLS : LOCATE 3
   PRINT SPC(10); "1. File name is a DOS file name. It can be 8 character"
   PRINT SPC(10); "plus up to 3 character extention (optional). For example,"
   PRINT SPC(10); "STRESS.1ST will save the current results to a file named"
   PRINT SPC(10); "STRESS.1ST in the default or current starting directory"
```

```
    PRINT SPC(10); "on default driver. A:\MYDESIGN\CUSHION.FIN will save
the"
    PRINT SPC(10); "results into a file called CUSHION.FIN in MYDESIGN "
    PRINT SPC(10); "directory of driver A ": PRINT
    PRINT SPC(10); "2. All files saved by CUDE are DOS Text or ASCII files."
    PRINT SPC(10); "They can be imported to any word process or spread
sheet"
    PRINT SPC(10); "program.": PRINT
    PRINT SPC(10); "3. Printer is the printing port name. The printer on LPT1"
    PRINT SPC(10); "or LPT2 is depended on the connecting of your computer."
    CALL Hit.any.key
    CLS
END SUB

SUB Hit.any.key
SHARED TextC%, BackC%
              '*** Subprogram Pauses Screen
    LOCATE 24, 25
    COLOR 0, 7
    PRINT " Hit Any Key to Continue! ";
    DO: LOOP UNTIL INKEY$ <> ""
    COLOR 7, 0
    LOCATE 24, 25
    PRINT "                    "
    COLOR TextC%, BackC%
    CLS
END SUB

SUB Info
CLS
                  '*** Note
PRINT : PRINT
PRINT SPC(10); "          About CUDE - Cushion Design Program ": PRINT
PRINT SPC(10); "CUDE is a computer aided cushion design software. When
running"
PRINT SPC(10); "it, please beware of: ": PRINT
PRINT SPC(10); "1. When MISSING FILE message appears on screen, check
the"
PRINT SPC(10); "   Current Directory. Make sure CUDE.DAT and CUDE.INI in"
PRINT SPC(10); "   it. CUDE.DAT contains all cushion data and CUDE.INI "
PRINT SPC(10); "   contains the default screen color settings.": PRINT
PRINT SPC(10); "2. Useful keys. F9, or Q  on screen ready (cusor blinking) "
PRINT SPC(10); "   always means EXIT. When screen frozen, press CTRl-
BREAK."
PRINT SPC(10); "   If that does not work,  press CTRL-ALT-DEL. This will "
```

```
PRINT SPC(10); "   force computer boot from DOS.": PRINT
PRINT SPC(10); "3. This version CUDE is one part of my M.S. thesis which is"
PRINT SPC(10); "   under the guidance of Dr. Julian Lee and Dr. Gary Bugess."
PRINT SPC(10); "   If the new version of this program is needed, please "
PRINT SPC(10); "   contact School of Packaging, Michigan State University,"
PRINT SPC(10); "   East Lansing, MI 48824."
CALL Hit.any.key
CLS
END SUB

SUB Ini.Data
        '*** Read Initial Settings & Data File
    SHARED TextC%, BackC%, Name$(), Impact$(), Density$()
    SHARED a(), b(), c(), d(), fs(), N
    OPEN "CUDE.INI" FOR INPUT AS #1    'Read Default Settings
    INPUT #1, TextC%, BackC%
    CLOSE #1
    IF TextC% = BackC% THEN TextC% = 7: BackC% = 0  'Default Color
    COLOR TextC%, BackC%

    OPEN "CUDE.DAT" FOR INPUT AS #1    ' Read Cushion Data
    i% = 1
    DO WHILE NOT EOF(1) AND i% <= 100
       INPUT #1, Name$(i%), Impact$(i%), Density$(i%), a(i%), b(i%), c(i%),
d(i%), fs(i%)
       i% = i% + 1
    LOOP
    CLOSE #1
    N = i% - 1
END SUB

SUB Input.1.Design
       '*** Input Data Screen for One Face Cushion Design
SHARED L, W, TextC%, BackC%
CLS
Sp% = 15
Row% = 8
Col% = 47
Min.F = 15
Face% = 6
  DO
    CLS
    LOCATE 5
    PRINT SPC(Sp%); "******** Data Input Screen For One Face Design ********"
    LOCATE Row%
```

```
PRINT SPC(Sp%); "Drop Height:                ...          in"
PRINT SPC(Sp%); "Fragility G:              ...          G's"
PRINT SPC(Sp%); "Product Weight:             ...          lbs"
PRINT SPC(Sp%); "Product Length (L):         ...          in"
PRINT SPC(Sp%); "Product Width (W):          ...          in"

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      h = R
      LOCATE Row%, Col%: PRINT USING " ###.##"; h
      Row% = Row% + 1
      EXIT DO
   END IF
LOOP

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      F = R
      IF F < Min.F THEN
         CALL message(F, h)
      ELSE
         LOCATE Row%, Col%: PRINT USING " ###.##"; F
         Row% = Row% + 1
         EXIT DO
      END IF
   END IF
LOOP
DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      P = R
      LOCATE Row%, Col%: PRINT USING " ###.##"; P
      Row% = Row% + 1
      EXIT DO
   END IF
LOOP
DO
```

```
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
       L = R
       LOCATE Row%, Col%: PRINT USING "####.##"; L
       Row% = Row% + 1
       EXIT DO
    END IF
  LOOP

  DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
       W = R
       LOCATE Row%, Col%: PRINT USING "####.##"; W
       Row% = 8   'Reset Row% to Start Value
       EXIT DO
    END IF
  LOOP

  LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
  LOCATE 20, 50: INPUT "", R$

  IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
  IF UCASE$(R$) <> "N" THEN
    LOCATE 20, 25: PRINT "                          "
    EXIT DO
  END IF
LOOP
              'Output to Screen
Out$ = "SCRN:"
CALL Solve.1.Face(Out$, F, h, P)

       'Select Output Results to a File or Printer
DO
  CLS
  LOCATE 12, 20: PRINT "Print, Save, Both or Quit ? ( Q )"
  LOCATE 12, 50: INPUT "", R$
  IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
     CALL Help.P.File          'Call on Screen Help
  ELSE
     EXIT DO
```

```
  END IF
LOOP
SELECT CASE LEFT$(UCASE$(R$), 1)              'Make Selection
CASE "P"
 DO
  CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
  LOCATE 12, 43: INPUT "", P$
  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL Solve.1.Face(Out$, F, h, P)
     EXIT DO
  ELSEIF P$ = "LPT2" OR P$ = "2" THEN
     Out$ = "LPT2"
     CALL Solve.1.Face(Out$, F, h, P)
     EXIT DO
  ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
     CALL Help.P.File
  END IF
 LOOP
CASE "F", "S"
 DO
  CLS : LOCATE 12, 20: INPUT "File Name: ", F$
  IF F$ = "" THEN
     LOCATE 15, 10: PRINT "Save to File : MATERIAL.OUT"
     Out$ = "MATERIAl.OUT"
     CALL Solve.1.Face(Out$, F, h, P)
     EXIT DO
  ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
     CALL Help.P.File
  ELSE
     Out$ = F$
     CALL Solve.1.Face(Out$, F, h, P)
     EXIT DO
  END IF
 LOOP
CASE "B"
 DO
  CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
  LOCATE 12, 43: INPUT "", P$
  LOCATE 13, 20: INPUT "File Name: ", F$

  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL Solve.1.Face(Out$, F, h, P)
     EXIT DO
```

```
    ELSEIF P$ = "LPT2" OR P$ = "2" THEN
        Out$ = "LPT2"
        CALL Solve.1.Face(Out$, F, h, P)
        EXIT DO
    ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
        CALL Help.P.File
    END IF
    IF F$ = "" THEN
        LOCATE 15, 10: PRINT "Save to File : MATERIAL.OUT"
        Out$ = "MATERIAL.OUT"
        CALL Solve.1.Face(Out$, F, h, P)
        EXIT DO
    ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
        CALL Help.P.File
    ELSE
        Out$ = F$
        CALL Solve.1.Face(Out$, F, h, P)
        EXIT DO
    END IF
    CLS
  LOOP
  CASE ELSE
    CLS
    EXIT SUB
  END SELECT
    CLS
END SUB

SUB Input.6.Design
        '*** Input Data Screen for 6 Faces Cushion Design
SHARED L, W, d, G(), TextC%, BackC%
CLS
Sp% = 15
Row% = 6
Col% = 47
Min.F = 15
Face% = 6
  DO
    CLS
    LOCATE 3
    PRINT SPC(Sp%); "******** Data Input Screen For Six Face Design ********"
    LOCATE Row%, 1
    PRINT SPC(Sp%); "Drop Height:                ...              in"
    PRINT SPC(Sp%); "Product Weight:               ...               lbs"
    PRINT SPC(Sp%); "Product Length (L):           ...               in"
```

```
PRINT SPC(Sp%); "Product Width (W):          ...          in"
PRINT SPC(Sp%); "Product Height (D):         ...          in"
PRINT SPC(Sp%); "Fragility G in Top:         ...         G's"
PRINT SPC(Sp%); "Fragility G in Bottom:      ...         G's"
PRINT SPC(Sp%); "Fragility G in Front:       ...         G's"
PRINT SPC(Sp%); "Fragility G in Back:        ...         G's"
PRINT SPC(Sp%); "Fragility G in Left:        ...         G's"
PRINT SPC(Sp%); "Fragility G in Right:       ...         G's"

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      h = R
      LOCATE Row%, Col%: PRINT USING " ###.##"; h
      Row% = Row% + 1
      EXIT DO
   END IF
LOOP
DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      P = R
      LOCATE Row%, Col%: PRINT USING " ###.##"; P
      Row% = Row% + 1
      EXIT DO
   END IF
LOOP
DO
   LOCATE Row%, Col%: INPUT "", R$
   IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
      L = R
      LOCATE Row%, Col%: PRINT USING "####.##"; L
      Row% = Row% + 1
      EXIT DO
   END IF
LOOP

DO
   LOCATE Row%, Col%: INPUT "", R$
```

```
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        W = R
        LOCATE Row%, Col%: PRINT USING "####.##"; W
        Row% = Row% + 1
        EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        d = R
        LOCATE Row%, Col%: PRINT USING "####.##"; d
        Row% = Row% + 1
        EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        F = R
        IF F < Min.F THEN
            CALL message(F, h)
        ELSE
            G(1) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(1)
            Row% = Row% + 1
            EXIT DO
       END IF
    END IF
LOOP
DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        F = R
        IF F < Min.F THEN
```

```
            CALL message(F, h)
         ELSE
            G(2) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(2)
            Row% = Row% + 1
            EXIT DO
         END IF
      END IF
   LOOP

   DO
      LOCATE Row%, Col%: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         F = R
         IF F < Min.F THEN
            CALL message(F, h)
         ELSE
            G(3) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(3)
            Row% = Row% + 1
            EXIT DO
         END IF
      END IF
   LOOP

   DO
      LOCATE Row%, Col%: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         F = R
         IF F < Min.F THEN
            CALL message(F, h)
         ELSE
            G(4) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(4)
            Row% = Row% + 1
            EXIT DO
         END IF
      END IF
   LOOP

   DO
```

```
      LOCATE Row%, Col%: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         F = R
         IF F < Min.F THEN
            CALL message(F, h)
         ELSE
            G(5) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(5)
            Row% = Row% + 1
            EXIT DO
         END IF
      END IF
   LOOP

   DO
      LOCATE Row%, Col%: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         F = R
         IF F < Min.F THEN
            CALL message(F, h)
         ELSE
            G(6) = F
            LOCATE Row%, Col%: PRINT USING " ###.##"; G(6)
            Row% = 6
            EXIT DO
         END IF
      END IF
   LOOP
            'Promt to Correct the Input Data

   LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
   LOCATE 20, 50: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF UCASE$(R$) <> "N" THEN
      EXIT DO
   ELSE
      LOCATE 20, 25: PRINT "                              "
   END IF
LOOP
Out$ = "SCRN:"
CALL Solve.6.Faces(Out$, Face%, h, P)
```

```
        'Select Output Results to a File or Printer
DO
  LOCATE 12, 20: PRINT "Print, Save, Both or Quit ? ( Q )"
  LOCATE 12, 50: INPUT "", R$
  IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
     CALL Help.P.File          'Call on Screen Help
  ELSE
     EXIT DO
  END IF
LOOP
SELECT CASE LEFT$(UCASE$(R$), 1)          'Make Selection
CASE "P"
 DO
  CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
  LOCATE 12, 43: INPUT "", P$
  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL Solve.6.Faces(Out$, Face%, h, P)
     EXIT DO
  ELSEIF P$ = "LPT2" OR P$ = "2" THEN
     Out$ = "LPT2"
     CALL Solve.6.Faces(Out$, Face%, h, P)
     EXIT DO
  ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
     CALL Help.P.File
  END IF
 LOOP
CASE "F", "S"
 DO
  CLS : LOCATE 12, 20: INPUT "File Name: ", F$
  IF F$ = "" THEN
     LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
     Out$ = "STRESS.OUT"
     CALL Solve.6.Face.File(Out$, Face%, h, P)
     EXIT DO
  ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
     CALL Help.P.File
  ELSE
     Out$ = F$
     CALL Solve.6.Face.File(Out$, Face%, h, P)
     EXIT DO
  END IF
 LOOP
CASE "B"
```

```
  DO
   CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
   LOCATE 12, 43: INPUT "", P$
   LOCATE 13, 20: INPUT "File Name: ", F$

   IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
      Out$ = "LPT1"
      CALL Solve.6.Faces(Out$, Face%, h, P)
      EXIT DO
   ELSEIF P$ = "LPT2" OR P$ = "2" THEN
      Out$ = "LPT2"
      CALL Solve.6.Faces(Out$, Face%, h, P)
      EXIT DO
   ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
      CALL Help.P.File
   END IF
   IF F$ = "" THEN
      LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
      Out$ = "STRESS.OUT"
      CALL Solve.6.Face.File(Out$, Face%, h, P)
      EXIT DO
   ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
      CALL Help.P.File
   ELSE
      Out$ = F$
      CALL Solve.6.Face.File(Out$, Face%, h, P)
      EXIT DO
   END IF
   CLS
  LOOP
   CASE ELSE
      CLS
      EXIT SUB
   END SELECT
   CLS
END SUB

SUB Input.D.All
        '*** Input & Output for User Design All
SHARED N, Name$(), Impact$()
CLS
CALL View.Data.File
Swith = 0
DO
  DO
```

```
LOCATE 5, 25: PRINT "User Design All Cushion Parameters"
PRINT SPC(4); STRING$(75, 205)
LOCATE 8
PRINT SPC(5); "Cushion Material:            ... "; SPC(35); "No."
PRINT
PRINT SPC(5); "Product Weight:              ... "; SPC(35); "lbs"
PRINT
PRINT SPC(5); "Expected Drop Height:        ... "; SPC(35); "in"
PRINT
PRINT SPC(5); "Designed Cushion Thickness:  ... "; SPC(35); "in"
PRINT
PRINT SPC(5); "Designed Cuchion Area:       ... "; SPC(35); "Sq.in"
PRINT
PRINT SPC(5); "Protected G:                 ? "; SPC(35); "G's"
PRINT SPC(4); STRING$(75, 205)


DO
   LOCATE 8, 36: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ = "" AND Swith = -1 THEN
     LOCATE 8, 34: PRINT Name$(i); ", "; Impact$(i); "Impact(s)";
     PRINT TAB(74); "No."; i
     EXIT DO
   END IF
   IF R$ <> "" THEN
   CALL Number.CK(R$, R)
    IF R <> 0 THEN
       i = R
       LOCATE 8, 34: PRINT Name$(i); ", "; Impact$(i); " Impact(s)";
       PRINT TAB(74); i; "#"
       Swith = -1
       EXIT DO
    END IF
   END IF
LOOP
DO
   LOCATE 10, 36: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ = "" THEN LOCATE 10, 36: PRINT USING "####.##"; W: EXIT DO
   CALL Number.CK(R$, R)
   IF R <> 0 THEN
       W = R
       LOCATE 10, 36: PRINT USING "####.##"; W
       EXIT DO
```

```
      END IF
   LOOP
   DO
      LOCATE 12, 36: INPUT "", R$
      IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      IF R$ = "" THEN LOCATE 12, 36: PRINT USING "####.##"; h: EXIT DO
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         h = R
         LOCATE 12, 36: PRINT USING "####.##"; h
         EXIT DO
      END IF
   LOOP
   DO
      LOCATE 14, 36: INPUT "", R$
      IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      IF R$ = "" THEN LOCATE 14, 36: PRINT USING "####.##"; t: EXIT DO
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         t = R
         LOCATE 14, 36: PRINT USING "####.##"; t
         EXIT DO
      END IF
   LOOP
   DO
      LOCATE 16, 36: INPUT "", R$
      IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      IF R$ = "" THEN LOCATE 16, 36: PRINT USING "####.##"; Area: EXIT
DO
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         Area = R
         LOCATE 16, 36: PRINT USING "####.##"; Area
         EXIT DO
      END IF
   LOOP
   LOCATE 18, 30
   IF d(i) = 0 THEN
      PRINT , USING " ###.##"; User.D.All.exp(W, h, t, Area, i);
   ELSE
      PRINT , USING " ###.##"; User.D.All.pol(W, h, t, Area, i);
   END IF

   LOCATE 20, 25: PRINT "                                    "
   LOCATE 20, 25: PRINT "Are These All Correct? ( N ) "
```

```
  LOCATE 20, 50: INPUT "", R$
  IF UCASE$(R$) = "Y" THEN
    EXIT DO
  ELSE
    LOCATE 20, 25: PRINT "Press ENTER Will Restore The Last Value"
  END IF
LOOP
      'Select Output Results to a File or Printer
  CLS
  DO
    LOCATE 12, 20: PRINT "Print, Save, or Quit ? ( Q )"
    LOCATE 12, 45: INPUT "", R$
    IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
      CALL Help.P.File          'Call on Screen Help
    ELSE
      EXIT DO
    END IF
  LOOP

  SELECT CASE LEFT$(UCASE$(R$), 1)        'Make Selection
  CASE "P"
    DO
      CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
      LOCATE 12, 43: INPUT "", P$
      IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
        Out$ = "LPT1"
        EXIT DO
      ELSEIF P$ = "LPT2" OR P$ = "2" THEN
        Out$ = "LPT2"
        EXIT DO
      ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
        CALL Help.P.File
      END IF
    LOOP
    CASE "F", "S"
     DO
      CLS : LOCATE 12, 20: INPUT "File Name: ", F$
      IF F$ = "" THEN
        LOCATE 15, 10: PRINT "Save to File : RECHECK.OUT"
        Out$ = "RECHECK.OUT"
        EXIT DO
      ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
        CALL Help.P.File
      ELSE
        Out$ = F$
```

```
            EXIT DO
          END IF
        LOOP
      CASE ELSE
        CLS : EXIT SUB
      END SELECT
    OPEN Out$ FOR OUTPUT AS #1
    PRINT #1, : PRINT #1, : PRINT #1,
    PRINT #1, : PRINT #1, : PRINT #1,
    PRINT #1, SPC(17); "CUDE Rport: User Design All Cushion Parameters":
PRINT #1,
    PRINT #1, SPC(12); STRING$(60, 61)
    PRINT #1, SPC(13); "Material:"; SPC(3); Name$(i); ", ";
    PRINT #1, Impact$(i); " Impact(s)"; TAB(66); i; "#"
    PRINT #1,
    PRINT #1, SPC(13); "Product Weight:"; SPC(16);
    PRINT #1, USING " ###.##"; W;
    PRINT #1, SPC(15); "lbs": PRINT #1,
    PRINT #1, SPC(13); "Drop Height:"; SPC(19);
    PRINT #1, USING "  ##.##"; h;
    PRINT #1, SPC(15); "in": PRINT #1,
    PRINT #1, SPC(13); "Cushion Thickness:"; SPC(13);
    PRINT #1, USING "  ##.##"; t;
    PRINT #1, SPC(15); "in": PRINT #1,
    PRINT #1, SPC(13); "Cushion Area:"; SPC(18);
    PRINT #1, USING "####.##"; Area;
    PRINT #1, SPC(15); "Sq.in": PRINT #1,
    PRINT #1, SPC(13); "Proteced G:"; SPC(20);

    IF d(i) = 0 THEN
       PRINT #1, USING " ###.##"; User.D.All.exp(W, h, t, Area, i);
    ELSE
       PRINT #1, USING " ###.##"; User.D.All.exp(W, h, t, Area, i);
    END IF

    PRINT #1, SPC(15); "G's": PRINT #1,
    PRINT #1, SPC(12); STRING$(60, 61)
    PRINT #1, SPC(45); TIME$; SPC(5); DATE$
    CLOSE #1
 CLS
 LOCATE 12, 25: PRINT "Have More Disign ? ( N )"
 LOCATE 12, 46: INPUT "", M$
 IF UCASE$(M$) <> "Y" THEN
  CLS
  EXIT SUB
```

```
 END IF
 CLS
 LOCATE 20, 25: PRINT "Press ENTER Will Restore The Last Value"
LOOP
END SUB

SUB Input.D.Area
        '*** Input Data Screen for Bearing Area Design
SHARED N, a(), b(), c()
LM = 15
CP = LM + 22
CLS
 DO
   CLS
   LOCATE 5
   PRINT SPC(LM); "***** Data Input Screen for User Design Area *****"
   LOCATE 8
   PRINT SPC(LM); "Protected G:       ...          g's."
   PRINT SPC(LM); "Drop Height:       ...          in"
   PRINT SPC(LM); "Product Weight:     ...           lbs"
   PRINT SPC(LM); "Expected Area:      ...           sq.in"

   DO
      LOCATE 8, CP: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         F = R
         LOCATE 8, CP: PRINT USING "####.##"; F
         EXIT DO
      END IF
   LOOP
   DO
      LOCATE 9, CP: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         h = R
         LOCATE 9, CP: PRINT USING " ###.##"; h
         EXIT DO
      END IF
   LOOP
   DO
      LOCATE 10, CP: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
```

```
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         P = R
         LOCATE 10, CP: PRINT USING " ###.##"; P
         EXIT DO
      END IF
   LOOP

   DO
      LOCATE 11, CP: INPUT "", R$
      IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
         Area = R
         LOCATE 11, CP: PRINT USING " ###.##"; Area
         EXIT DO
      END IF
   LOOP

   LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
   LOCATE 20, 50: INPUT "", R$
   IF UCASE$(R$) <> "N" THEN
      EXIT DO
   END IF
LOOP
                'Default Output to Screen
Out$ = "SCRN:"
CALL User.D.Area(Out$, F, h, P, Area)
CALL Hit.any.key

         'Select Output Results to a File or Printer
DO
   LOCATE 12, 20: PRINT "Print, Save, Both or Quit ? ( Q )"
   LOCATE 12, 50: INPUT "", R$
   IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
      CALL Help.P.File          'Call on Screen Help
   ELSE
      EXIT DO
   END IF
LOOP
SELECT CASE LEFT$(UCASE$(R$), 1)              'Make Selection
CASE "P"
 DO
   CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
   LOCATE 12, 43: INPUT "", P$
```

```
  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  ELSEIF P$ = "LPT2" OR P$ = "2" THEN
     Out$ = "LPT2"
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
     CALL Help.P.File
  END IF
 LOOP
CASE "F", "S"
 DO
  CLS : LOCATE 12, 20: INPUT "File Name: ", F$
  IF F$ = "" THEN
     LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
     Out$ = "STRESS.OUT"
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
     CALL Help.P.File
  ELSE
     Out$ = F$
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  END IF
 LOOP
CASE "B"
 DO
  CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
  LOCATE 12, 43: INPUT "", P$
  LOCATE 13, 20: INPUT "File Name: ", F$

  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  ELSEIF P$ = "LPT2" OR P$ = "2" THEN
     Out$ = "LPT2"
     CALL User.D.Area(Out$, F, h, P, Area)
     EXIT DO
  ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
     CALL Help.P.File
  END IF
```

```
    IF F$ = "" THEN
       LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
       Out$ = "STRESS.OUT"
       CALL User.D.Area(Out$, F, h, P, Area)
       EXIT DO
    ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
       CALL Help.P.File
    ELSE
       Out$ = F$
       CALL User.D.Area(Out$, F, h, P, Area)
       EXIT DO
    END IF
    CLS
  LOOP
    CASE ELSE
       CLS
       EXIT SUB
    END SELECT
    CLS

END SUB

SUB Input.D.Material
       '***  Input Data Screen for User Design Material
  SHARED L, W, N
  CLS
  Sp% = 15
  Row% = 8
  Col% = 42
  Min.F = 15
  CALL View.Data.File

  DO
    CLS
    LOCATE 5
    PRINT SPC(Sp%); "****** Data Input Screen For User Design Material ******"
    LOCATE Row%
    PRINT SPC(Sp%); "Material No.:          ...          # "
    PRINT SPC(Sp%); "Drop Height:           ...          in"
    PRINT SPC(Sp%); "Fragility G:          ...          G's"
    PRINT SPC(Sp%); "Product Weight:        ...          lbs"
    PRINT SPC(Sp%); "Product Length (L):    ...          in"
    PRINT SPC(Sp%); "Product Width (W):     ...          in"

    DO
```

```
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R > 0 AND R <= N THEN
        i = R
        LOCATE Row%, Col%: PRINT Name$(i); ", ";
        PRINT Impact$(i); " Impact(s)"; " #"; i
        Row% = Row% + 1
        EXIT DO
    ELSE
        LOCATE 22, 15
        PRINT "The Material is not available, Try One More Time."
        BEEP: SLEEP
        LOCATE 22, 15
        PRINT "                                                    "
    END IF

LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        h = R
        LOCATE Row%, Col%: PRINT USING " ###.##"; h
        Row% = Row% + 1
        EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    CALL Number.CK(R$, R)
    IF R <> 0 THEN
        F = R
        IF F < Min.F THEN
            CALL message(F, h)
        ELSE
            LOCATE Row%, Col%: PRINT USING " ###.##"; F
            Row% = Row% + 1
            EXIT DO
        END IF
    END IF
```

```
  LOOP
  DO
     LOCATE Row%, Col%: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        P = R
        LOCATE Row%, Col%: PRINT USING " ###.##"; P
        Row% = Row% + 1
        EXIT DO
     END IF
  LOOP
  DO
     LOCATE Row%, Col%: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        L = R
        LOCATE Row%, Col%: PRINT USING "####.##"; L
        Row% = Row% + 1
        EXIT DO
     END IF
  LOOP

  DO
     LOCATE Row%, Col%: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        W = R
        LOCATE Row%, Col%: PRINT USING "####.##"; W
        Row% = 8   'Reset Row% to Start Value
        EXIT DO
     END IF
  LOOP

  LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
  LOCATE 20, 50: INPUT "", R$
  IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
  IF UCASE$(R$) <> "N" THEN
    LOCATE 20, 25: PRINT "                          "
    EXIT DO
  END IF
LOOP
        'Default Output to Screen
```

```
Out$ = "SCRN:"
CALL User.D.Material(Out$, F, h, P, i)
CALL Hit.any.key

            'Select Output Results to a File or Printer
DO
  LOCATE 12, 20: PRINT "Print, Save, Both or Quit ? ( Q )"
  LOCATE 12, 50: INPUT "", R$
  IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
      CALL Help.P.File          'Call on Screen Help
   ELSE
      EXIT DO
   END IF
  LOOP
  SELECT CASE LEFT$(UCASE$(R$), 1)          'Make Selection
  CASE "P"
   DO
    CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
    LOCATE 12, 43: INPUT "", P$
    IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
       Out$ = "LPT1"
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
     ELSEIF P$ = "LPT2" OR P$ = "2" THEN
       Out$ = "LPT2"
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
     ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
       CALL Help.P.File
     END IF
    LOOP
    CASE "F", "S"
     DO
      CLS : LOCATE 12, 20: INPUT "File Name: ", F$
      IF F$ = "" THEN
         LOCATE 15, 10: PRINT "Save to File : THICK_A.OUT"
         Out$ = "THICK_A.OUT"
         CALL User.D.Material(Out$, F, h, P, i)
         EXIT DO
       ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
         CALL Help.P.File
       ELSE
         Out$ = F$
         CALL User.D.Material(Out$, F, h, P, i)
         EXIT DO
```

```
    END IF
  LOOP
 CASE "B"
  DO
    CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
    LOCATE 12, 43: INPUT "", P$
    LOCATE 13, 20: INPUT "File Name: ", F$

    IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
       Out$ = "LPT1"
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
    ELSEIF P$ = "LPT2" OR P$ = "2" THEN
       Out$ = "LPT2"
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
    ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
       CALL Help.P.File
    END IF
    IF F$ = "" THEN
       LOCATE 15, 10: PRINT "Save to File : THICK_A.OUT"
       Out$ = "THICK_A.OUT"
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
    ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
       CALL Help.P.File
    ELSE
       Out$ = F$
       CALL User.D.Material(Out$, F, h, P, i)
       EXIT DO
    END IF
    CLS
  LOOP
 CASE ELSE
    CLS
    EXIT SUB
 END SELECT
 CLS
END SUB

SUB Input.D.Thickness
          '*** Input Data Screen for User Thickness Design
CLS
LM = 15
CP = LM + 22
```

```
DO
  CLS
  LOCATE 5
  PRINT SPC(LM); "***** Data Input for User Design Thickness *****"
  LOCATE 8
  PRINT SPC(LM); "Protected G:       ...          g's."
  PRINT SPC(LM); "Drop Height:       ...          in"
  PRINT SPC(LM); "Product Weight:    ...          lbs"
  PRINT SPC(LM); "Expected Thickness: ...         in"

  DO
     LOCATE 8, CP: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        F = R
        LOCATE 8, CP: PRINT USING "####.##"; F
        EXIT DO
     END IF
  LOOP
  DO
     LOCATE 9, CP: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        h = R
        LOCATE 9, CP: PRINT USING " ###.##"; h
        EXIT DO
     END IF
  LOOP
  DO
     LOCATE 10, CP: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
     IF R <> 0 THEN
        P = R
        LOCATE 10, CP: PRINT USING " ###.##"; P
        EXIT DO
     END IF
  LOOP

  DO
     LOCATE 11, CP: INPUT "", R$
     IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
     CALL Number.CK(R$, R)
```

```
      IF R <> 0 THEN
         t = R
         LOCATE 11, CP: PRINT USING " ###.##"; t
         EXIT DO
      END IF
   LOOP

   LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
   LOCATE 20, 50: INPUT "", R$
   IF UCASE$(R$) <> "N" THEN
      EXIT DO
   END IF
LOOP
Out$ = "SCRN:"
CALL User.D.Thickness(Out$, F, h, P, t)
CALL Hit.any.key

        'Select Output Results to a File or Printer
DO
   LOCATE 12, 20: PRINT "Print, Save, Both or Quit ? ( Q )"
   LOCATE 12, 50: INPUT "", R$
   IF R$ = "?" OR UCASE$(R$) = "HELP" OR UCASE$(R$) = "H" THEN
      CALL Help.P.File          'Call on Screen Help
   ELSE
      EXIT DO
   END IF
LOOP
SELECT CASE LEFT$(UCASE$(R$), 1)          'Make Selection
CASE "P"
 DO
   CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
   LOCATE 12, 43: INPUT "", P$
   IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
      Out$ = "LPT1"
      CALL User.D.Thickness(Out$, F, h, P, t)
      EXIT DO
   ELSEIF P$ = "LPT2" OR P$ = "2" THEN
      Out$ = "LPT2"
      CALL User.D.Thickness(Out$, F, h, P, t)
      EXIT DO
   ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
      CALL Help.P.File
   END IF
 LOOP
CASE "F", "S"
```

```
 DO
  CLS : LOCATE 12, 20: INPUT "File Name: ", F$
  IF F$ = "" THEN
     LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
     Out$ = "STRESS.OUT"
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
     CALL Help.P.File
  ELSE
     Out$ = F$
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  END IF
 LOOP
CASE "B"
 DO
  CLS : LOCATE 12, 20: PRINT "1: LPT1 or 2: LPT2 ? ( 1 )"
  LOCATE 12, 43: INPUT "", P$
  LOCATE 13, 20: INPUT "File Name: ", F$

  IF P$ = "" OR UCASE$(P$) = "LPT1" OR P$ = "1" THEN
     Out$ = "LPT1"
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  ELSEIF P$ = "LPT2" OR P$ = "2" THEN
     Out$ = "LPT2"
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  ELSEIF P$ = "?" OR LEFT$(UCASE$(P$), 1) = "H" THEN
     CALL Help.P.File
  END IF
  IF F$ = "" THEN
     LOCATE 15, 10: PRINT "Save to File : STRESS.OUT"
     Out$ = "STRESS.OUT"
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  ELSEIF F$ = "?" OR LEFT$(UCASE$(F$), 1) = "H" THEN
     CALL Help.P.File
  ELSE
     Out$ = F$
     CALL User.D.Thickness(Out$, F, h, P, t)
     EXIT DO
  END IF
  CLS
```

```
  LOOP
    CASE ELSE
       CLS
       EXIT SUB
    END SELECT
    CLS
END SUB

SUB Input.SE.Data
       '*** Input Data Screen for Dynamic Stress-Energy Density Curve
SHARED N, Name$(), Impact$(), Density$(), a(), b(), c(), d(), fs(), TextC%,
BackC%
  CLS
  Sp% = 15
  Row% = 6
  Col% = 37

  DO
    FOR co% = 17 TO 21
       LOCATE co%, 14: PRINT CHR$(186)
       LOCATE co%, 68: PRINT CHR$(186)
    NEXT

    LOCATE 16, 14: PRINT STRING$(55, 205)
    LOCATE 17, 16: PRINT "CUDE uses the following Stress-Energy Equations:"
    LOCATE 19, 22: PRINT "G*s = a*(s*h/t)^3 +b*(s*h/t)^2 + c*(s*h/t)+ d"
    LOCATE 20, 16: PRINT "or:"
    LOCATE 21, 22: PRINT "G*s = a*exp[b*s*h/t] + c"
    LOCATE 22, 14: PRINT STRING$(55, 205)
    LOCATE 16, 14: PRINT CHR$(201)
    LOCATE 22, 14: PRINT CHR$(200)
    LOCATE 16, 68: PRINT CHR$(187)
    LOCATE 22, 68: PRINT CHR$(188)

    COLOR BackC%, TextC%
    LOCATE 23, 22: PRINT " Please Enter the Values or Q to quit. "
    COLOR TextC%, BackC%



    LOCATE 3
    PRINT SPC(Sp%); "******* Data Input Screen for Stress-Energy Curve *******"
    LOCATE Row%
    PRINT SPC(Sp%); "Cushion Name:       ..."
    PRINT SPC(Sp%); "Impact(s):          ..."; TAB(62); "1st/2-5"
```

```
PRINT SPC(Sp%); "Density:          ..."; TAB(62); "pcf"
PRINT SPC(Sp%); "Parameter a:      ..."
PRINT SPC(Sp%); "Parameter b:      ..."
PRINT SPC(Sp%); "Parameter c:      ..."
PRINT SPC(Sp%); "Parameter d:      ..."
PRINT SPC(Sp%); "Final Stress      ..."; TAB(62); "psi"

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ <> "" THEN
    Name$(N + 1) = R$
    LOCATE Row%, Col%: PRINT " "; Name$(N + 1); TAB(61); N + 1; "#"
    Row% = Row% + 1
    EXIT DO

   END IF
LOOP

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ <> "" THEN
    Impact$(N + 1) = R$
    LOCATE Row%, Col%: PRINT " "; Impact$(N + 1)
    Row% = Row% + 1
    EXIT DO
   END IF
LOOP
DO
   LOCATE Row%, Col%: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ <> "" THEN
    Density$(N + 1) = R$
    LOCATE Row%, Col%: PRINT " "; Density$(N + 1)
    Row% = Row% + 1
    EXIT DO
   END IF
LOOP

DO
   LOCATE Row%, Col%: INPUT "", R$
   IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
   IF R$ <> "" AND R$ <> "0" AND LEFT$(R$, 1) <> "-" THEN
    CALL Number.CK(R$, R)
```

```
      a(N + 1) = R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; a(N + 1)
      Row% = Row% + 1
      EXIT DO
    ELSEIF LEFT$(R$, 1) = "-" THEN
      R$ = MID$(R$, 2)
      CALL Number.CK(R$, R)
      a(N + 1) = -R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; a(N + 1)
      Row% = Row% + 1
      EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    IF R$ <> "" AND R$ <> "0" AND LEFT$(R$, 1) <> "-" THEN
      CALL Number.CK(R$, R)
      b(N + 1) = R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; b(N + 1)
      Row% = Row% + 1
      EXIT DO
    ELSEIF LEFT$(R$, 1) = "-" THEN
      R$ = MID$(R$, 2)
      CALL Number.CK(R$, R)
      b(N + 1) = -R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; b(N + 1)
      Row% = Row% + 1
      EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    IF R$ <> "" AND LEFT$(R$, 1) <> "-" THEN
      CALL Number.CK(R$, R)
      c(N + 1) = R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; c(N + 1)
      Row% = Row% + 1
      EXIT DO
    ELSEIF LEFT$(R$, 1) = "-" THEN
      R$ = MID$(R$, 2)
      CALL Number.CK(R$, R)
```

```
      c(N + 1) = -R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; c(N + 1)
      Row% = Row% + 1
      EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    IF R$ <> "" AND LEFT$(R$, 1) <> "-" THEN
      CALL Number.CK(R$, R)
      d(N + 1) = R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; d(N + 1)
      Row% = Row% + 1
      EXIT DO
    ELSEIF LEFT$(R$, 1) = "-" THEN
      R$ = MID$(R$, 2)
      CALL Number.CK(R$, R)
      d(N + 1) = -R
      LOCATE Row%, Col%: PRINT USING " #####.#####"; d(N + 1)
      Row% = Row% + 1
      EXIT DO
    END IF
LOOP

DO
    LOCATE Row%, Col%: INPUT "", R$
    IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    IF R$ <> "" THEN
      CALL Number.CK(R$, R)
      IF R <> 0 THEN
        fs(N + 1) = R
        LOCATE Row%, Col%: PRINT USING " #####.#####"; fs(N + 1)
        Row% = 6
        EXIT DO
      END IF
    END IF
LOOP

LOCATE 17, 15: PRINT "                                    "
LOCATE 19, 20: PRINT "                                     "
LOCATE 20, 15: PRINT "                                     "
LOCATE 22, 15: PRINT "                                     "
```

```
    LOCATE 17, 25: PRINT "Are These All Correct? ( Y ) "
    LOCATE 19, 25: PRINT "                          "
    LOCATE 21, 28: PRINT "                          "

    LOCATE 17, 50: INPUT "", R$

    IF UCASE$(R$) = "Q" THEN CLS : EXIT SUB
    IF UCASE$(R$) <> "N" THEN
      LOCATE 20, 25: PRINT "                        "
      N = N + 1
      EXIT DO
    END IF
  CLS
  LOOP
  CLS
  LOCATE 12, 20: PRINT "Add Them To Cushion Data File ? ( Y )"
  LOCATE 12, 54: INPUT "", R$
  IF UCASE$(R$) = "Y" OR R$ = "" THEN
   OPEN "CUDE.DAT" FOR APPEND AS #1
   WRITE #1, Name$(N), Impact$(N), Density$(N), a(N), b(N), c(N), d(N), fs(N)
   CLOSE #1
  END IF
  CLS
END SUB

SUB Input.Spe.Curve
    '*** Input Data Screen for Spesific Thickness Cushion Curves
SHARED N
CLS
  Sp% = 15
  Row% = 8
  Col% = 40
  CALL View.Data.File
  DO
    CLS
    LOCATE 3
    PRINT SPC(Sp%); "******* Data Input Screen for Cushion Curves *******"
    LOCATE Row%
    PRINT SPC(Sp%); "Material (#):                    #"
    PRINT SPC(Sp%); "Thickness:                       in"

    DO
       LOCATE Row%, Col%: INPUT "", R$
       IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
       CALL Number.CK(R$, R)
```

```
        IF R >= 1 AND R <= N THEN
            i = R
            LOCATE Row%, Col%
            PRINT Name$(i); " "; Impact$(i); " Impact(s)"; i; "#"
            Row% = Row% + 1
            EXIT DO
        ELSE
            LOCATE 22, 15
            PRINT "The Material is not available, Try One More Time."
            BEEP: SLEEP
            LOCATE 22, 15
            PRINT "                                                  "
        END IF

    LOOP
    DO
        LOCATE Row%, Col%: INPUT "", R$
        IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
        CALL Number.CK(R$, R)
        IF R <> 0 THEN
            t = R
            LOCATE Row%, Col%: PRINT USING " ##.##"; t
            Row% = Row% + 1
            EXIT DO
        END IF
    LOOP

    LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
    LOCATE 20, 50: INPUT "", R$
    IF UCASE$(R$) <> "N" THEN
        EXIT DO
    END IF
    LOCATE 20, 25: PRINT "                                  "
  LOOP
  CALL Curve.Spe.T(i, t)
  CLS
END SUB

SUB Input.Std.Curve

        '*** Input Data for Ploting Cushioning Curve
SHARED N
CLS
  Sp% = 15
  Row% = 8
```

```
    Col% = 40
    CALL View.Data.File
    DO
      CLS
      LOCATE 3
      PRINT SPC(Sp%); "****** Data Input Screen for Cushion Curves ******"
      LOCATE Row%
      PRINT SPC(Sp%); "Material (#):                              #"

      DO
         LOCATE Row%, Col%: INPUT "", R$
         IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
         CALL Number.CK(R$, R)
         IF R > 0 AND R <= N THEN
            i = R
            LOCATE Row%, Col%
            PRINT Name$(i); " "; Impact$(i); " Impact(s)"; i; "#"
            Row% = Row% + 1
            EXIT DO
         ELSE
            LOCATE 22, 15
            PRINT "The Material is not available, Try One More Time."
            BEEP: SLEEP
            LOCATE 22, 15
            PRINT "                                          "
         END IF

      LOOP

      LOCATE 20, 25: PRINT "Are These All Correct? ( Y ) "
      LOCATE 20, 50: INPUT "", R$
      IF UCASE$(R$) <> "N" THEN
         EXIT DO
      END IF
      LOCATE 20, 25: PRINT "                              "
   LOOP
CALL Curves.Graphic(i)
END SUB

SUB List.File
              ' *** List Files in Working Directory
    CLS
    SHELL "dir/p"
    CALL Hit.any.key
    CLS
```

```
END SUB

SUB Menu.Compu.Design
        '*** Computer Cushion Design Menu
CLS
DO

   LOCATE 4, 20: PRINT "***** Computer Design Menu *****"
   LOCATE 7, 20: PRINT "1   One Face Cushion Design"
   LOCATE 8, 20: PRINT "2   Six Face Cushion Design"
   LOCATE 9, 20: PRINT "3   Help"

   LOCATE 12, 20: PRINT "9   Quit"

   LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
   LOCATE 15, 43: INPUT "", s$

   SELECT CASE UCASE$(s$)
   CASE "1", "O"
      CALL Input.1.Design
   CASE "2", "S"
      CALL Input.6.Design
   CASE "3", "H", "?"
      CALL Help.CUDE
   CASE "9", "Q", ""
      CLS : EXIT DO
   CASE ELSE
      CALL Case.Else
   END SELECT
LOOP
END SUB

SUB Menu.Generate.Data
        '*** Generate Cushion Date Menu
CLS
DO

   LOCATE 2, 20: PRINT "******* Cushion Data Menu *******"
   LOCATE 6, 20: PRINT "1   Cushion Curves"
   LOCATE 7, 20: PRINT "2   Specific Thickness Curves"
   LOCATE 8, 20: PRINT "3   Input Stress-Energy Data"
   LOCATE 9, 20: PRINT "4   Help"

   LOCATE 12, 20: PRINT "9   Quit"
```

```
    LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
    LOCATE 15, 43: INPUT "", s$

    SELECT CASE UCASE$(s$)
    CASE "1", "C"
       CALL Input.Std.Curve
    CASE "2", "S"
       CALL Input.Spe.Curve
    CASE "3", "I"
        CALL Input.SE.Data
    CASE "5", "H"
       CALL Help.CUDE
    CASE "9", "Q", "E", ""
       CLS : EXIT DO
    CASE ELSE
       CALL Case.Else
    END SELECT
LOOP

END SUB

SUB Menu.Option
       ' Option Control Manu
CLS
DO
    LOCATE 2, 20: PRINT "******* Option Menu *******"
    LOCATE 5, 20: PRINT "1   Change Screen Color"
    LOCATE 6, 20: PRINT "2   DOS Shell"
    LOCATE 7, 20: PRINT "3   List Files"
    LOCATE 8, 20: PRINT "4   Infor ..."
    LOCATE 9, 20: PRINT "5   Help"

    LOCATE 12, 20: PRINT "9   Quit"

    LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
    LOCATE 15, 43: INPUT "", s$
    SELECT CASE UCASE$(s$)
    CASE "1", "C"
       CALL Screen.Color
    CASE "2", "D"
       CALL DOS
    CASE "3", "I", "L"
       CALL List.File
    CASE "4", "I"
       CALL Info
```

```
    CASE "5", "H", "?"
       CALL Help.CUDE
    CASE "9", "Q", "E", ""
       CLS : EXIT DO
    CASE ELSE
       CALL Case.Else
    END SELECT
LOOP
END SUB

SUB Menu.User.Design
          '*** User Cushion Design Menu
CLS
DO

    LOCATE 2, 20: PRINT "**** User Design Menu ****"
    LOCATE 5, 20: PRINT "1   Material Design"
    LOCATE 6, 20: PRINT "2   Thickness Design"
    LOCATE 7, 20: PRINT "3   Bearing Area Design"
    LOCATE 8, 20: PRINT "4   All of Above Parameters"
    LOCATE 9, 20: PRINT "5   Help"

    LOCATE 12, 20: PRINT "9   Quit"

    LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
    LOCATE 15, 43: INPUT "", s$

    SELECT CASE UCASE$(s$)
    CASE "1", "M"
      CALL Input.D.Material
    CASE "2", "T"
      CALL Input.D.Thickness
    CASE "3", "B"
      CALL Input.D.Area
    CASE "4", "A"
      CALL Input.D.All
    CASE "5", "H", "?"
      CALL Help.CUDE
    CASE "9", "Q", "E", ""
      CLS : EXIT DO
    CASE ELSE
      CALL Case.Else
    END SELECT
LOOP
```

```
END SUB

SUB Menu.View.Data

        ' Submenu for view available cuahion materials
CLS
DO
 CLS
    LOCATE 5, 20: PRINT "*** View Material Menu ***"
    LOCATE 7, 20: PRINT "1    Brief View"
    LOCATE 8, 20: PRINT "2    Detail View"
    LOCATE 9, 20: PRINT "3    Help"

    LOCATE 12, 20: PRINT "9    Quit"

    LOCATE 15, 20: PRINT "Enter Your Selection ( Q )"
    LOCATE 15, 43: INPUT "", s$
    SELECT CASE UCASE$(s$)
    CASE "1", "B"
       CALL View.Data.File
    CASE "2", "D"
       CALL Detail.Data
    CASE "3", "H", "?"
       CALL Help.CUDE
    CASE "9", "Q", "E", ""
       CLS : EXIT DO
    CASE ELSE
       CALL Case.Else
    END SELECT
LOOP
END SUB

SUB message (F, h)
              ' ** Output Low G  Message
    LOCATE 20, 20: PRINT "Expected Too Low G, No Solution!"
    LOCATE 21, 20: PRINT " G="; F; "   Drop Height= "; h
    BEEP: SLEEP
    LOCATE 20, 20: PRINT "                                  "
    LOCATE 21, 20: PRINT "                                  "
END SUB

SUB Number.CK (R$, R)
SHARED TextC%, BackC%
              '*** Check Numbers
```

```
    R = 0
    IF ASC(R$) = 47 OR ASC(R$) > 57 OR ASC(R$) < 46 THEN
       LOCATE 23, 30: COLOR 4, 7
       BEEP: BEEP
       PRINT "  A Number, Please!  "
       COLOR TextC%, BackC%
    ELSE
       LOCATE 23, 30
       PRINT "                    "
       R = VAL(R$)        'Convert to a Number
    END IF
END SUB

SUB Pause
SHARED TextC%, BackC%
                  '*** Pause the screen
    LOCATE 25, 25
    COLOR 0, 7
    PRINT " Hit any key to continue! ";
    DO: LOOP UNTIL INKEY$ <> ""
    COLOR TextC%, BackC%
    CLS
    LOCATE 1, 30
    PRINT " Continued "
    PRINT
END SUB

SUB Screen.Color
       '***     Changes Screen Color or Other Settings
SHARED TextC%, BackC%
    CLS
    CALL Show.Color
    LOCATE 3, 45: PRINT "Current Text Color:       "; TextC%
    LOCATE 4, 45: PRINT "Current Background Color: "; BackC%
    LOCATE 19, 45: PRINT "ENTER or F9 Keeps Current Colors."
    DO
       LOCATE 10, 45: INPUT "Text Color: ", R$
       IF R$ = "" OR UCASE$(R$) = "Q" THEN CLS : EXIT SUB
       IF ASC(R$) > 57 OR ASC(R$) < 48 THEN
          LOCATE 18, 45: COLOR 4, 7
          BEEP: BEEP: PRINT "  A Number, Please!  "
          COLOR TextC%, BackC%
       ELSE
          t% = VAL(R$)
          LOCATE 10, 56: PRINT t%
```

```
            EXIT DO
        END IF
    LOOP
    DO
        LOCATE 11, 45: INPUT "Background Color: ", R$
        IF R$ = "" OR UCASE$(R$) = "Q" THEN
            b% = BackC%
            EXIT DO
        END IF
        IF ASC(R$) > 57 OR ASC(R$) < 48 THEN
            LOCATE 18, 45: COLOR 4, 7
            BEEP: BEEP: PRINT "  A Number, Please!  "
            COLOR TextC%, BackC%
        ELSE
            b% = VAL(R$)
            LOCATE 11, 62: PRINT b%
            EXIT DO
        END IF
    LOOP
    IF t% = b% THEN
        CLS : LOCATE 12, 10
        PRINT "Background and Text Color are Same ! I Refuse  Setting them."
        TextC% = 7: BackC% = 0       ' Back to Default Color settings
        CALL Hit.any.key
        CLS
        EXIT SUB
    ELSE
        TextC% = t%: BackC% = b%
        COLOR TextC%, BackC%
    END IF
    CALL Hit.any.key
    CLS
    LOCATE 12, 20: PRINT "Save Changes to Disk? ( N )"
    LOCATE 12, 44: INPUT "", R$
    IF UCASE$(R$) <> "Y" THEN
        CLS
        EXIT SUB
    ELSE
        OPEN "CUDE.INI" FOR OUTPUT AS #1
        WRITE #1, TextC%, BackC%
        CLOSE #1
        CLS
    END IF
END SUB
```

```
SUB Show.Color
                '*** Display Screen Colors
SHARED TextC%, BackC%
SCREEN 0: WIDTH 80: CLS
COLOR BackC%, TextC%
LOCATE 2, 5: PRINT "  Available Colors  "
Col = 5: Row = 4
   FOR c% = 0 TO 15
      LOCATE Row, 2
      COLOR c%, 1, 0
      LOCATE Row, Col: PRINT STRING$(20, 219)
      LOCATE Row, 30: COLOR TextC%, BackC%: PRINT c%;

      Row = Row + 1
   NEXT c%
COLOR TextC%, BackC%
END SUB

SUB Solve.1.Face (Out$, F, h, P)
      ' ***  Select Cushion Material According to Minimum Thickness
      '              or Minimum Volume
SHARED N, L, W, Name$(), Impact$(), Density$(), a(), b(), c(), d(), fs()
SHARED Mt(), MtA(), Mvt(), MvA()

 CLS
 M = 1                'Screen Line Number
 G = F                'Input Fragility G
 Print.note = 0         'Switcher for Printing a Note, off
 ds = .05

      'Prompt Computer is Working on Printing Job or File
 IF Out$ <> "SCRN:" THEN CLS : LOCATE 12, 15: PRINT "I am working ..."

 OPEN Out$ FOR OUTPUT AS #1
 PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
 PRINT #1, SPC(12); "CUDE Report For One Face Design: Thickness &
Materials"
 PRINT #1,
 PRINT #1, SPC(23); "Protected G:        "; F; " g's"
 PRINT #1, SPC(23); "Drop Height:        "; h; " in"
 PRINT #1, SPC(23); "Product Weight:      "; P; " lbs"
 PRINT #1, SPC(23); "Face Area;"; L; "x"; W; ":  "; L * W; "in2"
 PRINT #1, SPC(10); STRING$(65, 61)
 PRINT #1, SPC(40); "Minimum Thickness  Minimum  Volume"
 PRINT #1, SPC(12); "No. Material     Impact(s)";
```

```
PRINT #1, SPC(3); "Thick.  Area    Thick.  Area"
PRINT #1, SPC(43); "in     in2     in     in2"
PRINT #1, SPC(11); STRING$(63, 45)
FOR j = 1 TO N                          'Loop Between Materials
  Flag = 0                            'Reset "Flag" for Minimum
  Mint = 0
  FOR s = P / (L * W) TO fs(j) STEP ds  'Loop from Minimum s to fs(j)
    IF d(j) = 0 THEN                  'Switch Between Models

      IF G * s > c(j) THEN          'Check Negative Number

        t = b(j) * h * s / (LOG(G * s - c(j)) - LOG(a(j)))

      END IF
    ELSE
            'Solve 3 order polynomial equation numerically
      PG = 5          'Set precision G = 5
      dt = .05        'Set loop step of t
      ft = 5          'Final Thickness
      IF Mint = 0 THEN
        FOR t = 1 TO ft STEP dt     'Thickness range: 1-5 in

          y = G - (a(j) * (s * h / t) ^ 3 + b(j) * (s * h / t) ^ 2 + c(j) * (s * h / t) +
d(j)) / s

          IF ABS(y) < PG THEN
            Mint = t
            EXIT FOR
          ELSE
            Mint = 0
          END IF
        NEXT t
      END IF
      IF Mint = 0 THEN
        t = -1          'No solution in current precisstion
      ELSE
        t = Mint
      END IF
      Mint = 0

    END IF

    IF t = -1 THEN
      Mt(j) = -1                  'Assign -1 to no solution
    ELSEIF t >= 0 THEN                'Thickness should > 0
```

```
        IF Flag = 0 THEN
           Mv = t * P / s              'Assign Minimum Values
           Mt(j) = t: Mvt(j) = t
           Ms = s: Mvs = s
           MtA(j) = P / Ms: MvA(j) = P / Mvs
           Flag = 1
        END IF
        IF Mt(j) > t THEN              'Find Minimum Thickness
           Mt(j) = t: Ms = s
           MtA(j) = P / Ms
        END IF
        v = t * P / s
        IF Mv > v THEN                 'Find Minimum Volume,
           Mv = v: Mvt(j) = t          'Thichness, Area
           Mvs = s: MvA(j) = P / Mvs
        END IF
     END IF
  NEXT s
NEXT j

Find.best = -1
FOR j = 1 TO N

  IF Find.best = -1 AND Mt(j) <> -1 THEN          'Assign Initial Value
     Best.T = Mt(j)
     best.no = j
     Find.best = 0
  END IF
  IF Best.T > Mt(j) AND Mt(j) <> -1 THEN          'Find Best Material
     Best.T = Mt(j): best.no = j
  END IF
  IF M = 10 AND Out$ = "SCRN:" THEN M = -6: CALL Pause 'Pause Screen
  M = M + 1
  IF Mt(j) = -1 THEN
     PRINT #1, TAB(12); USING "##"; j;
     PRINT #1, TAB(16); Name$(j); TAB(35); Impact$(j);
     PRINT #1, TAB(38); "    ******"; "  ******"; "   *******"; " *******"
     Print.note = -1
  ELSE
     PRINT #1, TAB(12); USING "##"; j;
     PRINT #1, TAB(16); Name$(j); TAB(35); Impact$(j);
     PRINT #1, TAB(38); USING "   ###.##"; Mt(j); MtA(j); Mvt(j); MvA(j)
  END IF
NEXT j
```

```
  PRINT #1,
  PRINT #1, SPC(12); "The Best Cushion Material:": PRINT #1,
  PRINT #1, TAB(12); USING "##"; best.no;
  PRINT #1, TAB(16); Name$(best.no); TAB(35); Impact$(best.no);
  PRINT #1, TAB(38); USING "   ###.##"; Mt(best.no); MtA(best.no);
Mvt(best.no); MvA(best.no)
  PRINT #1, SPC(10); STRING$(65, 61)
  PRINT #1, SPC(45); TIME$; SPC(10); DATE$: PRINT #1,
  IF Print.note = -1 THEN
    PRINT #1, SPC(12); " *****: CUDE can not find solution for this material."
  END IF
  CLOSE #1
  IF Out$ = "SCRN:" THEN CALL Hit.any.key
END SUB

SUB Solve.6.Face.File (Out$, Face%, h, P)

          'Save 6 Face Design Results to File

SHARED L, W, d, G(), a(), b(), c(), Name$(), Impact$(), Density$(), N
SHARED Mt(), MtA(), Mvt(), MvA()
CLS

ds = .05

       'Prompt Computer is Working on Printing Job or File

LOCATE 12, 15: PRINT "I am working ..."

FOR o% = 1 TO Face%
  OPEN Out$ FOR APPEND AS #1
  PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
  PRINT #1, SPC(15); "CUDE Report"; o%; ": Computer Designed Six Faces"
  PRINT #1, SPC(15); "Bearing Area & Minimum Thickness in Available
Materials"
  PRINT #1,
  IF o% = 1 THEN
      PRINT #1, SPC(23); "Top, Area:   "; L; "X"; W; "="; L * W; "in2"
  ELSEIF o% = 2 THEN
      PRINT #1, SPC(23); "Bottom, Area:"; L; "X"; W; "="; L * W; "in2"
  ELSEIF o% = 3 THEN
      PRINT #1, SPC(23); "Front, Area: "; L; "X"; d; "="; L * d; "in2"
  ELSEIF o% = 4 THEN
      PRINT #1, SPC(23); "Back, Area:  "; L; "X"; d; "="; L * d; "in2"
  ELSEIF o% = 5 THEN
```

```
    PRINT #1, SPC(23); "Left, Area:  "; W; "X"; d; "="; W * d; "in2"
ELSE
    PRINT #1, SPC(23); "Right, Area: "; W; "X"; d; "="; W * d; "in2"
END IF

PRINT #1, SPC(23); "Protected G in the Face:  "; G(o%); "  G's"
PRINT #1, SPC(23); "Drop Height:              "; h; "  in"
PRINT #1, SPC(23); "Product Weight:           "; P; "  lbs"
PRINT #1, SPC(23); "L X W X D:"; L; "x"; W; "x"; d; " ="; L * W * d; "in3"
PRINT #1, SPC(8); STRING$(67, 61)
PRINT #1, SPC(40); "Minimum Thickness  Minimum  Volume"
PRINT #1, SPC(11); "No. Material      Impact(s)";
PRINT #1, SPC(3); "Thick.   Area     Thick.   Area"
PRINT #1, SPC(43); "in      in2       in      in2"
PRINT #1, SPC(10); STRING$(63, 45)
Flag = 0
Print.note = 0          'Switcher for Printing a Note, off
M = 1                   'Screen Number
FOR j = 1 TO N          'Loop Between Materials
  Flag = 0              'Reset "Flag" for Minimum
  Mint = 0
  FOR s = P / (L * W) TO fs(j) STEP ds  'Loop from Minimum s to fs(j)
    IF d(j) = 0 THEN                    'Switch Between Models

      IF G(o%) * s > c(j) THEN          'Check Negative Number

        t = b(j) * h * s / (LOG(G(o%) * s - c(j)) - LOG(a(j)))

      END IF
    ELSE
                'Solve 3 order polynomial equation numerically
      PG = 5            'Set precision G = 5
      dt = .05          'Set loop step of t
      ft = 5            'Final Thickness
      IF Mint = 0 THEN
        FOR t = 1 TO ft STEP dt     'Thickness range: 1-5 in

          y = G(o%) - (a(j) * (s * h / t) ^ 3 + b(j) * (s * h / t) ^ 2 + c(j) * (s * h / t)
+ d(j)) / s

          IF ABS(y) < PG THEN
            Mint = t
            EXIT FOR
          ELSE
            Mint = 0
```

```
            END IF
          NEXT t
        END IF

        IF Mint = 0 THEN
           t = -1          'No solution in current precisstion
        ELSE
           t = Mint
        END IF
        Mint = 0

      END IF

      IF t = -1 THEN
         Mt(j) = -1                  'Assign -1 to no solution
      ELSEIF t >= 0 THEN                   'Thickness should > 0
         IF Flag = 0 THEN
            Mv = t * P / s            'Assign Minimum Values
            Mt(j) = t: Mvt(j) = t
            Ms = s: Mvs = s
            MtA(j) = P / Ms: MvA(j) = P / Mvs
            Flag = 1
         END IF
         IF Mt(j) > t THEN             'Find Minimum Thickness
            Mt(j) = t: Ms = s
            MtA(j) = P / Ms
         END IF
         v = t * P / s
         IF Mv > v THEN                'Find Minimum Volume,
            Mv = v: Mvt(j) = t         'Thichness, Area
            Mvs = s: MvA(j) = P / Mvs
         END IF
      END IF
  NEXT s
NEXT j

Find.best = -1
FOR j = 1 TO N

  IF Find.best = -1 AND Mt(j) <> -1 THEN       'Assign Initial Value
     Best.T = Mt(j)
     best.no = j
     Find.best = 0
  END IF
  IF Best.T > Mt(j) AND Mt(j) <> -1 THEN        'Find Best Material
```

```
        Best.T = Mt(j): best.no = j
    END IF
    IF Mt(j) = -1 THEN
        PRINT #1, TAB(10); USING "##"; j;
        PRINT #1, TAB(14); Name$(j); TAB(35); Impact$(j);
        PRINT #1, TAB(38); "    ******"; "  ******"; "    *******"; "  *******"
        Print.note = -1
    ELSE
        PRINT #1, TAB(10); USING "##"; j;
        PRINT #1, TAB(14); Name$(j); TAB(35); Impact$(j);
        PRINT #1, TAB(38); USING "   ###.##"; Mt(j); MtA(j); Mvt(j); MvA(j)
    END IF
  NEXT j

  PRINT #1,
  PRINT #1, SPC(12); "The Best Cushion Material:": PRINT #1,
  PRINT #1, TAB(10); USING "##"; best.no;
  PRINT #1, TAB(14); Name$(best.no); TAB(35); Impact$(best.no);
  PRINT #1, TAB(38); USING "   ###.##"; Mt(best.no); MtA(best.no);
Mvt(best.no); MvA(best.no)
  PRINT #1, SPC(8); STRING$(67, 61)
  PRINT #1, SPC(45); TIME$; SPC(10); DATE$: PRINT #1,
  IF Print.note = -1 THEN
    PRINT #1, SPC(12); " *****: CUDE can not find solution for this material."
  END IF
  PRINT #1, : PRINT #1, : PRINT #1,
  CLOSE #1
NEXT o%

END SUB

SUB Solve.6.Faces (Out$, Face%, h, P)

          'Select Material For 6 Face Design

SHARED L, W, d, G(), a(), b(), c(), Name$(), Impact$(), Density$(), N
SHARED Mt(), MtA(), Mvt(), MvA()
CLS
ds = .05

FOR o% = 1 TO Face%
  OPEN Out$ FOR OUTPUT AS #1
  PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
  PRINT #1, SPC(15); "CUDE Report"; o%; ": Computer Designed Six Faces"
```

```
 PRINT #1, SPC(15); "Bearing Area & Minimum Thickness in available
Materials"
 PRINT #1,
 IF o% = 1 THEN
     PRINT #1, SPC(23); "Top, Area:   "; L; "X"; W; "="; L * W; "in2"
 ELSEIF o% = 2 THEN
     PRINT #1, SPC(23); "Bottom, Area:"; L; "X"; W; "="; L * W; "in2"
 ELSEIF o% = 3 THEN
     PRINT #1, SPC(23); "Front, Area: "; L; "X"; d; "="; L * d; "in2"
 ELSEIF o% = 4 THEN
     PRINT #1, SPC(23); "Back, Area:  "; L; "X"; d; "="; L * d; "in2"
 ELSEIF o% = 5 THEN
     PRINT #1, SPC(23); "Left, Area:  "; W; "X"; d; "="; W * d; "in2"
 ELSE
     PRINT #1, SPC(23); "Right, Area: "; W; "X"; d; "="; W * d; "in2"
 END IF

 PRINT #1, SPC(23); "Protected G in the Face:  "; G(o%); "  G's"
 PRINT #1, SPC(23); "Drop Height:              "; h; "  in"
 PRINT #1, SPC(23); "Product Weight:           "; P; "  lbs"
 PRINT #1, SPC(23); "L X W X D:"; L; "x"; W; "x"; d; " ="; L * W * d; "in3"
 PRINT #1, SPC(8); STRING$(67, 205)
 PRINT #1, SPC(40); "Minimum Thickness  Minimum  Volume"
 PRINT #1, SPC(11); "No.  Material     Impact(s)";
 PRINT #1, SPC(3); "Thick.  Area    Thick.  Area"
 PRINT #1, SPC(43); "in     in2      in      in2"
 PRINT #1, SPC(10); STRING$(63, 196)
 Flag = 0
 Print.note = 0          'Switcher for Printing a Note, off
 M = 1                   'Screen Number
 FOR j = 1 TO N          'Loop Between Materials
   Flag = 0              'Reset "Flag" for Minimum
   Mint = 0
   FOR s = P / (L * W) TO fs(j) STEP ds    'Loop from Minimum s to fs(j)
      IF d(j) = 0 THEN                     'Switch Between Models

         IF G(o%) * s > c(j) THEN          'Check Negative Number

            t = b(j) * h * s / (LOG(G(o%) * s - c(j)) - LOG(a(j)))

         END IF
      ELSE
                'Solve 3 order polynomial equation numerically

         PG = 5          'Set precision G = 5
```

```
        dt = .05          'Set loop step of t
        ft = 5            'Final Thickness
        IF Mint = 0 THEN
          FOR t = 1 TO ft STEP dt     'Thickness range: 1-5 in

            y = G(o%) - (a(j) * (s * h / t) ^ 3 + b(j) * (s * h / t) ^ 2 + c(j) * (s * h / t)
+ d(j)) / s

            IF ABS(y) < PG THEN
               Mint = t
               EXIT FOR
            ELSE
               Mint = 0
            END IF
          NEXT t
        END IF

       IF Mint = 0 THEN
          t = -1          'No solution in current precisstion
        ELSE
          t = Mint
        END IF
        Mint = 0

    END IF

    IF t = -1 THEN
       Mt(j) = -1                  'Assign -1 to no solution
    ELSEIF t >= 0 THEN                    'Thickness should > 0
       IF Flag = 0 THEN
          Mv = t * P / s           'Assign Minimum Values
          Mt(j) = t: Mvt(j) = t
          Ms = s: Mvs = s
          MtA(j) = P / Ms: MvA(j) = P / Mvs
          Flag = 1
        END IF
        IF Mt(j) > t THEN           'Find Minimum Thickness
          Mt(j) = t: Ms = s
          MtA(j) = P / Ms
        END IF
        v = t * P / s
        IF Mv > v THEN              'Find Minimum Volume,
          Mv = v: Mvt(j) = t        'Thichness, Area
          Mvs = s: MvA(j) = P / Mvs
        END IF
```

```
      END IF
    NEXT s
  NEXT j

  Find.best = -1
  FOR j = 1 TO N

    IF Find.best = -1 AND Mt(j) <> -1 THEN        'Assign Initial Value
       Best.T = Mt(j)
       best.no = j
       Find.best = 0
    END IF
    IF Best.T > Mt(j) AND Mt(j) <> -1 THEN         'Find Best Material
       Best.T = Mt(j): best.no = j
    END IF
    IF M = 10 THEN M = -5: CALL Pause'Pause Screen
    M = M + 1
    IF Mt(j) = -1 THEN
       PRINT #1, TAB(10); USING "##"; j;
       PRINT #1, TAB(14); Name$(j); TAB(35); Impact$(j);
       PRINT #1, TAB(38); "    *****"; "  *****"; "   *******"; " *******"
       Print.note = -1
    ELSE
       PRINT #1, TAB(10); USING "##"; j;
       PRINT #1, TAB(14); Name$(j); TAB(35); Impact$(j);
       PRINT #1, TAB(38); USING "   ###.##"; Mt(j); MtA(j); Mvt(j); MvA(j)
    END IF
  NEXT j

  PRINT #1,
  PRINT #1, SPC(12); "The Best Cushion Material:": PRINT #1,
  PRINT #1, TAB(10); USING "##"; best.no;
  PRINT #1, TAB(14); Name$(best.no); TAB(35); Impact$(best.no);
  PRINT #1, TAB(38); USING "   ###.##"; Mt(best.no); MtA(best.no);
Mvt(best.no); MvA(best.no)
  PRINT #1, SPC(8); STRING$(67, 205)
  PRINT #1, SPC(45); TIME$; SPC(10); DATE$: PRINT #1,
  IF Print.note = -1 THEN
    PRINT #1, SPC(12); " *****: CUDE can not find solution for this material."
  END IF
  PRINT #1, : PRINT #1, : PRINT #1,
  CLOSE #1
  CALL Hit.any.key
NEXT o%
END SUB
```

```
FUNCTION User.D.All.exp (W, h, t, Area, i)
        ' **   User design all cushion parameters using Exponential Model

    SHARED a(), b(), c()
    IF Area <= 0 OR W <= 0 THEN        'Check Area<=0
        EXIT FUNCTION
    END IF
    s = W / Area
    User.D.All.exp = (a(i) * EXP(b(i) * s * h / t) + c(i)) / s
END FUNCTION

FUNCTION User.D.All.pol! (W, h, t, Area, i)
        ' **   User design all cushion parameters using Polynomial Model

    IF Area <= 0 OR W <= 0 THEN        'Check Area<=0
        EXIT FUNCTION
    END IF
    s = W / Area

    User.D.All.pol = (a(i) * (h * s / t) ^ 3 + b(i) * (h * s / t) ^ 2 + c(i) * h * s / t + d(i)) /
s

END FUNCTION

SUB User.D.Area (Out$, F, h, P, Area)
      '*** Solve Materials & Thickness for User Design Area
SHARED N, t(), Name$(), Impact$(), Density$(), a(), b(), c(), d()
  CLS
  s = P / Area
  G = F

        'Prompt Computer is Working on Printing Job or File
  IF Out$ <> "SCRN:" THEN CLS : LOCATE 12, 15: PRINT "I am working ..."

  OPEN Out$ FOR OUTPUT AS #1
  PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
  PRINT #1, SPC(16); "CUDE Report: Thickness & G in Available Materials "
  PRINT #1,
  PRINT #1, SPC(20); "User Designed Bearing Area:"; TAB(50); Area; TAB(58);
"Sq.in "
  PRINT #1, SPC(20); "Static stress:"; TAB(50);
  PRINT #1, USING "  #.##"; s;
  PRINT #1, TAB(58); "psi"
  PRINT #1, SPC(20); "Drop Height:"; TAB(50); h; TAB(58); "in"
```

```
PRINT #1, SPC(20); "Protected G:"; TAB(50); F; TAB(58); "G's"
PRINT #1, SPC(20); "Product Weight:"; TAB(50); P; TAB(58); "lbs"
PRINT #1, SPC(15); STRING$(54, 61)
PRINT #1, SPC(17); "No."; SPC(5); "Material       Impact(s) ";
PRINT #1, SPC(6); "Thickness"
PRINT #1, SPC(60); "in"
PRINT #1, SPC(16); STRING$(52, 45)

j = 1                        'Control Screen Page
note% = 0                        'switch print notes is off
Flag% = 1                        'Switch is on for initial Minimum Thickness
FOR i = 1 TO N                    'Loop in All available Materials

  IF d(i) = 0 THEN

     IF G * s - c(i) = a(i) THEN
        t(i) = -1                'Filt out dividing 0,  assign -1 to t
     ELSE                         'Solve thickness
        t(i) = b(i) * h * s / (LOG(G * s - c(i)) - LOG(a(i)))
     END IF

  ELSE                'Solve 3 order polynomial equation numerically

    PG = 2            'Set precision G = 2
    dt = .01          'Set loop step of t
    ft = 5           'Final Thickness

    FOR t = 1 TO ft STEP dt     'Thickness range: 0.1" - 5"

      y = G - (a(i) * (s * h / t) ^ 3 + b(i) * (s * h / t) ^ 2 + c(i) * (s * h / t) + d(i)) / s

      IF ABS(y) < PG THEN
      Mint = t
      END IF
    NEXT t
    IF Mint = 0 THEN
      t(i) = -1
    ELSE
      t(i) = Mint
    END IF
    Mint = 0

  END IF

  IF Out$ = "SCRN:" AND j = 13 THEN j = -8: CALL Pause
```

```
    PRINT #1, SPC(16);
    PRINT #1, USING "###"; i;
    PRINT #1, TAB(25); Name$(i); TAB(45); Impact$(i);

    IF t(i) > 0 THEN
       PRINT #1, TAB(57); USING " ####.##"; t(i)
       IF Flag% = 1 THEN
          Min.T = t(i): No = i: Flag% = 0
       END IF
       IF Min.T > t(i) THEN Min.T = t(i): No = i
    ELSE
       PRINT #1, TAB(57); "    **** "
       note% = 1      'switch is on for nosoulution message
    END IF
    j = j + 1
  NEXT
  IF No <> 0 THEN
    PRINT #1,
    PRINT #1, SPC(16); "The Best Material & Thickness For This Design:"
    PRINT #1,
    PRINT #1, SPC(16); USING "###"; No;
    PRINT #1, TAB(25); Name$(No); TAB(45); Impact$(No);
    PRINT #1, TAB(57); USING " ####.##"; t(No)
  END IF
  PRINT #1, SPC(15); STRING$(54, 61)
  PRINT #1, SPC(37); TIME$; SPC(10); DATE$: PRINT #1,
  IF note% = 1 THEN PRINT #1, SPC(17); "Note:  **** means no solution."
  CLOSE #1
  IF Out$ <> "SCRN:" THEN LOCATE 12, 35: PRINT "Done !"
END SUB

SUB User.D.Material (Out$, F, h, P, i)
        '*** User Select the Cushion Material
    SHARED N, L, W, a(), b(), c(), d(), fs(), Name$(), Impact$(), Density$()
    CLS
    IF Out$ <> "SCRN:" THEN LOCATE 12, 20: PRINT "I am working ..."
    OPEN Out$ FOR OUTPUT AS #1
    PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
    PRINT #1, SPC(19); "CUDE Report: Minimum Cushion Thickness & Area "
    PRINT #1,
    PRINT #1, SPC(22); "User Designed: "; Name$(i); "; ";
    PRINT #1, Impact$(i); "  Impact(s)"
    PRINT #1, SPC(37); "Density = "; Density$(i); " pcf"
    PRINT #1, SPC(22); "Drop Height:"; h; "in"
    PRINT #1, SPC(22); "Weight:"; P; "lbs"
```

```
PRINT #1, SPC(22); "Face Area:"; "("; L; "x"; W; ") ="; L * W; "sq.in"
PRINT #1, SPC(17); STRING$(48, 61)
PRINT #1, SPC(17); "        Minimum Thickness  :  Minimum Volume"
PRINT #1, SPC(17); "    G    Thickness    Area :  Thickness Area"
PRINT #1, SPC(17); "   g's       in       in2  :    in      in2"
PRINT #1, SPC(19); STRING$(45, 45)
j = 1                          'Control Screen Page
FOR G = F TO 10 STEP -10             'Loop form Input G to Minimum G
   Flag = 0                    'Reset "Flag" for Minimum Values

    FOR s = P / (L * W) TO fs(i) STEP .1    'Loop from Minimum s to 3

     IF d(i) = 0 THEN
      IF G * s > c(i) THEN           'Check Negative Input to LOG

       t = b(i) * h * s / (LOG(G * s - c(i)) - LOG(a(i)))

       IF t >= 0 THEN                'Thickness should > 0
          IF Flag = 0 THEN
             Mv = t * P / s        'Assign Minimum Values
             Mt = t: Mvt = t
             Ms = s: Mvs = s
             MtA = P / Ms: MvA = P / Mvs
             Flag = 1
          END IF
          IF Mt > t THEN            'Find Minimum Thickness
             Mt = t: Ms = s
             MtA = P / Ms
          END IF
          v = t * P / s
          IF Mv > v THEN            'Find Minimum Volume,
             Mv = v: Mvt = t      'Thichness, Area
             Mvs = s: MvA = P / Mvs
          END IF
       END IF
      END IF
    ELSE

            'Solve 3 order polynomial equation numerically

      PG = 4             'Set precision G = 4
      dt = .1          'Set loop step of t
      ft = 8           'Final Thickness

      FOR t = .2 TO ft STEP dt      'Thickness range: 0.1-8 in
```

```
            y = G - (a(i) * (s * h / t) ^ 3 + b(i) * (s * h / t) ^ 2 + c(i) * (s * h / t) +
d(i)) / s

            IF ABS(y) < PG THEN
               Mint = t
            END IF
            NEXT t
            IF Mint = 0 THEN
               t = -1
            ELSE
               t = Mint
            END IF
            Mint = 0

            IF t >= 0 THEN              'Thickness should > 0
               IF Flag = 0 THEN
                  Mv = t * P / s        'Assign Minimum Values
                  Mt = t: Mvt = t
                  Ms = s: Mvs = s
                  MtA = P / Ms: MvA = P / Mvs
                  Flag = 1
               END IF
               IF Mt > t THEN           'Find Minimum Thickness
                  Mt = t: Ms = s
                  MtA = P / Ms
               END IF
               v = t * P / s
               IF Mv > v THEN           'Find Minimum Volume,
                  Mv = v: Mvt = t       'Thichness, Area
                  Mvs = s: MvA = P / Mvs
               END IF
            END IF
         END IF
      NEXT s
      IF Out$ = "SCRN:" AND j = 11 THEN j = -10: CALL Pause
      IF Mt = -1 AND Mvt = -1 THEN
         PRINT #1, SPC(17); USING "  ####.##"; G

         'Need More Print !

      ELSE
         PRINT #1, SPC(17); USING "  ####.##"; G; Mt; MtA; Mvt; MvA
      END IF
      j = j + 1
```

```
    NEXT G
    PRINT #1, SPC(17); STRING$(48, 61)
    PRINT #1, SPC(40); TIME$; SPC(5); DATE$
    CLOSE #1
    IF Out$ <> "SCRN:" THEN LOCATE 12, 45: PRINT "Done !"
END SUB

SUB User.D.Thickness (Out$, F, h, P, t)
SHARED N, a(), b(), c(), d(), fs(), Name$(), Impact$()
    CLS
    Print.note = 0      'Set the print note swither off
    Precission = 2      'Set precision G = 2
    ds = .005           'Set loop step of s
    G = F               'Fragility G
    IF Out$ <> "SCRN:" THEN LOCATE 12, 20: PRINT "I am working ..."
    OPEN Out$ FOR OUTPUT AS #1
    PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
    PRINT #1, SPC(18); "CUDE Report: Bearing Area & Materials"
    PRINT #1,
    PRINT #1, SPC(25); "User Designed Thickness:  "; t; TAB(58); "inches"
    PRINT #1, SPC(25); "Protected G:              "; G; TAB(58); "G's"
    PRINT #1, SPC(25); "Drop Height:              "; h; TAB(58); "inches"
    PRINT #1, SPC(25); "Product Weight:             "; P; TAB(58); "lbs"
    PRINT #1, SPC(15); STRING$(55, 61)
    PRINT #1, SPC(18); "No."; SPC(4); "Materials       Impacts ";
    PRINT #1, SPC(11); "Area"
    PRINT #1, SPC(61); "in2"
    PRINT #1, SPC(16); STRING$(53, 45)

    Flag = 0
    j = 1
    FOR i = 1 TO N
    Max.S = 0
    FOR s = .2 TO fs(i) STEP ds      'Stress range: 0.2 - fs psi
      IF d(i) = 0 THEN

        y = G - (a(i) * EXP(b(i) * s * h / t) - c(i)) / s

      ELSE

   y = G - (a(i) * (s * h / t) ^ 3 + b(i) * (s * h / t) ^ 2 + c(i) * (s * h / t) + d(i)) / s

      END IF

      IF ABS(y) < Precission THEN Max.S = s
```

```
    NEXT s

    IF Out$ = "SCRN:" AND j = 9 THEN j = -10: CALL Pause
    IF Max.S = 0 THEN
        PRINT #1, SPC(16); USING " ##"; i;
        PRINT #1, TAB(25); Name$(i); TAB(45); Impact$(i);
        PRINT #1, TAB(62); "******"
        Print.note = -1
    ELSE
        PRINT #1, SPC(16); USING " ##"; i;
        PRINT #1, TAB(25); Name$(i); TAB(45); Impact$(i); TAB(60);
        PRINT #1, USING "####.##"; P / Max.S
    END IF
    IF Flag = 1 THEN            ' initial minimum
      Best.S = Max.S
      No = i
      Flag = 0
    END IF
    IF Best.S < Max.S THEN 'Find Min. Area and Material
      Best.S = Max.S: No = i
    END IF
    j = j + 1
    NEXT i
    PRINT #1,
    IF No <> 0 THEN
      PRINT #1, SPC(17); "The Best Material & Bearing Area:"
      PRINT #1,
      PRINT #1, SPC(16); USING " ##"; No;
      PRINT #1, TAB(25); Name$(No); TAB(45); Impact$(No); TAB(60);
      PRINT #1, USING "####.##"; P / Best.S
    END IF
    PRINT #1, SPC(15); STRING$(55, 61)
    PRINT #1, SPC(37); TIME$; SPC(10); DATE$: PRINT #1,
    IF Print.note = -1 THEN
        PRINT #1, SPC(17); "Note: ***** means no solution or CUDE can not find
it."
    END IF
    CLOSE #1
    IF Out$ <> "SCRN:" THEN LOCATE 12, 45: PRINT "Done !"
END SUB

SUB View.Data.File
SHARED N, a(), b(), c(), Name$(), Impact$(), Density$()
            '*** Displays available Cushion Materials
    CLS
```

```
    LOCATE 2, 25: PRINT "Available Cushion Materials in CUDE"
    PRINT : PRINT SPC(15); STRING$(55, 205)
    PRINT SPC(17); "No.     Materials          Impact      Density"
    PRINT TAB(63); "pcf"
    PRINT SPC(16); STRING$(53, 196)
    M = 1
    FOR j = 1 TO N
       IF j = 16 * M THEN M = M + 1: CALL Pause
          PRINT TAB(18); j; TAB(28); Name$(j); TAB(50); Impact$(j);
          PRINT TAB(61); Density$(j)
    NEXT
    PRINT SPC(15); STRING$(55, 205)

    LOCATE 23, 20: PRINT "Print ?     ( N ) "
    LOCATE 23, 35: INPUT "", P$
    IF UCASE$(P$) <> "Y" THEN CLS : EXIT SUB
    LOCATE 13, 20: PRINT "Printing Port: 1. LPT1; 2. LPT2 ( 1 )"
    LOCATE 13, 54: INPUT "", R$
    IF UCASE$(R$) = "" OR R$ = "1" THEN
       Out$ = "LPT1"
    ELSEIF UCASE$(R$) = "LPT2" OR R$ = "2" THEN
       Out$ = "LPT2"
    ELSE
       CLS : EXIT SUB
    END IF
    CLS
    LOCATE 12, 25: PRINT "I am Working ...."
    OPEN Out$ FOR OUTPUT AS #1
    PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1, : PRINT #1,
    PRINT #1, SPC(25); "Available Cushion Materials in CUDE"
    PRINT #1, : PRINT #1, SPC(15); STRING$(55, 61)
    PRINT #1, SPC(17); "No.     Materials          Impact      Density"
    PRINT #1, TAB(63); "pcf"
    PRINT #1, SPC(16); STRING$(53, 45)
    FOR j = 1 TO N
       PRINT #1, TAB(18); j; TAB(28); Name$(j); TAB(50); Impact$(j);
       PRINT #1, TAB(64); Density$(j)
    NEXT
    PRINT #1, SPC(15); STRING$(55, 61)
    PRINT #1, TAB(45); TIME$; SPC(5); DATE$
    CLOSE #1
    LOCATE 12, 45: PRINT "Done!"
    CLS
END SUB
```

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